Before writing the documentation of validation of a case test of Code_Aster one will refer obligatorily to document [A3.02.02-A].

Handbook of Validation
Booklet VN.NN: Heading of the booklet
Document: VN.NN.NNN

MODEL01 - Titrate case test (Model of one document of validation)

To respect the typography of the title. See [A3.02.02-A §4.2.3].

Summary:
To write a relevant summary.
See [A3.02.02-A §4.3]

1
Problem of reference

1.1 Geometry

1.2
Properties of material

1.3
Boundary conditions and loadings

1.4 Conditions
initial

2
Reference solution

2.1
Method of calculation
To respect the instructions of drafting of the formulas
mathematics in the documentation of
Code_Aster [D8.01.03-A]
2.2
Sizes and results of reference

2.3
Uncertainties on the solution

2.4 References
bibliographical
See the typography of drafting of
bibliography in [D8.01.01-A §12]

3 Modeling
With

3.1
Characteristics of modeling

3.2
Characteristics of the grid

3.3 Functionalities
tested
This table is a typographical model.
Noncontractual contents.

Orders

AFFE_CARA_ELEM
BEAM
SECTION
"GENERAL"
DISCRETE
K_T_D_L
"LOCAL"
DEFI_ARC
ORIE_ARC
ORIENTATION

CARA
"VECT_Y"
AFFE_CHAM_NO
"TEMP_R"
"TEMP"
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
DEFI_MATERIAU
ELAS

3.4
Sizes tested and results

3.5 Remarks

---

4 Modeling
B

6.0

Titrate:
MODEL01 - Model of document of validation

Date:
07/10/02
Author (S):
N.SELLALI, P1. Key NOM1
:
V0.01.001-A Page:
4/4

5
Summary of the results

To write a relevant synthesis. See
[A3.02.02-A §4.4]
Handbook of Validation
Booklet VN.NN: Heading of the booklet
HT-66/02/001/A

Code_Aster ®
Version
6.3

Titrate:
ZZZZ100 - Functions, tablecloths, formulas

Date
:
14/10/02
Author (S):
Key COURTEOUS Mr.
:
V1.01.100-A Page:
1/12

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
V1.01.100 document

ZZZZ100 - Functions, tablecloths, formulas

Summary:

This test validates the functions tabulées with one or two variables (tablecloth) as well as the functions "formulas", in
using the various possibilities of operator CALC_FONCTION.

:
V1.01.100-A Page:
2/12

1 Definition of two tabulées functions

The definition of a function formula is carried out using the order FORMULATES.

We defined two functions formulates that we will use to validate the operator CALC_FONCTION:

IF = FORMULA (REEL= """ (REAL: INST) = SIN (INST) """)
CO = FORMULA (REEL= """ (REAL: INST) = COS (INST) """)

From these formulas, we calculated two functions (operator CALC_FONC_INTERP) for moments defined by a list of real.

These moments that one will find in all the document, are:

```
INST0=0.
INST1=DEFI_VALEUR (
R8=EVAL (""" INST0 + (2. * PAS1) """))
INST2=DEFI_VALEUR (
R8=EVAL (""" INST0 + (4. * PAS1) """))
INST3=DEFI_VALEUR (
R8=EVAL (""" INST0 + (6. * PAS1) """))
INST4=DEFI_VALEUR (
R8=EVAL (""" INST0 + (10. * PAS1) """))
INST5=DEFI_VALEUR (
R8=EVAL (""" INST0 + (12. * PAS1) """))
INST6=DEFI_VALEUR (
R8=EVAL (""" INST0 + (14. * PAS1) """))
INST7=DEFI_VALEUR (
R8=EVAL (""" INST0 + (16. * PAS1) """))
INST8=DEFI_VALEUR (
R8=EVAL (""" INST0 + (18. * PAS1) """))
INST9=DEPI
```

with
DEPI=DEFI_VALEUR (

*R8=EVAL (""" 2. * Pi """))*
PAS1=DEFI_VALEUR (
R8=EVAL (""" DEPI/20. """))

2 Order CALC_FONCTION

2.1 Key words factors DERIVES, JUST

2.1.1 Definition

From the functions defined in [§1], we calculate the derivatives of these two functions, that one integrate then:

```
DER1=CALC_FONCTION (DERIVE=_F (
FUNCTION = IF))
INT1=CALC_FONCTION (INTEGRE=_F (
FUNCTION = DER1))
DER2=CALC_FONCTION (DERIVE=_F (
FUNCTION = CO))
INT2=CALC_FONCTION (INTEGRE=_F (
FUNCTION = DER2,
COEF = 1. ,
METHOD = "SIMPSON"))
```

2.1.2 Values
tested

Function der1

Identification Reference
Aster Difference
NOM_RESU
QUICKLY
QUICKLY
%
VALE_PARA: inst0
1.
0.999835
-0.016
VALE_PARA: inst1
0.809017
0.808883
-0.016
VALE_PARA: inst2
0.309017
0.308966
-0.016
VALE_PARA: inst3
-0.309017
-0.308966
-0.016
VALE_PARA: inst4
-1.
-0.999835
-0.016
VALE_PARA: inst5
-0.809017
-0.808883
-0.016
VALE_PARA: inst6
-0.309017
-0.308966
-0.016
VALE_PARA: inst7

0.309017
0.308966
-0.016
VALE_PARA: inst8
0.809017
0.808883
-0.016
VALE_PARA: inst9
1.
0.999835
-0.016

Function int1

Identification Reference
Aster Difference
NOM_RESU
DEPL
DEPL
%
VALE_PARA: inst0
0.
0.
VALE_PARA: inst1
0.587785
0.587688
-0.025
VALE_PARA: inst2
0.951056
0.950900
-0.025
VALE_PARA: inst3
0.951056
0.950900
-0.025
VALE_PARA: inst4
0.
0.
VALE_PARA: inst5
-0.587785
-0.587688
-0.025
VALE_PARA: inst6

-0.951056
-0.950900
-0.025
VALE_PARA: inst7
-0.951056
-0.950900
-0.025
VALE_PARA: inst8
-0.587785
-0.587688
-0.025
VALE_PARA: inst9
0.
0.

Function der2

Identification Reference
Aster Difference
NOM_RESU
QUICKLY
QUICKLY
%
VALE_PARA: inst0
0.
-0.015706
-1.571
VALE_PARA: inst1
-0.587785
-0.587688
-0.016
VALE_PARA: inst2
-0.951056
-0.950900
-0.016
VALE_PARA: inst3
-0.951056
-0.950900
-0.016
VALE_PARA: inst4
0.
0.
VALE_PARA: inst5

0.587785
0.587688
-0.016
VALE_PARA: inst6
0.951056
0.950900
-0.016
VALE_PARA: inst7
0.951056
0.950900
-0.016
VALE_PARA: inst8
0.587785
0.587688
-0.016
VALE_PARA: inst9
0.
-0.015706
-1.571

Function int2

Identification Reference
Aster Difference
NOM_RESU
DEPL
DEPL
%
VALE_PARA: inst0
1.
1.
VALE_PARA: inst1
0.809017
0.808883
-0.016
VALE_PARA: inst2
0.309017
0.308966
-0.016
VALE_PARA: inst3
-0.309017
-0.308966
-0.016

VALE_PARA: inst4
-1.
-0.999835
-0.016
VALE_PARA: inst5
-0.809017
-0.808883
-0.016
VALE_PARA: inst6
-0.309017
-0.308966
-0.016
VALE_PARA: inst7
0.309017
0.308966
-0.016
VALE_PARA: inst8
-0.809017
-0.808883
-0.016
VALE_PARA: inst9
1.
1.

2.2
Key word factor MAX

This key word is used in the test of SPEC_OSCI.

2.3
Key word factor WRAPS

2.3.1 Definition

From the functions defined in [§1], we calculate the envelope of these two functions:

ENV1=CALC_FONCTION (ENVELOPPE=_F (
FUNCTION = (IF,
CO,),
CRITERION = "SUP"))
ENV2=CALC_FONCTION (ENVELOPPE=_F (
FUNCTION = (IF,
CO,),
CRITERION = "INF"))

2.3.2 Values
tested

Function env1

Identification Reference
Aster Difference
VALE_PARA: inst0
1.
1.
VALE_PARA: inst1
0.809017
0.809017
VALE_PARA: inst2
0.951056
0.951056
VALE_PARA: inst3
0.951056
0.951056
VALE_PARA: inst4
0.
0.

VALE_PARA: inst5
-0.587785
-0.587785
VALE_PARA: inst6
-0.309017
-0.309017
VALE_PARA: inst7
-0.309017
-0.309017
VALE_PARA: inst8
0.809017
0.809017
VALE_PARA: inst9
1.
1.

Function env2

Identification Reference
Aster Difference
VALE_PARA: inst0
0.
0.
VALE_PARA: inst1
0.587785
0.587785
VALE_PARA: inst2
0.309017
0.309017
VALE_PARA: inst3
-0.309017
-0.309017
VALE_PARA: inst4
-1.
-1.
VALE_PARA: inst5
-0.809017
-0.809017
VALE_PARA: inst6
-0.951056
-0.951056
VALE_PARA: inst7
-0.951056

-0.951056
VALE_PARA: inst8
-0.587785
-0.587785
VALE_PARA: inst9
0.
0.

2.4
Key word factor COMB

2.4.1 Definition

From the functions defined in [§1], we calculate the combination of these two functions:

```
COM0=CALC_FONCTION (
LIST_PARA=LST, COMB= (
_F (
FUNCTION = IF, COEF = 1.),
_F (
FUNCTION = CO, COEF = +1.))
)
COM1=CALC_FONCTION (COMB= (_F (
FUNCTION = IF, COEF = 1.),
```

_F (
FUNCTION = INT1, COEF = -1.))
)
COM2=CALC_FONCTION (COMB= (_F (
FUNCTION = CO, COEF = 1.),
_F (
FUNCTION = INT2, COEF = -1.))
)

2.4.2 Values tested

Function com0

Identification	Reference	Aster	Difference
VALE_PARA: inst0	1.	1.	
VALE_PARA: inst1	1.39680E+00	1.39680E+00	
VALE_PARA: inst2	1.26007E+00	1.26007E+00	
VALE_PARA: inst3	6.42039E-01	6.42039E-01	
VALE_PARA: inst4	-1.	-1.	
VALE_PARA: inst5	-1.39680E+00	-1.39680E+00	
VALE_PARA: inst6	-1.26007E+00	-1.26007E+00	
VALE_PARA: inst7	-6.42039E-01	-6.42039E-01	
VALE_PARA: inst8	2.21231E-01	2.21231E-01	

VALE_PARA: inst9
1.
1.

Function com1

Identification Reference
Aster Difference
VALE_PARA: inst0
0.
0.
VALE_PARA: inst1
0.
1.45018E-04
1.45E-04
VALE_PARA: inst2
0.
2.34644E-04
2.35E-04
VALE_PARA: inst3
0.
2.34644E-04
2.35E-04
VALE_PARA: inst4
0.
0.
VALE_PARA: inst5
0.
-1.45018E-04
-1.45E-04
VALE_PARA: inst6
0.
-2.34644E-04
-2.35E-04
VALE_PARA: inst7
0.
-2.34644E-04
-2.35E-04
VALE_PARA: inst8
0.
-1.45018E-04
-1.45E-04
VALE_PARA: inst9

0.
1.92220E-16
0.

Function com2

Identification Reference
Aster Difference
VALE_PARA: inst0
0.
0.
VALE_PARA: inst1
0.
1.33067E-04
1.33E-04
VALE_PARA: inst2
0.
5.08270E-05
5.08E-05
VALE_PARA: inst3
0.
-5.08270E-05
-5.08E-05
VALE_PARA: inst4
0.
1.64479E-04
-1.64E-04
VALE_PARA: inst5
0.
-1.33067E-04
-1.33E-04
VALE_PARA: inst6
0.
-5.08270E-05
-5.08E-05
VALE_PARA: inst7
0.
5.08270E-05
5.08E-05
VALE_PARA: inst8
0.
1.33067E-04
1.33E-04

VALE_PARA: inst9
0.
0.

2.5
Key word factor COMB_C

2.5.1 Definition

The two complex functions are defined:

```
DFC1=DEFI_FONCTION (
NOM_PARA=' INST',
NOM_RESU=' FREQ',
VALE_C= (0. , 1. , 2. , 1. , 3. , 4. , 5. , 2. , 4. ,))
DFC2=DEFI_FONCTION (
NOM_PARA=' INST',
NOM_RESU=' FREQ',
VALE_C= (0. , 1. , 1. , 2. , 3. , 2. , 5. , 5. , 6. ,))
```

One calculates the linear combination complexes DFC3=DFC1 + 2i.DFC2.

2.5.2 Values

tested

Function DFC3

Identification Reference
Aster Difference
VALE_PARA: 0.
(-1.,4.)
(-1.,4.)
0.
VALE_PARA: 1.
(0.,8.)
(0.,8.)
0.
VALE_PARA: 5.
(-10.,14.)
(-10.,14.)
0.

2.6
Key word factor COMPOSES

2.6.1 Definition

Two real functions are defined:

FONC1=DEFI_FONCTION (
NOM_PARA=' X',
NOM_RESU=' F',
VALE= (0. ,
0.,
2.,
5.,
3., 10.,
5., 15.,
7., 13.,
8., 10.,
10., 9.,
12., 8.,
13., 5.,
15., 1.,
20., 0.,))
FONC2=DEFI_FONCTION (

NOM_PARA=' INST',
NOM_RESU=' X',
VALE= (0. ,
0.,
0.1,
2.,
0.2,
4.,
0.3,
6.,
0.4,
8.,
0.5, 10.,
0.6, 12.,
0.7, 14.,
0.8, 16.,
0.9, 18.,
1.0, 20.,))

One calculates COMP1 (para) =FONC1 (FONC2 (para)).

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2.6.2 Values tested

Function COMP1

Identification Reference
Aster *Difference*
VALE_PARA: 0.
0.
0.
0.
VALE_PARA: 0.1
5.
5.
0.
VALE_PARA: 0.2
12.5
12.5
0.
VALE_PARA: 0.3
14.
14.
0.
VALE_PARA: 0.4
10.
10.
0.

VALE_PARA: 0.5
9.
9.
0.
VALE_PARA: 0.6
8.
8.
0.
VALE_PARA: 0.7
3.
3.
0.
VALE_PARA: 0.8
0.8
0.8
0.
VALE_PARA: 0.9
0.4
0.4
0.
VALE_PARA: 1.0
0.
0.
0.

2.7 Key word factor ADZE

2.7.1 Definition

Two real functions are defined:

DFC1=DEFI_FONCTION (
NOM_PARA=' X',
NOM_RESU=' Y',
VALE= (0. , 10. , 4. , 14. , 6. , 16. ,),
PROL_DROITE=' LINEAIRE',
PROL_GAUCHE=' LINEAIRE'
)
DFC2=DEFI_FONCTION (
NOM_PARA=' X',
NOM_RESU=' Y',
VALE= (5. , 25. , 7. , 27. , 8. , 28. ,),

PROL_DROITE=' LINEAIRE',
PROL_GAUCHE=' LINEAIRE'
)

One assembles these two functions, while overloading on the right.

2.7.2 Values
tested

Function DFC3

Identification Reference
Aster *Difference*
VALE_PARA: 4.
14.
14.
0.
VALE_PARA: 5.
25.
25.
0.

2.8

Key word factor EXTRACTION

2.8.1 Definition

One extracts from the function defined in paragraph "COMB_C" the real part, the imaginary part, sound
modulate and its phase:

DFR4=CALC_FONCTION (
EXTRACTION=_F (
FUNCTION = DFC1,
PART = "REAL"))
DFR5=CALC_FONCTION (
EXTRACTION=_F (
FUNCTION = DFC1,
PART = "IMAG"))
DFR6=CALC_FONCTION (
EXTRACTION=_F (
FUNCTION = DFC1,
PART = "PHASE"))
DFR7=CALC_FONCTION (
EXTRACTION=_F (
FUNCTION = DFC1,
PART = "MODULE"))

2.8.2 Values
tested

Functions, DFR4, DFR5, DFR6, DFR7

Identification Reference
***Aster** Difference*
DFR4, VALE_PARA: 5.
2.
2.
0.
DFR5, VALE_PARA: 5.
4.
4.
0.
DFR6, VALE_PARA: 5.
63.4349
63.4349

0.
DFR7, VALE_PARA: 5.
4.47213
4.47213
0.

2.9
Key word factor RMS

2.9.1 Definition

One calculates value RMS of the two functions defined in [§1].

2.9.2 Values
tested

Count RMS_SI

Identification Reference
Aster *Difference*
NOM_PARA: RMS
7.07107E-01
7.07107E-01
0.

Count RMS_CO

Identification Reference
Aster *Difference*
NOM_PARA: RMS
7.07107E-01
7.07107E-01
0.

2.10 Key word factor NOCI_SEISME

2.10.1 Definition

One calculates the whole of the indices of harmfulness for a real accélérogramme, option by option and at the same time.

2.10.2 Values tested

Identification Reference
Aster *Difference*
NOM_PARA: ACCE_MAX
1.
1.
0.
NOM_PARA: VITE_MAX
2.29056E-01
2.29057E-01
0.0003
NOM_PARA: DEPL_MAX
1.34245E+00
1.34245E+00
0.
NOM_PARA: INTE_ARIAS
2.58200E-01
2.58206E-01
0.002
NOM_PARA: POUV_DEST
2.09825E-01
2.09826E-01
0.0007
NOM_PARA: ACCE_SUR_VITE

4.36573E+00
4.36573E+00
0.
NOM_PARA: VITE_ABSO_CUMU
4.43370E+00
4.43375E+00
0.001
NOM_PARA: DUREE_PHAS_FORT
1.48300E+01
1.48300E+01
0.
NOM_PARA: INTE_SPECT
5.86000E+00
5.86208E-01
0.036

The values of reference are of nonregression.

2.11 Key word factor SPEC_OSCI

2.11.1 Definition

We defined a accélérogramme:

*F = FORMULA (REEL= """ (REAL: INST) = COS (OMEGA*INST) """)*
in order to calculate the spectrum of oscillator
SOD=CALC_FONCTION (SPEC_OSCI=_F (
FUNCTION = F,
NATURE = "DEPL",
AMOR_REDUIT = (AMOR1, AMOR2,),
FREQ = (FREQ1, FREQ2, FREQ3,),
= 1 NORMALIZES.)
)
SOV=CALC_FONCTION (SPEC_OSCI=_F (
FUNCTION = F,
NATURE = "QUICKLY",
AMOR_REDUIT = (AMOR1, AMOR2,),
FREQ = (FREQ1, FREQ2, FREQ3,),
= 1 NORMALIZES.)
)
SOA=CALC_FONCTION (SPEC_OSCI=_F (
FUNCTION = F,
NATURE = "ACCE",

AMOR_REDUIT = (AMOR1, AMOR2,),
FREQ = (FREQ1, FREQ2, FREQ3,),
= 1 NORMALIZES.)
)
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2.11.2 Values tested

The reference solution is an analytical solution:

· solution in displacement:

That is to say:

= 3.566
T = urgent
F = frequency

= damping
1
U (T, F,) = (B - C - D)
With

with:

2

With = (2
4
F 2 - 2) + (4 F
) 2
B = (2
4
F 2 - 2). (
cos T
) + 4 F
sin (T)
C = (2
4
F 2 - 2) .cos (2 ft
)
D = (2
4
F 2 - 2) .sin (2 ft
)
- 2 ft
E

.

· solution of speed:

u& (T, F
,) =
2 F .u (T, F
,)

· solution in acceleration:

U (&t, F
,) = (
2 F) 2.u (T, F
,)

One tests the moments when the maximum is reached (one validates the key word MAX thus).

Function sod (displacement)

Identification Reference
Aster *Difference*
%

NOM_PARA:
(“AMOR”
“FREQ”)
1.95737E-03
1.95716E-03
-0.011
VALE_PARA: (
0.01
5.
)
NOM_PARA:
(“AMOR”
“FREQ”)
1.07089E-04
1.07077E-04
-0.011
VALE_PARA: (
0.01
21.
)
NOM_PARA:
(“AMOR”
“I FREQ”)
3.38318E-06
3.38503E-06
0.055
VALE_PARA: (
0.01
105.
)
NOM_PARA:
(“AMOR”
“FREQ”)
1.89836E-03
1.89814E-03
-0.011
VALE_PARA: (
0.03
5.
)
NOM_PARA:
(“AMOR”
“FREQ”)

1.03108E-04
1.03096E-04
-0.011
VALE_PARA: (
0.03
21.
)
NOM_PARA:
(“AMOR”
“FREQ”)
2.57820E-06
2.57915E-06
0.037
VALE_PARA: (
0.03
105.
)

Function sov (speed)

Identification Reference
Aster *Difference*
%

NOM_PARA:
(“AMOR”
“FREQ”)
6.14925E-02
6.14859E-02
-0.011
VALE_PARA: (
0.01
5.
)
NOM_PARA:
(“AMOR”
“FREQ”)
1.41300E-02
1.41285E-02
-0.011
VALE_PARA: (
0.01
21.
)
NOM_PARA:
(“AMOR”
“I FREQ”)
2.23200E-03
2.23322E-03
0.055
VALE_PARA: (
0.01
105.
)
NOM_PARA:
(“AMOR”
“FREQ”)
5.96387E-02
5.96320E-02
-0.011
VALE_PARA: (
0.03
5.
)
NOM_PARA:
(“AMOR”
“FREQ”)

1.36048E-02
1.36032E-02
-0.011
VALE_PARA: (
0.03
21.
)
NOM_PARA:
(“AMOR”
“FREQ”)
1.70155E-03
1.70093E-03
0.037
VALE_PARA: (
0.03
105.
)

Function soa (acceleration)

Identification Reference
Aster *Difference*
%
NOM_PARA:
(“AMOR”
“FREQ”)
1.93184E+00
1.93163E+00
-0.011
VALE_PARA: (
0.01
5.
)
NOM_PARA:
(“AMOR”
“FREQ”)
1.86441E+00
1.86421E+00
-0.011
VALE_PARA: (
0.01
21.
)

NOM_PARA:
("AMOR"
"I FREQ")
1.47252E+00
1.47333E+00
0.055
VALE_PARA: (
0.01
105.
)
NOM_PARA:
("AMOR"
"FREQ")
1.87360E+00
1.87339E+00
-0.011
VALE_PARA: (
0.03
5.
)
NOM_PARA:
("AMOR"
"FREQ")
1.79511E+00
1.79491E+00
-0.011
VALE_PARA: (
0.03
21.
)
NOM_PARA:
("AMOR"
"FREQ")
1.12216E+00
1.12257E+00
0.037
VALE_PARA: (
0.03
105.
)

2.12 Key word factor FFT

2.12.1 Definition

One calculates the transform of Fourier of a accélérogramme real X.

2.12.2 Values tested

Function XFF

Identification Reference
***Aster** Difference*
%
VALE_PARA: 50.8
(0.124,
(0.124358,
0.279
0.0383)
0.03825)
VALE_PARA: 121.1
(0.177,
(0.17702,
0.013
-0.0347)
-0.03471)

The values of reference are of nonregression.

12/12

2.13 Key word factor CORR_ACCE

2.13.1 Definition

One calculates the correction of a commonplace accélérogramme (curve refines), and that of the real accélérogramme
used in paragraph "NOCI_SEISME".

2.13.2 Values tested

One tests the value of the RMS of the corrected functions obtained.

Identification Reference
Aster *Difference*
NOM_PARA: RMS1
0.
5.684E-14
0.
NOM_PARA: RMS2
2.278E-01
2.278E-01
0.
NOM_PARA: RMS3
0.
2.406E-11
0.
NOM_PARA: RMS4
2.243E-01
2.243E-01
0.

3
Generation of a function by IMPR_COURBE

One tests the possibility of IMPR_COURBE of writing a function with the format "ORDERS".
The line of order generated by IMPR_COURBE is carried out by making a INCLUDE in CONTINUATION; then, it is checked that one finds the values of the printed function.

4
Summary of the results

This test validates the whole of the orders which create functions (DEFI_FONCTION, IMPR_COURBE, and in particular order CALC_FONCTION).

The attributes of the functions there are tested: type of interpolation, prolongations,… as well as the values
interpolated or not for tablecloths and functions real or complex.

The only significant errors are raised on real applications (accélérogramme by
example), where one has only values of nonregression.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
ZZZZ101 - Validation of operators AFFE_CARA_ELEM and POST_ELEM
Date:
29/10/01
Author (S):
***J.M. PROIX**, L. VIVAN Key*
:
V1.01.101-A Page:
1/9

Organization (S): EDF/MTI/MMN, CS IF

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.101

ZZZZ101 - Validation of the operators AFFE_CARA_ELEM and POST_ELEM

Summary:

Validation of operators AFFE_CARA_ELEM and POST_ELEM.

This test relates to the calculation of the mass, the centre of gravity and the tensor of inertia in the centre of gravity for
following modelings:

· discrete elements: DIS_TR and DIS_T,
· elements of bar: BAR,
· elements of beam: POU_D_E, POU_D_T, POU_C_T,
· elements of hulls: DKT, DST, Q4G,
· voluminal elements: 3D.

1
Problem of reference

1.1 Geometry

Grid in space 3D not modelling any defined structure, formed of specific meshs, linear, of plates, and a volume hexaedric.

ma_qua4
ma_tri3
y
P6
P5
3
P4
Plan Z = 7
2
1
P1
P2
P3
X
Parallépipède on side 1, 2, 7.
y ''
According to Z '': thickness 1.
In the reference mark (X, y, Z) A has as co-ordinates
(1. 0. 0.).
One passes from reference mark (X, y, Z) to the reference mark (X '', y '', Z '') with the angles of Euler (45°, 45°, 0°).
X ''
2
With

1.2 Properties

material

E = 2.1011 Pa
= 0.3
= 1.5 kg/m3 (except for the discrete elements: = 1.5.104 kg/m3)

1.3
Boundary conditions and loadings

Without object (not of resolution).

1.4 Conditions
initial

Without object.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

2
Reference solution

2.1
Method of calculation

Mass and centre of gravity:

m = FD
= dx.dy.dz

v
v
x.dv
y.dv
z.dv

X
v
=
y
v
=
Z
v
G
=
m
G
m
G
m

Tensor of inertia:

I
2
2
xx = (y + Z) .dv
I
= X. y.dv
xy

v
v
I
2
2
yy = (X + Z) .dv
I
= x.z.dv
xz

v
v
I
2

2
zz = (X + y) .dv
I
= y.z.dv
yz

v
v

2.2 Sizes and results of reference

Masses and inertias for various modelings.

2.3 Uncertainties on the solution

Note:

For one of the grids modelled in hulls, the solution is numerical (not regression).

---

3 Modeling With

3.1

Characteristics of modeling

DISCRETE element:

· modeling M_T_D_N:
calculation of the mass and the centre of gravity
· modeling M_T_N:
calculation of the mass and the centre of gravity
· modeling M_TR_D_N:
calculation of the mass, the centre of gravity and the tensor of inertia + offsetting
· modeling M_TR_N:
calculation of the mass, the centre of gravity and the tensor of inertia + offsetting
· modeling M_T_L:
calculation of the mass and the centre of gravity
· modeling M_TR_L:
calculation of the mass and the centre of gravity

Element BARS:

· modeling BARS:
calculation of the mass and the centre of gravity
general section, right-angled section and section ring (full and dig)

Element BEAM:

· modeling POU_D_E:
calculation of the mass
general section, right-angled section and section ring (full and dig)
· modeling POU_D_T:
calculation of the mass
general section, right-angled section and section ring (full and dig)
· modeling POU_C_T:
calculation of the mass
general section, right-angled section and section ring (full and dig)

Element HULL:

· modeling DKT: (triangle calculation of the mass, the centre of gravity and the tensor of inertia

and quadrangle)
· DST modeling: (triangle calculation of the mass, the centre of gravity and the tensor of inertia and quadrangle)
· modeling Q4G: (triangle calculation of the mass, the centre of gravity and the tensor of inertia and quadrangle)
· modeling 3D (HEXA8)
calculation of the mass, the centre of gravity and the tensor of inertia

3.2 Characteristics

grid

DISCRETE element:

· modeling M_T_D_N, M_T_N, M_TR_D_N, M_TR_N:
1 mesh POI1
· modeling M_T_L, M_TR_L:
1 mesh SEG2

Element BARS:

· modeling BARS:
1 mesh SEG2

Element BEAM:

· modeling POU_D_E, POU_D_T:
1 mesh SEG2
· modeling POU_C_T:
7 meshs SEG2
Handbook of Validation
V1.01 booklet: Tests of validity of orders
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Element HULL:

· modeling DKT, DST, Q4G:
5 meshs TRIA3 and QUAD4
2 meshs TRIA3 (grid
irregular 2 meshs QUAD4)

Element 3D:

1
net
HEXA8

3.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM

BAR

BEAM

HULL + DEFI_ARC

POST_ELEM MASS_INER

3.4
Sizes tested and results

Modeling Grid AFFE_CARA_ELEM Identification
Reference
***Aster** %*
difference
DIS_T 1
POI1
M_T_D_N
MASS
5,1585E+01 5,1585E+01 0
CDG_X
1,0000E+00 1,0000E+00 0
CDG_Y
1,0000E+00 1,0000E+00 0
CDG_Z
7,0000E+00 7,0000E+00 0
DIS_T 1
POI1
M_T_N
MASS
5,1585E+01 5,1585E+01 0
CDG_X
1,0000E+00 1,0000E+00 0
CDG_Y
1,0000E+00 1,0000E+00 0
CDG_Z
7,0000E+00 7,0000E+00 0
DIS_TR 1
POI1
M_TR_D_N
MASS
5,1585E+01 5,1585E+01 0
CDG_X
1,0000E+00 1,0000E+00 0

CDG_Y
1,0000E+00 1,0000E+00 0
CDG_Z
7,0000E+00 7,0000E+00 0
IX_G
6,9815E04 6,9815E04 0
IY_G
5,2962E04 5,2962E04 0
IZ_G
2,7170E04 2,7170E04 0
IXY_G
1,0317E 1,0317E04 0
04
IXZ_G
1,5476E 1,5476E04 0
04
IYZ_G
3,0951E 3,0951E04 0
04
DIS_TR 1
POI1
M_TR_N
MASS
5,1585E+01 5,1580E+01 0,01

CDG_X
1,0000E+00 1,0000E+00 0

CDG_Y
1,0000E+00 1,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0

IX_G
6,9815E04 6,9810E04 0,006

IY_G
5,2962E04 5,2960E04 0,004

IZ_G
2,7170E04 2,7170E04 0,002

IXY_G

1,0317E 1,0320E04 0,029
04

IXZ_G
1,5476E 1,5480E04 0,029
04

IYZ_G
3,0951E 3,0950E04 0,003
04

DIS_T 1
SEG2
M_T_L
MASS
2,0000E+00 2,0000E+00 0

CDG_X
1,5000E+00 1,5000E+00 0

CDG_Y
1,0000E+00 1,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0
DIS_TR 1
SEG2

M_TR_L
MASS
5,1585E+01 5,1585E+01 0

CDG_X
1,5000E+00 1,5000E+00 0

CDG_Y
1,0000E+00 1,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0
BAR 1
SEG2
section: general
MASS
6,6609E+00 6,6609E+00 0

CDG_X
3,0000E+00 3,0000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0
1 SEG2
section: full square MASSES
4,2426E+00 4,2426E+00 0
1 SEG2
section: hollow square MASSES
8,0610E01 8,0610E01 0
1 SEG2
section: rectangle
MASS
1,0861E+00 1,0861E+00 0
hollow
1 SEG2
section: full circle MASSES
1,3329E+01 1,3329E+01 0
1 SEG2
section: ring hollow MASSES

7,8772E01 7,8772E01 0
POU_D_E 1
SEG2 section: general
MASS
6,6609E+00 6,6609E+00 0

CDG_X
3,0000E+00 3,0000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0
1 SEG2
section: full square MASSES
4,2426E+00 4,2426E+00 0
1 SEG2
section: hollow square MASSES
8,0610E01 8,0610E01 0
1 SEG2
section: rectangle
MASS
1,0861E+00 1,0861E+00 0
hollow
1 SEG2
section: full circle MASSES
1,3329E+01 1,3329E+01 0
1 SEG2
section: ring hollow MASSES
7,8772E01 7,8772E01 0
POU_D_T 1
SEG2
section: general
MASS
6,6609E+00 6,6609E+00 0

CDG_X
3,0000E+00 3,0000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0
1 SEG2
section: full square MASSES
4,2426E+00 4,2426E+00 0
1 SEG2
section: hollow square MASSES
8,0610E01 8,0610E01 0
1 SEG2
section: rectangle
MASS
1,0861E+00 1,0861E+00 0
hollow
1 SEG2
section: full circle MASSES
1,3329E+01 1,3329E+01 0
1 SEG2
section: ring hollow MASSES
7,8772E01 7,8772E01 0
DKT 2
TRIA3
thickness
MASS
1,8000E01 1,8000E01 0

CDG_X
3,0000E+00 3,0000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0

IX_G
6,0020E02 6,0014E02 0,011

IY_G
6,0020E02 6,0014E02 0,011

IZ_G
1,2000E01 1,2000E01 0
DKT 2
QUAD4
thickness
MASS
2,7000E01 2,7000E01 0

CDG_X
2,5000E+00 2,5000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0

IX_G
9,0020E02 9,0020E02 0

IY_G
2,0252E01 2,0252E01 0

IZ_G
2,9250E01 2,9250E01 0
DST 2
TRIA3
thickness
MASS
1,8000E01 1,8000E01 0

CDG_X
3,0000E+00 3,0000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0

IX_G
6,0020E02 6,0014E02 0,011

IY_G
6,0020E02 6,0014E02 0,011

IZ_G
1,2000E01 1,2000E01 0
DSQ 2
QUAD4
thickness
MASS
2,7000E01 2,7000E01 0

CDG_X
2,5000E+00 2,5000E+00 0

CDG_Y

2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0

IX_G
9,0020E02 9,0020E02 0

IY_G
2,0252E01 2,0252E01 0

IZ_G
2,9250E01 2,9250E01 0

IX_P
7,1100E+00 7,1100E+00 0

IY_P
7,5600E+00 7,5600E+00 0

IZ_P
1,1700E+00 1,1700E+00 0
Q4G 2
QUAD4
thickness
MASS
2,7000E01 2,7000E01 0

CDG_X
2,5000E+00 2,5000E+00 0

CDG_Y
2,0000E+00 2,0000E+00 0

CDG_Z
7,0000E+00 7,0000E+00 0

IX_G
9,0020E02 9,0020E02 0

IY_G
2,0252E01 2,0252E01 0

IZ_G
2,9250E01 2,9250E01 0

POU_C_T and 7 SEG2
DEFI_ARC centers
MASS
5,5488E+00 5,5488E+00 0
POU_D_T
POU_C_T and 7 SEG2
Different DEFI_ARC
MASS
3,6664E+01 3,6664E+01 0
POU_D_T
center
DKT 3
TRIA3
MASS
3,9000E+02 3,9000E+02 0
2 QUAD4

CDG_X
8,5000E01 8,5000E01 0

CDG_Y
1,4722E+00 1,4722E+00 0

CDG_Z
1,9000E+00 1,9000E+00 0

IX_PRIN_G
3,2500E+01 3,2503E+01 0,01

IY_PRIN_G
8,1250E+02 8,1250E+02 0

IZ_PRIN_G
8,4500E+02 8,4500E+02 0

ALPHA
6,0000E+01 6,0000E+01 0

GAMMA
9,0000E+01 9,0000E+01 0
DST 3
TRIA3
MASS
3,9000E+02 3,9000E+02 0

2 QUAD4

CDG_X
8,5000E01 8,5000E01 0

CDG_Y
1,4722E+00 1,4722E+00 0

CDG_Z
1,9000E+00 1,9000E+00 0

IX_PRIN_G
3,2500E+01 3,2503E+01 0,01

IY_PRIN_G
8,1250E+02 8,1250E+02 0

IZ_PRIN_G
8,4500E+02 8,4500E+02 0

ALPHA
6,0000E+01 6,0000E+01 0

GAMMA
9,0000E+01 9,0000E+01 0
Q4G 1
QUAD4
MASS
3,9000E+02 3,9000E+02 0

CDG_X
8,5000E01 8,5000E01 0

CDG_Y
1,4722E+00 1,4722E+00 0

CDG_Z
1,9000E+00 1,9000E+00 0

IX_PRIN_G
3,2500E+01 3,2503E+01 0,01

IY_PRIN_G
8,1250E+02 8,1250E+02 0

IZ_PRIN_G
8,4500E+02 8,4500E+02 0

ALPHA
6,0000E+01 6,0000E+01 0

GAMMA
9,0000E+01 9,0000E+01 0
3D 1
HEXA8
MASS
7,8000E+04 7,8000E+04 0

CDG_X
2,4883E+00 2,4883E+00 0

CDG_Y
2,4883E+00 2,4883E+00 0

CDG_Z
2,2008E+00 2,2008E+00 0

IX_PRIN_G
1,9500E+04 1,9500E+04 0

IY_PRIN_G

3,3150E+05 3,3150E+05 0

IZ_PRIN_G
3,3800E+05 3,3800E+05 0

ALPHA
4,5000E+01 4,5000E+01 0

3.5 Remarks

All the values tested are exact.

3.6 Parameters of execution

Version: 5.2

Machine: SGI/ORIGIN 2000

Obstruction memory: 128 MW
Time CPU To use: 10 seconds

4
Summary of the results

The results are equal to the reference solutions and make it possible to validate key word MASS_INER of
POST_ELEM.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
V1.01.102 document
ZZZZ102 - To see accélérogramme and spectrum
of oscillator

Summary:

This test concerns:
1) reading under various formats of a accélérogramme on an external file (LIRE_FONCTION [U4.21.08]) and the test of the attributes of the function and the value max,
2) the checking of the calculation of the spectrum of oscillator by CALC_FONCTION [U4.62.04] and of the value of
high frequency acceleration (> 35.5 Hz) according to the value max of the accélérogramme,
3) reading of a spectrum of oscillators in free format on an external file (LIRE_FONCTION [U4.21.08]).
There are not grid or of model finite element and two modelings.

---

1 *Problem of reference*

Several reading of signals are to be realized:

· reading of a accélérogramme not centered (maximum amplitudes > 0 and < 0 different) expressed in G (9.81 ms2) and research of the maximum amplitude,

· calculation of the spectra of oscillator for a reduced damping = 0.01 (1%) with the options of calculation:

-
pseudo absolute acceleration and to find the acceleration of high frequency drive (F ³ 35.5 Hz),

- displacement relative,

· reading of a accélérogramme centered (LBEW: seism Length Beach East West) and seeks maximum amplitude,

· calculation of the spectrum of oscillator in pseudo absolute acceleration,

· reading of a spectrum of oscillator in free format.

2 *Reference solution*

2.1 *Results of reference*

· Accélérogramme not centered
T = 7.935
amax = 0.638
F = 35.5
= 0.01
pseudo absolute acceleration
0.638 X 9.81 = 6.25878
displacement
1.282343 105
· Centered Accélérogramme
T = 3.1
amax = 1.

F = 35.5 Hz
= 0.01
pseudo absolute acceleration
1.
· Spectre of oscillator
F = 0.5 Hz
= 0.01
pseudo absolute acceleration
1.09558
= 0.05
pseudo absolute acceleration
0.657348
= 0.1
pseudo absolute acceleration
0.109558

2.2
Uncertainty on the solution

Analytical solution.

2.3 References
bibliographical

[1]
J.R. LEVESQUE, L. VIVAN, D. SELIGMANN "seismic Response by spectral method"
[R4.05.03].

---

3 Modeling
With

3.1 Files
read

· Accélérogramme SEPTEN not centered read on unit 19.
· Accélérogramme centered doseism read on unit 20.

3.2
Test and calculation

· for each signal read:
-
research of the value max,
-
calculation of the spectrum of oscillator.
CALC_FONCTION
MAX
SPEC_OSCI
NATURE: “OCCC”
NATURE: “DEPL” or “ACCE”
NORMALIZES: 1. /g or 1.

4
Results of modeling A

4.1 Values
tested
Identification
Reference
Aster
% difference
% tolerance
amplitude max accélérogramme 1
T = 7.935
0.638
0.638
0.
0.1
spectrum of oscillator 1 (not centered)
freq. 35.5 acceleration
6.258778
6.546182
4.59
5.
displacement
1.28234 E5
1.34123 E5
4.59
5.
amplitude max accélérogramme 2
T = 3.1

1.0
1.0
0.
0.1
spectrum of oscillator 2 (centered)
freq. 35.5
1.0
1.0962
9.6
10

4.2 Remarks

The precision of integration of the spectrum of oscillator is not satisfactory.
All these attributes of the functions read or created are tested and exact.

4.3 Parameters of execution

Version: 3.05.02
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
3.34 seconds

---

5 Modeling B

5.1 File read

· Spectre of oscillator
7 frequencies

0.2
0.25
0.3
0.35
0.4
0.45
0.5
5 depreciation
0.01
0.1
0.2
0.3
0.5
5.2
Extraction of the values
For FREQ = 0.5 Hz
test of the values associated with the spectrum of oscillator for:
= 0.01 and 0.1 (values read)
= 0.05 (values to be interpolated linearly)
6
Results of modeling A
6.1 Values
extracted
FREQ = 0.5 Hz
Reference
Aster
% difference
Damping = 0.01
1.09558
1.09558
0.
Damping = 0.05
0.657348
0.657348
0.
(interpolated value) = 0.1
0.109558
0.109558
0.
6.2 Remarks
All the attributes of the tablecloth read are good.
6.3 Parameters
of execution

Version: 3.05.02
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
1.98 seconds
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HI-75/97/001 - Ind A

Code_Aster ®
Version
4.0
Titrate:
ZZZZ102 Lira accélérogramme and spectrum of oscillator
Date:
05/01/98
Author (S):
J.R. LEVESQUE
Key: V1.01.102-A
Page:
5/6

7 *Summary of the results*

The calculation algorithm of the spectrum of oscillator does not give a sufficient precision with the list of frequencies of integration per defect.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/97/001 - Ind A

Intentionally white left page.

Organization (S): EDF/IMA/MMN, CISI

Handbook of Validation

V1.01 booklet: Tests of validity of orders

Document: V1.01.106

ZZZZ106 - Geometrical criteria in DEFI_GROUP [U4.12.03]

Summary:

This test validates the various options of creation of groups of meshs (or nodes) by criteria **geometrical** in order DEFI_GROUP [U4.12.03]:

· "SPHERE"
· "CYLINDER"
· "BAND"
· "FACE_NORMALE"
· "ENV_SPHERE"

· “ENV_CYLINDRE”
· “PLANE”

---

1 Problem of reference

y
C
B
has
With
has
X

It is about a square plate on side is = 10. and thickness T = 1.

1.1 Material properties

E = 1.
= 0.3

1.2 Boundary conditions and loading

The plate is embedded along side AB.
One has 7 loading cases for modeling A and 5 loading cases for modeling B.
Each loading case corresponds to the superposition of 2 loadings which are cancelled.
One of these loadings applies to a GROUP_MA or a GROUP_NO defined starting from a criterion geometrical in DEFI_GROUP, the other, of opposed sign, applies to the GROUP_MA or the GROUP_NO
defined “in extension” (with the hand).
Modeling A uses a model “3D” in hull DKT.
Modeling B uses a model “D_PLAN” in TRIA3.

The grids are the same ones.

---

2 Reference solution

2.1 Results of reference

For all the loading cases, the solution is commonplace.
One must have a field of null displacements in all the nodes.

3 Modeling With

3.1 Characteristics of modeling

The elements are DKT.
One defines 7 loading cases in the following way:

Loading case n°1: "SPHERE"

y
Tr6b
Tr7a
The side of an element is equal to 2.5.
21
20
19
18
22
The sphere of ray 2. and centered with node 1 has
an intersection not-vacuum with the element
8
7

6
23
17
hatched on the figure, i.e. Tr6a, Tr6b, Tr7a,
Tr6a
Tr10b, Tr11a and Tr11b.
9
1
5
24
16
One applies a pressure equalizes to 1. on
Tr11b
this list of name GM1 built while using
2
3
4
25
15
the option “SPHERE” of CREA_GROUP_MA of
order DEFI_GROUP and a pressure
equalize to 1. on this list defined in extension.
10
11
12
13
14
X
Tr10b Tr11a

Loading case n°2: “CYLINDER”

y
Tr6b
Tr7a
The cylinder of ray 2d' axis **Z** and passing by
21
20
19
18
node 1 has an intersection not-vacuum with
22
elements hatched on the figure i.e. Tr6a,
Tr6b, Tr7a, Tr10b, Tr11a and Tr11b.
8

7
6
23
17
One applies a pressure equalizes to 1. on
Tr6a
9
1
5
this list of name GM2 built while using
24
16
the option “ROLLS” CREA_GROUP_MA of
Tr11b
order DEFI_GROUP and a pressure
2
3
4
25
equalize to 1. on this list defined in extension.
15
10
11
12
13
14
X
Tr10b Tr11a
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Loading case n°3: “BAND”

y

Elements of the shaded zone i.e. Tr5A, Tr5B,

21

20

19

18

Tr6A, Tr6B, Tr7A, Tr7B, Tr8A, Tr8B, Tr9A, Tr9B,

22

Tr10A, Tr10B, Tr11A, Tr11B, Tr12A, Tr12B define

the intersection of the plate with the band of which sides

8

7

6

23

17

are parallel to the axis **X**, whose medium passes by

5B

6B

7B

8B

6A

7A

8A

N1 node, and of which the half-width is equal to 2.

5A

9

1

5

24

16

9B

10B

11B

12B

One applies a pressure equal to 1. to this zone

9A

10A

11A

12A

defined thus geometrically of name GM3 in

2

3
4
25
15
employing the option CREA_GROUP_MA “BANDAGES” of
order DEFI_GROUP and a pressure equalizes to 1.
on this zone defined in extension.
10
11
12
13
14
X
Loading case n°4: “FACE_NORMALE”
y
One defines the elements of the plate as being
21
20
19
18
perpendiculars with axis **Z** by using the option
22
“FACE_NORMALE” of CREA_GROUP_MA of
order
DEFI_GROUP.
8
7
6
23
17
One applies a pressure equal to 1. to this list of
9
1
5
name GM4 and a pressure equalizes to 1. on the same list
24
16
defined in extension (here all meshs).
2
3
4
25
15

10
11
12
13
14
X

Loading case n°5: "ENV_SPHERE"

y
Nodes 3, 5, 7 and 9 are defined as being them
nodes of the grid pertaining to the intersection of
21
20
19
18
plate with the sphere of N1 centre and 2.5
22
(it is the length on the side of an element).
8
7
6
23
17
This list of nodes of name GN1 is defined in
using option "ENV_SPHERE" of CREA_GROUP_NO
9
1
5
order DEFI_GROUP.
24
16
One applies a nodal force F
2
3
4
Z = 1 of each one of
25
15
nodes of this list and a nodal force Fz = 1 in
each node of the same list defined in
extension (N3, N5, N7, N9).
10
11
12

13
14
X

Loading case n°6: "ENV_CYLINDRE"

y
Nodes 3, 5, 7 and 9 are defined as being them
nodes of the grid pertaining to the intersection of
21
20
19
18
plate with the cylinder of axis **Z** passing by node 1
22
and of ray 2.5.
8
7
6
23
17
This list of nodes of name GN2 is defined in
using option "ENV_CYLINDRE" of CREA_GROUP_NO
9
1
5
order DEFI_GROUP.
24
16

One applies a nodal force F
2
3
4
Z = 1 of each one of
25
15
nodes of this list and a nodal force Fz = 1 in
each node of the same list defined in
extension (N3, N5, N7, N9).
10
11
12
13
14
X
Loading case n°7: "PLANE"
y
Nodes 14, 15, 16, 17 and 18 are defined like
21
20
19
18
belonging to the plan passing by the node 14 and of which
22
normal is parallel to **X**.
8
7
6
23
17
This list of nodes of name GN3 is defined in
using the option "PLAN" of CREA_GROUP_NO of
9
1
5
order GROUP_NO.
24
16
One applies a nodal force F
2
3
4

Z = 1 of each one of
25
15
nodes of this list and a nodal force Fz = 1 in
each node of the same list defined in
extension.
10
11
12
13
14
X

3.2
Characteristics of the grid

The grid comprises 32 meshs DKT.

3.3 Functionalities
tested

One tests the following options of creation of group of meshs of order DEFI_GROUP for
3D:

· "SPHERE"
· "CYLINDER"
· "BAND"
· "FACE_NORMALE"

and following options of creation of group of nodes of order DEFI_GROUP:

· "ENV_SPHERE"
· "ENV_CYLINDRE"
· "PLANE"

4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference
Loading case n°1:
DZ (C)
0.
0.
Loading case n°2:
DZ (C)
0.
0.
Loading case n°3:
DZ (C)
0.
0.
Loading case n°4:
DZ (C)
0.
0.
Loading case n°5:
DZ (C)
0.
0.
Loading case n°6:
DZ (C)
0.
0.
Loading case n°7:
DZ (C)
0.
0.
4.2 Remarks
The values are tested in absolute and the tolerance is equal to 1. E10.
4.3 Parameters
of execution
Version: 4.01.12
Machine: CRAY C90
Obstruction memory:

8 MW
Time CPU To use:
100 seconds
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---

5 Modeling
B
5.1
Characteristics of modeling

The elements are TRIA3 in plane deformation. One defines 5 loading cases in the manner following:

Loading case n°1: "SPHERE"

y
Tr6b
Tr7a
The side of an element is equal to 2.5.
21
20
19
18
22
The circle of radius 2. and centered with node 1 has
an intersection not-vacuum with the element
8
7
6
23
17
hatched on the figure, i.e. Tr6a, Tr6b, Tr7a,

Tr10b, Tr11a and Tr11b.
Tr6a
9
1
5
24
16
One applies a voluminal force of density
Tr11b
1 according to **y** on this zone of definite name GM1
2
3
4
25
15
by employing the option “SPHERE” of
CREA_GROUP_MA of the order
DEFI_GROUP and a voluminal force
10
11
12
13
14
X
opposed on this zone defined in extension.
Tr10b Tr11a
Loading case n°2: “BAND”
y
Elements of the shaded zone i.e. Tr5A, Tr5B,
21
20
19
18
Tr6A, Tr6B, Tr7A, Tr7B, Tr8A, Tr8B, Tr9A, Tr9B,
22
Tr10A, Tr10B, Tr11A, Tr11B, Tr12A, Tr12B define
8
7
6
the intersection of the plate with the band of which sides
23
17
are parallel to the axis **X**, whose medium passes by

5B
6B
7B
8B
6A
7A
8A
N1 node, and of which the half-width is equal to 2.
5A
9
1
5
24
16
9B
10B
11B
12B
One applies a voluminal force of density 1 according to
9A
10A
11A
12A
y on this zone defined thus geometrically of
2
3
4
25
15
name GM3 by employing the option “BANDAGES”
CREA_GROUP_MA of order DEFI_GROUP and
voluminal force of density 1. opposed to the preceding one
10
11
12
13
14
X
on this same zone defined in extension.
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Loading case n°3: "FACE_NORMALE"

y
The list of the elements of the geometrical type SEG2, S1,
21
20
19
18
S2, S3, S4 are defined as the list of the elements of
22
grid perpendiculars with direction **Y.**
8
7
6
23
17
One applies a pressure equal to 1. to this list of
geometrically definite name GM4 in the manner
9
1
5
indicated, by employing option "FACE_NORMALE" of
24
16
CREA_GROUP_MA of order DEFI_GROUP and
a pressure with 1. on this same list defined in
2
3
4
25
15
extension.

S1
S2
S3
S4
10
11
12
13
14
X

Loading case n°4: “ENV_SPHERE”

y
Nodes 3, 5, 7 and 9 are defined as being them
nodes of the grid pertaining to the intersection of
21
20
19
18
plate with the circle of N1 centre and 2.5
22
(it is the length on the side of an element).
8
7
6
23
17
This list of nodes of name GN1 is defined in
using option “ENV_SPHERE” of CREA_GROUP_NO
9
1
5
order DEFI_GROUP.
24
16
One applies a nodal force F
2
3
4
y = 1 of each one of
25
15
nodes of this list and a nodal force Fy = 1 in
each node of the same list defined in

extension.
10
11
12
13
14
X
Loading case n°5: "PLANE"
y
Nodes 14, 15, 16, 17 and 18 are defined like
21
20
19
18
belonging to the right-hand side passing by the node 14 and of which
22
the normal is parallel to **X**.
8
7
6
23
17
This list of nodes of name GN3 is defined in
using the option "PLAN" of CREA_GROUP_NO of
9
1
5
order GROUP_NO.
24
16
One applies a nodal force F
2
3
4
y = 1 of each one of
25
15
nodes of this list and a nodal force Fy = 1 in
each node of the same list defined in
extension.
10
11
12

13
14
X

5.2
Characteristics of the grid

The grid comprises 32 meshs TRIA3 and 4 meshs SEG2.

5.3 Functionalities
tested

One tests the following options of creation of group of meshs of order DEFI_GROUP for
2D:

· "SPHERE"
· "BAND"
· "FACE_NORMALE"

and following options of creation of group of nodes of order DEFI_GROUP for the 2D:

· "ENV_SPHERE"
· "PLANE"

---

6 Results of modeling B

6.1 Values tested

Identification	**Reference**	**Aster**	**% difference**
Loading case n°1: DY (C)	0.	0.	
Loading case n°2: DY (C)	0.	0.	
Loading case n°3: DY (C)	0.	0.	
Loading case n°4: DY (C)	0.	0.	
Loading case n°5: DY (C)	0.	0.	

6.2 Remarks

The values are tested in absolute and the tolerance is equal to 1. E10.

6.3 Parameters

of execution
Version: 4.01.12
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
100 seconds

7
Summary of the results

The results are good: the groups calculated by order DEFI_GROUP are well the groups waited.
Attention however with the fact that the test “3D” is actually a test on a plate in plan XOY: role of the 3rd co-ordinate in FORTRAN is thus not tested.

Author (S):
***C. CHAVANT**, Key Mr. LAINET*

Organization (S): EDF/MTI/MMN, CS IF

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.111

ZZZZ111 - Validation of operator DEFI_CABLE_BP

Summary:

The goal of this case-test is to validate the operator DEFI_CABLE_BP [U4.23.06], who calculates the profiles of tension in the cables of prestressed of a structure of concrete, in accordance with the rules of the BPEL: those allow to take account of the losses of tension per contact between the cables and the concrete, by retreat with anchorings, by shrinking and creep of the concrete and relieving of steel, material constituting the cables.

The structure considered is a semi-cylindrical veil, containing in its thickness four cables of prestressed. The cables describe each one a half-circle in a horizontal plane, and thus traverse the veil over its length. Two cables have an eccentricity compared to the average radius of the veil.

The results obtained are validated by comparison with those theoretically awaited. Profiles of tension can be clarified analytically out of the zones where the losses by retreat apply to anchorings.
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Code_Aster ®
Version
5.0

Titrate:
ZZZZ111 - Validation of operator DEFI_CABLE_BP

Date:
07/12/01
Author (S):
C. CHAVANT, Key Mr. LAINET
:

1
Problem of reference

1.1 Geometry

The concrete veil has a semi-cylindrical form: the height is H = 10 m and the average radius is worth R = 10 Mr.
The thickness of the veil is worth E = 0,6 Mr. the "average radius equivalent", within the meaning of the BPEL on the section
vertical of the veil is worth thus rm = 0,283 m, knowing that:

eH
rm =
(ref. BPEL 2.1, 5)
2 (E + H)

The cables describe each one a half-circle in a horizontal plane, and thus traverse the veil on its length. The dimensions of the plans containing the cables are:

- ***for the cable n°1: z1 = 1 m;***
- ***for the cable n°2: z2 = 3,5 m;***
- ***for the cable n°3: z3 = 6 m;***
- ***for the cable n°4: z4 = 8,5 Mr.***

Cables 3 and 4 have an eccentricity compared to the average radius of the veil, being worth respectively:

- ***ex3 = 0,05 m;***
- ***ex4 = 0,1 Mr.***

The surface of the cross-section of each cable is worth Its = 1,5.104 m2.

1.2
Properties of materials

1.2.1 Material concrete constituting the veil

Elastic properties:

Young modulus
Eb = 3.1010 Pa
Poisson's ratio b= 0,2

Parameters characteristic for estimate of the losses of tension:

Standard rate of loss of tension by creep of the concrete
xflu = 0,07
Standard rate of loss of tension by shrinking of the concrete
xret = 0,08

1.2.2 Material steel constituting the cables

Elastic properties:

Young modulus
Ea = 2,1.1011 Pa
Poisson's ratio has = 0,3

Parameters characteristic for estimate of the losses of tension:
Relieving of steel at 1000 hours
1000 = 2 %
Adimensional coefficient of relieving of prestressed steel
µ = 0,3
0
Stress ultimate elastic steel
F prg = 1,77.109 Pa
Coefficient of friction in curve
F = 0,2 rad1
Loss ratio of tension per unit of length
= 3.10-3 m1
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Code_Aster ®
Version
5.0

Titrate:
ZZZZ111 - Validation of operator DEFI_CABLE_BP

Date:
07/12/01
Author (S):
C. CHAVANT, Key Mr. LAINET
:
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1.3 Loading

One applies at the two ends of each cable a normal effort of traction. The value of the tension applied = 2.105 NR is F0.

To evaluate the losses of tension by relieving of the cables in time, the relations are used following:

=
pj
p (X) R (J)
(ref. BPEL 3.3, 24)
6
(X)

=

pi

- µ
(ref. BPEL 3.3, 23)
p

0 pi (X)
100 1000 F prg

J

R (J) =

(ref. BPEL 3.3, 24 and 2.1, 51)
J + 9 × rm

pi (X) called initial tension, the tension at the point of X-coordinate X, after losses of tension instantaneous.

J
moment of evaluation, in day
R
equivalent average radius, in cm
m

The characteristics are evaluated at the D-day = 10.

To evaluate the losses of tension in the vicinity of anchorings, one takes account of a retreat with anchorings = 5.104 Mr.

Note:

This problem disregards resolution of the balance of the structure supplements steel concrete and is limited to the determination according to BPEL'S of prestressed in the cables.

2
Reference solution

2.1
Curvilinear X-coordinate and cumulated angular deviation

The cables describe each one a trajectory in the form of half-circle in a horizontal plane. In consequence, the curvilinear X-coordinate S and the cumulated angular deviation are expressed very simply:

S = Rc
=

where Rc indicates the ray of the half-circle described by the cable, and the azimuth in cylindrical co-ordinates.
The values of reference for the tests are estimated using these expressions.

2.2
Normal effort in the cables

One considers a cable describing a horizontal half-circle of Rc ray. The 0 locating azimuth is noted end of the zone where the losses of tension by retreat apply to the first anchoring; - 0 reference mark it
beginning of the zone where the losses of tension by retreat apply to the second anchoring.
Taking into account the preceding expressions of the curvilinear X-coordinate and angular deviation cumulated, the profile of tension along the cable can be parameterized by the azimuth, out of the zones where
apply the losses by retreat to anchorings:

F () = - F0 (X flu + xret)
5
+

F0 1 + R (J) ×

×

μ

1000
0 ex (
p
(F
Rc))

100

-
+

5

-
F

0
F0 × R (J) ×

×
×

1000
ex (
p - (
2 F + Rc)) on interval 0;
100
S F
has

2
prg

F () = - F0 (X flu + xret)
5
+

F0 1 + R (J) ×

×

μ

1000
0 ex (
p
(F
Rc) (
))

100

-
+
-
5
-
F

0
F0 × R (J) ×

×
×

1000
ex (
p - (
2 F + Rc) (-)) on the interval
100
S F
has
prg

; -

2
0

The values of reference for the tests are estimated using these expressions, which define one symmetrical profile of tension compared to the central node.

2.3
Index of projection

The projection of a node pertaining to the one of the cables on a mesh of the concrete veil gives place to
the assignment of an index of projection IPROJ in accordance with the following rule:

Projection on a mesh triangle of nodes N1 tops, N2 and N3:
•

IPROJ = 0
if the projected point is inside the triangle;
.
IPROJ = 11, 12 or 13 if the projected point belongs respectively to the edge [N1; N2], [N2; N3] or [N3; N1];
.
IPROJ = 2
if there is coincidence of the point projected with a node top.

Projection on a mesh quadrangle of nodes N1 tops, N2 N3 and N4:
.
IPROJ = 0
if the projected point is inside the quadrangle;
.
IPROJ = 11, 12, 13 or 14 if the projected point belongs respectively to the edge [N1; N2], [N2; N3], [N3; N4] or [N4; N1];
.
IPROJ = 2
if there is coincidence of the point projected with a node top.

The values of reference for the tests are estimated by predicting the places of projection of the cables, taking into account their situation compared to the veil and provision of the meshs on this one.

2.4 Eccentricity

The eccentricity of a node pertaining to the one of the cables is defined as the distance from this node with
net concrete veil on which it is projected.
Seen in a horizontal plane, the trace of the mesh is a cord on the half-circle of ray R. One notes the angular sector covered by the mesh. The node of the cable, noted NC, is located on the half-circle of Rc ray. Its relative position compared to the mesh is located by the azimuth.

NC

R
Rc

The vector cos
; sin

2
2 is normal with the cord, which passes by the point (R; 0).

The equation of the cord is thus cos
X + sin
y - R cos
= 0
2
2
2

The distance from a point on a line, in the plan, is given by:

ax0 + by + C
D =
0

a2 + b2

where (x0; y0) is the co-ordinates of the point and ax+by+c=0 is the equation of the right-hand side.

Node NC pertaining to the cable has as co-ordinates (Rc cos; Rc sin). Its eccentricity by report/ratio with the mesh of the veil on which it is projected is thus worth:

exc = Rc cos
-
R

2

- cos
2

The values of reference for the tests are estimated using this expression.

---

3 Modeling
With

3.1
Characteristics of modeling

The concrete veil is represented by elements DKT, supported by meshs quadrangles to 4 nodes: one counts 10 meshs on a vertical generator and 32 on a horizontal half-circle. With this provision, the meshs have dimensions close to those of a square of 1 m on side.

A thickness E = 0,6 m is assigned to all the meshs of the veil, as well as a material concrete for which are defined behaviors ELAS and BPEL_BETON: the parameters take the values data previously in paragraph [§ 2.2.1].

Each cable is represented by 128 elements MECA_BARRE, supported by meshs segments with 2 nodes. On a horizontal half-circle, one thus counts 4 times more meshs on one cable that on the concrete veil.

A surface of cross-section Its = 1,5.104 m2 is assigned to all the meshs of the cables, like one material steel for which behaviors ELAS and BPEL_ACIER are defined: parameters take the values given previously in paragraph [§ 2.2.2].

The F0 tension = 2.105 NR is applied to the two nodes ends of each cable. The value of this tension is coherent with the values of section and of stress ultimate elastic, for cables of prestressed toronés. The evaluation of the losses of tension by relieving and retreat with anchorings is carried out in accordance with the rules of the BPEL; the parameters take the values given previously in paragraph [§ 2.2.3].

As one applies the same tension at the two ends of each cable, and as one imposes the same retreat with anchorings, the profiles of tension obtained must be symmetrical compared to nodes mediums of the cables.

Taking into account the geometrical characteristics and grid, nodes of the cables n°1 and n°2 project on the nodes tops and the edges of the meshs of the concrete veil. For the nodes of these two cables, the indices of projection obtained must be in conformity with the following sequence: 2 for the first node, then 13-13-13-2 until the last node.

The nodes of the cables n°3 and n°4 are projected as for them on the edges and inside the meshs of veil concrete. For the nodes of these two cables, the indices of projection obtained must be in conformity with the following sequence: 14 for the first node, then 0-0-0-12 until the last node.

The rule of assignment of the index of projection is previously defined in paragraph [§ 3.3].

Taking into account the characteristics of the grid, the eccentricities of the nodes of the cables are evaluated

3
using the expression of the paragraph [§ 3.4] with =
and
= 0
,
,

, .
32
4
2
4

3.2 Functionalities tested

The functionalities which one wishes to validate are as follows:

.
operator DEFI_MATERIAU [U4.23.01]
: definition of the relations of behavior
BPEL_BETON and BPEL_ACIER, if all possible losses of tension
are taken into account;
.
operator DEFI_CABLE_BP [U4.23.06]: calculation of the profiles of tension along the cables of
prestressed; projection of the nodes of the cables on the meshs of the concrete veil,
preliminary with the calculation of the coefficients of the relations kinematics between the DDL of the nodes
cables and DDL of the nodes "close" to the concrete veil.

---

4 Results of modeling A

4.1 Values tested

4.1.1 X-coordinate curvilinear

The tolerance of relative variation compared to the reference is worth 0,1%.

Node	Value of reference	Code_Aster	Relative variation
NC001032	7,608545.100 m	7,6085416350199.100 m	-4,42.10-7 %
NC001033	7,853982.100 m	7,8539785609573.100 m	-4,38.10-7 %
NC001034	8,099419.100 m	8,0994154868947.100 m	-4,34.10-7 %
NC001064	1,546253.101 m	1,5462523265015.101 m	-4,36.10-7 %
NC001065	1,570796.101 m	1,5707960190953.101 m	1,22.10-8 %
NC001066	1,595340.101 m	1,5953397116890.101 m	-1,81.10-7 %
NC001096	2,331651.101 m	2,3316504895010.101 m	-2,19.10-7 %
NC001097	2,356194.101 m	2,3561941820946.101 m	

7,73.10-8 %
NC001098
2,380738.101 m
2,3807378746885.101 m
-5,26.10-8 %

NC002032
7,608545.100 m
7,6085416350199.100 m
-4,42.10-7 %
NC002033
7,853982.100 m
7,8539785609573.100 m
-4,38.10-7 %
NC002034
8,099419.100 m
8,0994154868947.100 m
-4,34.10-7 %
NC002064
1,546253.101 m
1,5462523265015.101 m
-4,36.10-7 %
NC002065
1,570796.101 m
1,5707960190953.101 m
1,22.10-8 %
NC002066
1,595340.101 m
1,5953397116890.101 m
-1,81.10-7 %
NC002096
2,331651.101 m
2,3316504895010.101 m
-2,19.10-7 %
NC002097
2,356194.101 m
2,3561941820946.101 m
7,73.10-8 %
NC002098
2,380738.101 m
2,3807378746885.101 m

-5,26.10-8 %

NC003032
7,646587.100 m
7,6465843431956.100 m
-3,47.10-7 %
NC003033
7,893252.100 m
7,8932484537622.100 m
-4,49.10-7 %
NC003034
8,139916.100 m
8,1399125643288.100 m
-4,22.10-7 %
NC003064
1,553984.101 m
1,5539835881341.101 m
-2,65.10-7 %
NC003065
1,578650.101 m
1,5786499991908.101 m
-5,13.10-10 %
NC003066
1,603317.101 m
1,6033164102475.101 m
-3,68.10-7 %
NC003096
2,343309.101 m
2,3433087419485.101 m
-1,10.10-7 %
NC003097
2,367975.101 m
2,3679751530052.101 m
6,46.10-8 %
NC003098
2,392642.101 m
2,3926415640619.101 m
-1,82.10-7 %

NC004032
7,684630.100 m
7,6846270513697.100 m
-3,84.10-7 %
NC004033
7,932521.100 m
7,9325183465668.100 m
-3,35.10-7 %
NC004034
8,180413.100 m
8,1804096417640.100 m
-4,11.10-7 %
NC004064
1,561715.101 m
1,5617148497666.101 m
-9,62.10-8 %
NC004065
1,586504.101 m
1,5865039792862.101 m
-1,31.10-8 %
NC004066
1,611293.101 m
1,6112931088059.101 m
6,75.10-8 %
NC004096
2,354967.101 m
2,3549669943960.101 m
-2,38.10-9 %
NC004097
2,379756.101 m
2,3797561239157.101 m
5,21.10-8 %
NC004098
2,404546.101 m
2,4045452534354.101 m
-3,10.10-7 %

4.1.2 Cumulated angular deviation

The tolerance of relative variation compared to the reference is worth 1%.

Node
Value of reference
Code_Aster
Relative variation
NC001032
7,608545.101 rad
7,5505221851277.101 rad
-0,763 %
NC001033
7,853982.101 rad
7,7959596039949.101 rad
-0,739 %
NC001034
8,099419.101 rad
8,0413970228620.101 rad
-0,716 %
NC001064
1,546253.100 rad
1,5404519589725.100 rad
-0,375 %
NC001065
1,570796.100 rad
1,5649957008614.100 rad
-0,369 %
NC001066
1,595340.100 rad

1,5895394427503.100 rad
-0,364 %
NC001096
2,331651.100 rad
2,3258516994343.100 rad
-0,249 %
NC001097
2,356194.100 rad
2,3503954413232.100 rad
-0,246 %
NC001098
2,380738.100 rad
2,3749391832123.100 rad
-0,244 %

NC002032
7,608545.101 rad
7,5505221851277.101 rad
-0,763 %
NC002033
7,853982.101 rad
7,7959596039949.101 rad
-0,739 %
NC002034
8,099419.101 rad
8,0413970228620.101 rad
-0,716 %
NC002064
1,546253.100 rad
1,5404519589725.100 rad
-0,375 %
NC002065
1,570796.100 rad
1,5649957008614.100 rad
-0,369 %
NC002066
1,595340.100 rad
1,5895394427503.100 rad
-0,364 %
NC002096
2,331651.100 rad

2,3258516994343.100 rad
-0,249 %
NC002097
2,356194.100 rad
2,3503954413232.100 rad
-0,246 %
NC002098
2,380738.100 rad
2,3749391832123.100 rad
-0,244 %

NC003032
7,608545.101 rad
7,5505221853611.101 rad
-0,763 %
NC003033
7,853982.101 rad
7,7959596042577.101 rad
-0,739 %
NC003034
8,099419.101 rad
8,0413970231543.101 rad
-0,716 %
NC003064
1,546253.100 rad
1,5404519589969.100 rad
-0,375 %
NC003065
1,570796.100 rad
1,5649957008877.100 rad
-0,369 %
NC003066
1,595340.100 rad
1,5895394427786.100 rad
-0,364 %
NC003096
2,331651.100 rad
2,3258516994599.100 rad
-0,249 %
NC003097
2,356194.100 rad

2,3503954413473.100 rad
-0,246 %
NC003098
2,380738.100 rad
2,3749391832400.100 rad
-0,244 %

NC004032
7,608545.101 rad
7,5505221850191.101 rad
-0,763 %
NC004033
7,853982.101 rad
7,7959596039041.101 rad
-0,739 %
NC004034
8,099419.101 rad
8,0413970227892.101 rad
-0,716 %
NC004064
1,546253.100 rad
1,5404519589583.100 rad
-0,375 %
NC004065
1,570796.100 rad
1,5649957008524.100 rad
-0,369 %
NC004066
1,595340.100 rad
1,5895394427464.100 rad
-0,364 %
NC004096
2,331651.100 rad
2,3258516994251.100 rad
-0,249 %
NC004097
2,356194.100 rad
2,3503954413144.100 rad
-0,246 %
NC004098
2,380738.100 rad

2,3749391832027.100 rad
-0,244 %
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4.1.3 Normal effort in the cables

The tolerance of relative variation compared to the reference is worth 0,5%.

Node
Value of reference
Code_Aster
Relative variation
NC001032
1,334446.105 NR
1,3362458647761.105 NR
0,135 %
NC001033
1,325720.105 NR
1,3275099211945.105 NR
0,135 %
NC001034
1,317036.105 NR
1,3188178238811.105 NR
0,135 %
NC001064
1,076002.105 NR

1,0775306667470.105 NR
0,142 %
NC001065
1,068586.105 NR
1,0701071214644.105 NR
0,142 %
NC001066
1,076002.105 NR
1,0775306667471.105 NR
0,142 %
NC001096
1,317036.105 NR
1,3188178238804.105 NR
0,135 %
NC001097
1,325720.105 NR
1,3275099211945.105 NR
0,135 %
NC001098
1,334446.105 NR
1,3362458647768.105 NR
0,135 %

NC002032
1,334446.105 NR
1,3362458647761.105 NR
0,135 %
NC002033
1,325720.105 NR
1,3275099211945.105 NR
0,135 %
NC002034
1,317036.105 NR
1,3188178238811.105 NR
0,135 %
NC002064
1,076002.105 NR
1,0775306667470.105 NR
0,142 %
NC002065
1,068586.105 NR

1,07010071214644.105 NR
0,142 %
NC002066
1,076002.105 NR
1,07753066667471.105 NR
0,142 %
NC002096
1,317036.105 NR
1,3188178238804.105 NR
0,135 %
NC002097
1,325720.105 NR
1,3275099211945.105 NR
0,135 %
NC002098
1,334446.105 NR
1,3362458647768.105 NR
0,135 %

NC003032
1,334270.105 NR
1,3360688116680.105 NR
0,135 %
NC003033
1,325538.105 NR
1,3273280739561.105 NR
0,135 %
NC003034
1,316850.105 NR
1,3186312358105.105 NR
0,135 %
NC003064
1,075696.105 NR
1,0772249041795.105 NR
0,142 %
NC003065
1,068278.105 NR
1,0697980987005.105 NR
0,142 %
NC003066
1,075696.105 NR

1,0772249041796.105 NR
0,142 %
NC003096
1,316850.105 NR
1,3186312358105.105 NR
0,135 %
NC003097
1,325538.105 NR
1,3273280739554.105 NR
0,135 %
NC003098
1,334270.105 NR
1,3360688116683.105 NR
0,135 %

NC004032
1,334093.105 NR
1,3358917765746.105 NR
0,135 %
NC004033
1,325356.105 NR
1,3271462458317.105 NR
0,135 %
NC004034
1,316664.105 NR
1,3184446679805.105 NR
0,135 %
NC004064
1,075391.105 NR
1,0769192061838.105 NR
0,142 %
NC004065
1,067969.105 NR
1,0694891422717.105 NR
0,142 %
NC004066
1,075391.105 NR
1,0769192061839.105 NR
0,142 %
NC004096
1,316664.105 NR

1,31844466798O3.105 NR
0,135 %
NC004097
1,325356.105 NR
1,3271462458318.105 NR
0,135 %
NC004098
1,334093.105 NR
1,3358917765746.105 NR
0,135 %
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4.1.4 Index of projection

Node Value
waited Code_Aster
NC001032
13 13
NC001033
2 2
NC001034
13 13
NC001064
13 13
NC001065
2 2
NC001066
13 13
NC001096
13 13
NC001097
2 2
NC001098
13 13

NC002032
0 0
NC002033

12 12
NC002034
0 0
NC002064
0 0
NC002065
12 12
NC002066
0 0
NC002096
0 0
NC002097
12 12
NC002098
0 0

NC003032
13 13
NC003033
2 2
NC003034
13 13
NC003064
13 13
NC003065
2 2
NC003066
13 13
NC003096
13 13
NC003097
2 2
NC003098
13 13

NC004032
0 0
NC004033
12 12
NC004034

0 0
NC004064
0 0
NC004065
12 12
NC004066
0 0
NC004096
0 0
NC004097
12 12
NC004098
0 0
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

4.1.5 Eccentricity

The tolerance of relative variation compared to the reference is worth 0,1%.

Node
Value of reference
Code_Aster
Relative variation
NC001032
9,033625.103 m
9,0336249114191.103 m

-9,81.10-9 %
NC001033
0 0

NC001034
9,033625.103 m
9,0336249114209.103 m
-9,81.10-9 %
NC001064
9,033625.103 m
9,0336249102569.103 m
-9,93.10-9 %
NC001065
0 0

NC001066
9,033625.103 m
9,0336249102566.103 m
-9,93.10-9 %
NC001096
9,033625.103 m
9,0336249114191.103 m
-9,81.10-9 %
NC001097
0 0

NC001098
9,033625.103 m
9,0336249114209.103 m
-9,81.10-9 %

NC002032
9,033625.103 m
9,0336249114191.103 m
-9,81.10-9 %
NC002033
0 0

NC002034
9,033625.103 m
9,0336249114209.103 m

-9,81.10-9 %
NC002064
9,033625.103 m
9,0336249102569.103 m
-9,93.10-9 %
NC002065
0 0

NC002066
9,033625.103 m
9,0336249102566.103 m
-9,93.10-9 %
NC002096
9,033625.103 m
9,0336249114191.103 m
-9,81.10-9 %
NC002097
0 0

NC002098
9,033625.103 m
9,0336249114209.103 m
-9,81.10-9 %

NC003032
5,901857.102 m
5,9018565845884.102 m
-7,04.10-8 %
NC003033
5.102 m
5,0000000000957.102 m
1,91.10-11 %
NC003034
5,901857.102 m
5,9018565845884.102 m
-7,04.10-8 %
NC003064
5,901857.102 m
5,9018565848231.102 m
-7,03.10-8 %
NC003065

5.102 m
4,9999999999955.102 m
-9,02.10-13 %
NC003066
5,901857.102 m
5,9018565848231.102 m
-7,03.10-8 %
NC003096
5,901857.102 m
5,9018565845216.102 m
-7,04.10-8 %
NC003097
5.102 m
5,0000000000957.102 m
1,91.10-11 %
NC003098
5,901857.102 m
5,9018565845884.102 m
-7,04.10-8 %

NC004032
1,090035.101 m
1,0900350678046.101 m
6,22.10-8 %
NC004033
101 m
1,0000000000047.101 m
4,68.10-12 %
NC004034
1,090035.101 m
1,0900350678046.101 m
6,22.10-8 %
NC004064
1,090035.101 m
1,0900350677825.101 m
6,22.10-8 %
NC004065
101 m
1,0000000000002.101 m
2,31.10-13 %
NC004066

1,090035.101 m
1,0900350677825.101 m
6,22.10-8 %
NC004096
1,090035.101 m
1,0900350678046.101 m
6,22.10-8 %
NC004097
101 m
1,0000000000047.101 m
4,68.10-12 %
NC004098
1,090035.101 m
1,0900350678046.101 m
6,22.10-8 %

4.2 Remarks

One clearly obtains relative variations for the cumulated angular deviation of an order of magnitude higher than those obtained for the curvilinear X-coordinate, which is calculated with very good precision.
The cause is inherent in the method of interpolation spline cubic used to interpolate them trajectories of the cables. This method consists in interpolating the trajectory on each subinterval by a polynomial of order 3, by guaranteeing the continuity of the derived first and the derivative seconds at the boundaries of the subintervals. The interpolation of a circular trajectory by

polynomials of order 3 is in is an approximation, of which the effects are more sensitive on the derivative seconds that on the derivative first.
This is why precision obtained for the curvilinear X-coordinate, calculated using the derivative first of the trajectory, is definitely better than that obtained for the angular deviation cumulated, calculated using products crossed between the derivative first and the derivative second.
To improve the precision on the cumulated angular deviation, it would appreciably be necessary to refine it grid: this step is not valid a priori, because it would lead to overcosts of calculation very consequent for a weak profit of precision.

One obtains indeed symmetrical profiles of tension compared to the nodes mediums of the cables.
The variations by defect on the curvilinear X-coordinate and the cumulated angular deviation induce variations by excess on the calculated values of tension, but the precision remains satisfactory: this validates method of calculation.

The indices of projection obtained are in conformity with those awaited, and the eccentricities are calculated with a very good precision: this validates the operations of projection.

4.3 Parameters of execution

Version: 5.07.01

Machine: SGI/ORIGIN 2000 R12000
System:
Obstruction memory:
64 Mo
Time CPU To use: 14 seconds

5 Summary of the results

The results obtained are validated by comparison with those theoretically awaited with one good precision.

The particular functionalities tested are as follows:

.

operator DEFI_MATERIAU [U4.23.01]: definition of the parameters characteristic of materials steel and concrete allowing the calculation of the tension along the cables of prestressed, in accordance with the rules of the BPEL;

·

operator DEFI_CABLE_BP [U4.23.06]: calculation of the tension along the cables; projection nodes of the cables on the meshs representing the structure of concrete, preliminary with calculation of the coefficients of the relations kinematics between the DDL of the nodes of the cables and them
DDL of the nodes "close" to the structure of concrete.

ZZZZ112 - Roll under variable pressure.
Validation of LIRE_PLEXUS

Summary:

The purpose of this test is to validate the operation of order LIRE_PLEXUS. This one makes it possible to read
fields of pressures calculated by PLEXUS on a telegraphic grid, and to apply these pressures to a grid composed of hulls or telegraphic elements.

This test has an analytical solution: it is about a cylinder subjected to a pressure which varies linearly along its axis.

Two modelings are proposed: the cylinder is with a grid in elements DKT (modeling A) or in elements COQUE_3D (modeling B).

The results differ from the reference solution only by the lack of refinement of the grid of hulls
(in particular for modeling A).
This test thus validates order LIRE_PLEXUS.

1
Problem of reference

1.1 Geometry

Roll of axis X, length L, average radius R, thickness E.

R
C
X
D
With
B
X=0
X=L

Here, L=1m, R=0.1m, e=0.01m.

1.2
Material properties

Linear elasticity:

Young modulus: E = 2 1011
.
Pa
Poisson's ratio = 0 3
.

1.3
Boundary conditions and loadings

The grid in hulls is connected to elements of beams in A and B. This makes it possible to give boundary conditions compatible with the kinematics of beam. However, One is interested here only with the solution of hulls subjected to an internal pressure.
The point D is embedded.

The pressure is read on a grid "plexus" of segment AB, comprising 20 elements of beams.

It varies in the following way:

X
P = 10. 1 -
Pa

L

2
Reference solution

2.1
Method of calculation used for the reference solution

analytical:

If the pressure varies like:

X
P = - P. 1 + -

p

L
0

then the circumferential component of the tensor of constraints is worth:

P R
X
= 0
. 1 + -

E
p
L

and the field of displacement is worth:

P R
0

X
U = -
. X 1 + -
X
E E
p

2L
P R2
0

X
U = -
. 1 + -
R
E
E
p

L

2.2
Results of Reference

Here, =0.
p

X U (m) U (m)

R
X
(Pa)
0 5d-11
0
100
1 0.7.5d-11
0

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibiographic

[1]
PILKEY W.D.: "Formulated for stress, strain and structural matrices". Wiley & Sounds, New York, 1994.

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling DKT and POU_D_E

3.2
Characteristics of the grid

A number of nodes: 339
A number of meshs and types: 395 QUAD4
7 SEG2

3.3 Functionalities
tested

Orders

Keys
LIRE_PLEXUS

[U4.xx.xx]
AFFE_CHAR_MECA LIAISON_ELEM
OPTION
COQ_POU
[U4.25.01]

4
Results of modeling A

4.1 Values
tested

Identification X Reference Aster %
difference

0 100
97.13
2.9
U
0 5.D-11
4.84D-11
3.1
R

4.2 Parameters
of execution

Version: 5.2

Machine: SGI/ORIGIN 2000

Obstruction memory:
128 Mo
Time CPU To use:
4 seconds
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5 Modeling
B

5.1
Characteristics of modeling

Modeling COQUE_3D and POU_D_E

5.2
Characteristics of the grid

A number of nodes: 429
A number of meshs and types: 145 QUAD9
7 SEG2

5.3 Functionalities
tested

Orders

Keys
LIRE_PLEXUS

[U4.xx.xx]
AFFE_CHAR_MECA LIAISON_ELEM
OPTION
COQ_POU
[U4.25.01]

6
Results of modeling B

6.1 Values
tested

Identification X Reference Aster %

difference

0 100
98.7
1.3
U
0 5.D-11
4.81D-11
3.8
R

6.2 Parameters
of execution

Version: 5.2

Machine: SGI/ORIGIN 2000

Obstruction memory:
128 Mo
Time CPU To use:
4 seconds

---

7 Modeling
C

7.1
Characteristics of modeling

Modeling COQUE_3D, PIPE and POU_D_T
A half of cylinder (0<X<L/2) is with a grid in elements of hulls, other half is with a grid in elements PIPE.

7.2
Characteristics of the grid

A number of nodes: 436
A number of meshs and types: 100 QUAD9 (modeling COQUE_3D), 5 SEG3 (modeling PIPE), 4 SEG2 (modeling POU_D_T)

7.3 Functionalities
tested

Orders

Keys
LIRE_PLEXUS

[U4.xx.xx]
AFFE_MODELE AFFE
MODELING
PIPE
[U4.2201]
AFFE_CHAR_MECA LIAISON_ELEM
OPTION
COQ_TUYAU
[U4.25.01]

8
Results of modeling C

8.1 Values tested

Identification X Reference Aster % difference

0 100
95
5
U
0 5.D-11
4.85D-11
3.0
R

8.2 Parameters of execution

Version: 5.2

Machine: SGI/ORIGIN 2000

Obstruction memory:
128 Mo
Time CPU To use:
6 seconds

9
Summary of the results

The results differ from the reference solution only by the lack of refinement of the grid from hulls (in particular for modeling A).

This test thus validates order LIRE_PLEXUS.

Code_Aster ®
Version
5.0

Titrate:
ZZZZ113 - Chaining 3D (R, théta) and 2D (R, Z) CYRANO3-Code_Aster
Date:
07/11/01
Author (S):
P. MASSIN, Mr. BONNAMY
Key: V1.01.113-A Page:
1/12

Organization (S): EDF/MTI/MMN, AUSY

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V1.01 booklet: Tests of validity of orders
V1.01.113 document

ZZZZ113 - Chainings 3D (R, théta) and 2D (R, Z)
CYRANO3-Code_Aster

Summary:

This test makes it possible to validate nonthe regression of the tool for chaining C3ASTER between codes CYRANO3 and
Code_Aster. Two-dimensional modeling represents the unit pelletizes sheath in a plan (R, Z) and

three-dimensional modeling is contingent on a structure made up of two fragments of pastille and an edge of sheath of fuel pin. In three-dimensional modeling, the chaining makes it possible to model one slice fuel pin in the plan (R, théta) with a 0,1 mm thickness in order to simulate the efforts axial. The pellet-sheath spaces inter-fragments and play are modelled by elements 3D of contact-friction.

The loadings and the initial conditions come from a base of results CYRANO3. The chaining provides in Code_Aster of the files of grid and data of orders.

The versions considered here are:

· CYRANO3, version 2.6,
· C3ASTER, version 3.0.

The file of validation for this test is to be begun again since values of not-regression changed for modelings has and C since version 5.4.8 compared to the establishment of origin per Mr. Bonnamy in version 5.1.8. The values of origin of version 5.1.8 are indicated in reference.
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1
Problem of reference

1.1 Geometry

Y
p
J
Z

p
O
X
dtrou/2
diap/2
rgext-rgint

rev
dchamf/2
hchamf
devap/2
hev
hp/2
PELLETIZES
PLAY
SHEATH
diap/2
dtrou/2

· diap (diameter pelletizes): 4,0975 Misters.
· dtrou (central bore): 0 Misters.
· rgint (interior ray sheaths): 4,18 Misters.
· rgext (external ray sheaths): 4,75 Misters.
· p (half angle of the fragments): 22,5 degrees.
· J (angle between fragments): 2.105 degrees.
· height H following Z: 0,1 Misters.
· hev (depth of obviously): 0,3 mm
· rev (spherical ray obviously): 14,64 mm
· devap (apparent diameter obviously): 5,9 mm
· dchamf (diameter chamfer): 0,00 mm
· hchamf (height chamfer): 0,00 mm

1.2
Material properties

E (T), (T), (T) for the combustible pastille, coming from CYRANO3
E (T), (T), (T) for the sheath, coming from CYRANO3.

1.3
Boundary conditions and loadings

1.3.1 Loadings

Loading coming from calculation CYRANO3 (version 2.6) for the same moment (not of time number
101, urgent t=25,0564 S.) on the case-test called "test1c3", transcribed in orders *Aster* by

C3ASTER, version 3.0:

· internal pressure pi on the interior edge of the sheath,
· internal pressure pi on the edge external of the pastille,
· external pressure EP on the edge external of the sheath,
· surface forces according to Z, FP and Fg, equivalent to axial stresses zz imposed on fragments of pastille and sheath,
· field of temperature T to radial dependence, decreasing of the interior towards outside.
· field of anelastic deformations year, read in the form of dataset IDEAS.

For modeling A, one adds:

· internal pressure pi on the edges of the zone inter-fragments.

1.3.2 Boundary conditions:

For modeling a:

· Normal Déplacement no one at the edges = 2p+j and = 0,
· Déplacement following Z null on the Z=0 face,
· Uniform Déplacements for the whole of the nodes of the fragments of pastille in z=h,
· Uniform Déplacements for the whole of the nodes of the sheath in z=h,
· Point O blocked with rigid connections with the crown of central elements of which displacement normal is imposed on zero.

Unilateral contact
Y
with friction
Simple support
External pressure
Internal pressure
X
Simple support

Modeling a: Seen top (z=h)
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
ZZZZ113 - Chaining 3D (R, théta) and 2D (R, Z) CYRANO3-Code_Aster
Date:
07/11/01
Author (S):
P. MASSIN, Mr. BONNAMY
Key: V1.01.113-A Page:
4/12

Z
Constraint sig
Constraint sig
Z (T)
Z (T)
H
Pi
EP
Pelletizes
Sheath
X

Plane modeling a: of cut (= 0)

For modeling b:

· Conditions of symmetry compared to axis X and axisymetry around the axis Y

pressure interns pint (T)
Y
thermal deformations (X, T)
imposed axial stress SIGz (T)
anelastic deformations (X, T)
external pressure pext (T)
Dx = 0 or
PELLETIZES
SHEATH
imposed pressure
if central hole
X
Dy=0 (cond. of symmetry)
conditions of unilateral contact

Plane modeling b: (R, Z)

1.4 Conditions
initial

Field 3D of constraints, displacements and variables intern at the moment T = 25,04528 S. coming from
calculation CYRANO3, read in the form of dataset IDEAS.

2
Reference solution

2.1
Method of calculation used for the reference solution

No the reference solution.

2.2
Results of reference

No results of reference.

---

3 Modeling
With

3.1
Characteristics of modeling

Elements of volume

Names of the nodes: Not P2 = N308 (node supported on Ona+1)

Not P3 = N288 (node resulting from the rotation of Ona+1 of the angle =p)

Not P4 = N264 (node supported on Ona+2)

Not P6 = N44 (node supported on Ona+ngn+2)

Not P7 = N244 (node resulting from the rotation of Ona+2 of the angle = p)

Not P9 = N288 (node resulting from the rotation of Ona+ngn+2 of the angle =p)

sheath
p
J
Z
2nd fragment
p
H
X
Y
O
Ona+ngn+2
O
na+2
na+1
O O1
1st fragment

· De O1 with Ona+1: 16 elements (fragment of pastille)
· De Ona+1 with Ona+2: 1 element (zone of pellet-sheath contact)
· De Ona+2 with Ona+ngn+2: 5 elements (sheath)
· 10 elements in circumference in each fragment (p),
· 1 element in the zone inter-fragments (I) (zone of contact between fragments)
· 1 following element (Z).

3.2 Characteristics

grid

A number of nodes:
1013
A number of meshs and type:
461 HEXA8

3.3 Functionalities
tested

Orders

LIRE_RESU "IDEAS"

AFFE_CHAM_NO "TEMP_R"

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
LIAISON_UNIF
GROUP_MA

TEMP_CALCULEE

EPSA_CALCULEE

PRES_REP
GROUP_MA

FORCE_FACE
GROUP_MA

AFFE_MATERIAU GROUP_MA

“MECHANICAL” AFFE_MODELE
“3D”
PASTTOT
GAINTOT
“MECHANICAL”
“3D_CONTACT”
JEUTOT
BCTFUELT
DEFI_MATERIAU ELAS_FO

LEMAITRE

ZIRC_CYRA2

CONTACT
E_N

E_T

COULOMB

STAT_NON_LINE

4 Results of modeling A

4.1 Values tested

Standard identification of *Aster*	Reference value	
P2 node ux	2.759 10-2	2.198 10-2
P4 node ux	4.863 10-3	4.863 10-3
P6 node ux	6.284 10-3	6.284 10-3
P3 node ur	2.865 10-2	2.211 10-2
P7 node ur	4.824	

10-3 4.824
10-3
P9 node
ur 6.245
10-3 6.245
10-3
P2 node
vmis
359.96 495.4
P4 node
vmis
60.5 60.5
P6 node
vmis
40.5 40.5
P3 node
vmis
366.14 514.7
P7 node
vmis
60.8 60.8
P9 node
vmis
40.2 40.2

4.2 Remarks

The results observed to ensure itself of nonthe regression of the code are:

· Ur displacements at the points P2, P4, P6 and P3, P7, P9,
· constraints equivalent *vmis* to the points P2, P4, P6 and P3, P7, P9.

Contents of the file results: Displacements with the nodes, constraints with the nodes

4.3 Parameters
of execution

Version: 5.01.07

Machine
: Origin 2000

CLASTER
Obstruction memory:
128 Megabytes
Time CPU To use:
145.7 seconds

5 Modeling
B

5.1
Characteristics of modeling

Elements plans QUAD4, representation in a plan (R, Z) of the unit pelletizes combustible and sheath:

· 10 elements axially according to (Z),
· Radial Maillage resulting from CYRANO3: 10 elements in the pastille and 5 in the sheath.

5.2 Characteristics

grid

A number of nodes:

187
A number of meshs and type:
150 QUAD4

5.3 Functionalities tested

Orders

LIRE_RESU "IDEAS"

AFFE_CHAM_NO "TEMP_R"

"DEPL_R"

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
LIAISON_UNIL_NO
GROUP_MA

TEMP_CALCULEE

EPSA_CALCULEE

PRES_REP
GROUP_MA

FORCE_CONTOUR
GROUP_MA
FY
AFFE_MATERIAU GROUP_MA

"MECHANICAL" AFFE_MODELE "AXIS"
DEFI_MATERIAU ELAS_FO

LEMAITRE

ZIRC_CYRA2

STAT_NON_LINE

6
Results of modeling B

6.1 Values
tested

Identification
Type of value
Aster
N77 node
ux 2.350
10-2
N66 node
ux 4.796
10-3
N41 node
ux 6.217
10-3
N67 node
ur 2.335
10-2

N5 node
ur 4.798
10-3
N1 node
ur 6.219
10-3
N77 node
vmis
395.12
N66 node
vmis
59.32
N41 node
vmis
38.80
N67 node
vmis
390.0
N5 node
vmis
59.28
N1 node
vmis
38.78

6.2 Remarks

The results observed to ensure itself of nonthe regression of the code are:

· Ux displacement and constraint equivalent *vmis* to the N77 points (end pelletizes), N66 (face intern sheaths) and N41 (external face sheaths) for Y = 0.
· Ux displacement and constraint equivalent *vmis* to the N67 points (end pelletizes), N5 (face intern sheaths) and N1 (external face sheaths) for Y = hp/2.

Contents of the file results: Displacements with the nodes, constraints with the nodes

6.3 Parameters of execution

Version: 5.03.01

Machine
: Origin 2000

CLASTER
Obstruction memory:
32 Megabytes
Time CPU To use:
5.98 seconds
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

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7 Modeling
C

7.1
Characteristics of modeling

Identical to modeling A

7.2 Characteristics

grid

A number of nodes:
1013
A number of meshs and type:
461 HEXA8

7.3 Functionalities tested

Orders

LIRE_RESU “IDEAS”

AFFE_CHAM_NO “TEMP_R”

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
FACE_IMPO
GROUP_MA
DNOR
LIAISON_UNIF
GROUP_MA

LIAISON_UNIL_NO
GROUP_MA_1
BCONT
GROUP_MA_2
BCONTS
TEMP_CALCULEE

EPSA_CALCULEE

PRES_REP
GROUP_MA

FORCE_FACE
GROUP_MA

AFFE_MATERIAU GROUP_MA

“MECHANICAL” AFFE_MODELE “3D” PASTTOT
GAINTOT
“MECHANICAL”

“3D_CONTACT”
JEUTOT

DEFI_MATERIAU ELAS_FO

LEMAITRE

ZIRC_CYRA2

CONTACT
E_N

E_T

COULOMB

STAT_NON_LINE

---

8 Results of modeling C

8.1 Values tested

Standard identification
of
***Aster* Reference**
initial
value
P2 node
ux 2.759
10-2 2.198
10-2
P4 node
ux 4.863
10-3 4.863
10-3
P6 node
ux 6.284
10-3 6.284
10-3
P3 node
ur 2.865
10-2 2.211
10-2
P7 node
ur 4.824
10-3 4.824
10-3
P9 node
ur 6.245
10-3 6.245
10-3
P2 node
vmis
359.96 495.4
P4 node
vmis
60.5 60.5
P6 node
vmis
40.5 40.5
P3 node
vmis
366.14 514.7
P7 node

vmis
60.8 60.8
P9 node
vmis
40.2 40.2

8.2 Remarks

The results observed to ensure itself of nonthe regression of the code are:

· Ur displacements at the points P2, P4, P6 and P3, P7, P9,
· constraints equivalent *vmis* to the points P2, P4, P6 and P3, P7, P9.

Contents of the file results: Displacements with the nodes, constraints with the nodes

8.3 Parameters of execution

Version: 5.01.07

Machine
: Origin 2000

CLASTER
Obstruction memory:
128 Megabytes
Time CPU To use:
105.8 seconds

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

9
Summary of the results

Not-regression. The file of validation for this test is to be begun again since values of not-regression changed for modelings has and C since its establishment of origin by Mr. Bonnamy in version 5.4.8. The values of origin of version 5.1.8 are indicated in reference. One can nevertheless suppose that the new values obtained are better insofar as the results on the constraints between modelings has and B or C and B approach. But that remains to check.

Titrate:
ZZZZ118 - Test of nonregression INCLUDE_MATERIAU
Date
:

16/11/01
Author (S):
Key ***A.M. DONORE***
:
V1.01.118-A Page:
1/6

Organization (S): EDF/MTI/MMN

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.118

ZZZZ118 - Test of nonregression INCLUDE_MATERIAU

Summary:

The purpose of this test is to check the correct operation of the order INCLUDE_MATERIAU (which carries out
connection between the Catalogue Materials Aster and Code_Aster). It is a test of nonregression.

1
Problem of reference

1.1 Geometry

Thin rectangular plate thickness 0.01 m (see test HSLS01B).

D
C
With
B

1.2
Material properties

Young modulus:

T (°C)
0.
20.
50.
100. 150.

200.
250. 300.
350.
400. 450. 500. 550. 600.

E (T) (109 Pa) 205. 204. 203. 200. 197.
193.
189. 185.
180.
176. 171. 166. 160. 155.

Poisson's ratio: = 0.3

Definite dilation coefficient average compared to 20°C:

T (°C)
20.
50.
100.
150.
200.
250.

300.
350.
400.
450.

(T) (106 /K) 11.22 11.45 11.79 12.14 12.47 12.78 13.08 13.40 13.72 14.02

1.3
Boundary conditions and loadings

Embedded thin section: GROUP_NO: (AB BC CD DA)
DX=DY=DZ=DRX=DRY=DRZ=0.

Heat gradient in the thickness:

temp
=
AFFE_CHAM_NO
(

NOM_CMP =_F
("TEMP", "TEMP_INF", "TEMP_SUP"),
VALE_R
=
(
50.
,
20.
,
100.
)
)

The temperature of Tref reference of calculation is of 20°C.

A pressure distributed on the meshs of the grid

PRES_REP=_F (GROUP_MA=' STOT', PRES= -100),

2
Reference solution

2.1
Method of calculation used for the reference solution

One makes initially a linear thermomechanical calculation (MECA_STATIQUE) by defining material in
the command file (DEFI_FONCTION and DEFI_MATERIAU), which gives the values of reference. Then one uses the values of the characteristics materials available in the Catalogue Materials with order INCLUDE_MATERIAU (NOM_AFNOR: "18MND5" TYPE_MODELE: "Ref."
ALTERNATIVE: "A" TYPE_VALE: "NOMI") and one remake linear thermomechanical calculation. Results of
these two calculations must be identical (the goal is not the validation of the order MECA_STATIQUE).

2.2

Results of reference

Taking into account the loading, the reference solution in constraints is uniform on all the structure, one tests the value of fields SIXX, SIYY

2.3
Uncertainty on the solution

Case test of nonregression ==> exact solution.

2.4 References
bibliographical

[1]
Case test HSLS01B.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

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3 Modeling
With

3.1
Characteristics of modeling

The structure is modelled in elements DKT, DST and Q4.

3.2 Characteristics

grid

A number of nodes: 675

A number of meshs and types: 236 SEG2, 624 TRIA3, 312 QUAD4

3.3 Functionalities tested

Orders

INCLUDE_MATERIAU

4 Results of modeling A

4.1 Values tested

Identification Reference Aster % difference
SIXX
1.62356342360E+00 1.62356342360E+00
0.000
SIYY
2.2097781405E+00 2.2097781405E+00
0.000

4.2 Notice

The precision is excellent.

4.3 Parameters
of execution

Version: 5.02

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
64 megawords
Time CPU To use: 9.73 seconds
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-75/01/010/A

---

5 Modeling
B

5.1
Characteristics of modeling

The structure is modelled in elements C_PLAN

5.2 Characteristics

grid

A number of nodes: 675

A number of meshs and types: 236 SEG2, 624 TRIA3, 312 QUAD4

5.3 Functionalities tested

Orders
Key word

INCLUDE_MATERIAU EXTRACTION

6
Results of modeling B

6.1 Values tested

Identification Reference Aster
% difference
SIXX
-2.694857+08 -2.694857+08
0.000
SIYY
-2.694857+08
-2.694857+08
0.000

6.2 Notice

The precision is excellent.

6.3 Parameters of execution

Version: 6.00

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
64 megawords
Time CPU To use: 4.71 seconds

7
Summary of the results

The found results are in conformity for two modelings.

ZZZZ119 - PROJ_CHAMP for HULLS

Date:
09/02/00
Author (S):
Key J.PELLET
:
V1.01.119-A Page:
1/4

Organization (S): EDF/MTI/MMN

Handbook of Validation
V1.01 booklet: Data-processing tests
Document: V1.01.119

ZZZZ119 - PROJ_CHAMP for surfaces in 3D

Summary:

One treats the case of a quarter of cylinder (modelled by hulls DKQ) subjected to a pressure interns on one
first grid ma1. The field of displacement obtained (ch1) is supposed just. One projects this field of displacement on another grid (ma2) of the same quarter of cylinder. Ch2 is obtained. One Re-projects ch2 on
ma1, one obtains ch1bis. The result (ch1bis) is close to ch1 (2% of difference). This validates the method of

projection of a field of a surface on the other.
Handbook of Validation
V1.10 booklet: Data-processing tests
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

A cylindrical hull (1/4 of cylinder) height H = 40 and ray R = 10 and thickness E = 0.2 is embedded on its line of centers and subjected to a pressure p interns = 2.

It is with a grid twice:

ma1: 7 X 14
QUAD4
ma2: 8 X 16 X 2
TRIA6

ma1 ma2

1.2

Material properties

E =1. 106

= 0.3

1.3
Boundary conditions, loading

The group of nodes AB1 is embedded (three displacements and three rotations are blocked).

DX = DY = DZ = 0.
DRX = DRY = DRZ = 0.

The hull is subjected to a pressure interns p = 2.

1.4 Functionalities
validated

Orders

Keys
PROJ_CHAMP VIS_A_VIS
GROUP_MA_1

[U4.53.05]
METHOD
“ELEM”

The validation relates to method “ELEM in the case of” the surface meshs plunged in R3 space. One also tests key word VIS_A_VIS for method “ELEM”.

2
Reference solution

2.1
Method of calculation used for the reference solution

For the field ch1, calculated on the grid ma1, the reference solution is obtained with Code_Aster (version 5.02.07).

For the field ch1bis obtained by a projection “return ticket” (ma1 - > ma2 - > ma1), the solution of reference is the field ch1.

One thus measures the error due to 2 successive projections of fields: ch1 - > ch2 - > ch1bis

3 Values
Tested

Field
Node
CMP
Reference
Found value
Difference (%)

CH1 CH1BIS

CH1BIS N123

DX
2.17555E01 2.14000E01
-1.634
CH1BIS N123
DY
3.96143E01 3.99026E01 0.728
CH1BIS N48 DX
9.35364E02 9.18094E02
-1.846
CH1BIS N48 DY
1.90742E01 1.93265E01 1.323
CH1BIS N66 DX
2.17555E01 2.14000E01
-1.634

3.1
Parameters of execution (last observation)

Version: 5.02

Machine: SGI-ORIGIN 2000-R12000

Obstruction memory:
64 Mo
Time CPU to use:
5.3 S

Handbook of Validation
V1.10 booklet: Data-processing tests
HT-66/02/001/A

4
Summary of the results

This case test makes it possible to check the correct operation of order PROJ_CHAMP for surfaces in 3D.

Organization (S): EDF R & D /SINETICS

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.121

ZZZZ121 - Adaptation of grid with LOBSTER

Summary

This series of case-tests validates by means of computer the adaptation of grid with LOBSTER. On a grid
simple, either in 2D, or in 3D, a static calculation of mechanics is launched, with production of an indicator
errors. From there, a call to the software LOBSTER will involve a modification of the grid. On it
new grid, a new calculation of static mechanics is activated, corresponding to the same problem physics.
These case-tests are not examples of the interest of the adaptation of grid. They are used only as tests of
not-regression of the functionality in the various possible configurations.

Titrate:
ZZZZ121 - Adaptation of grid with LOBSTER

Date:
01/09/05
Author (S):
G. Key NICOLAS
:
V1.01.121-C Page:
2/20

Count

matters

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

Code_Aster ®
Version
8.2

Titrate:
ZZZZ121 - Adaptation of grid with LOBSTER

Date:
01/09/05
Author (S):
G. Key NICOLAS
:
V1.01.121-C Page:
3/20

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1 Context

The objective is only to test the not-regression of the future evolutions of ASTER and LOBSTER.
Even if the case-tests are realistic from the physical point of view for representing studies well real, one should not attach importance to the value of the results.
In particular, one should not anything deduce some as for the performance indicating couple from error adaptation of grid.

These case-tests validate the operation of two macro orders MACR_INFO_MAIL and MACR_ADAP_MAIL which control the whole of the process.

More precisely, the functionalities tested are as follows:

- *readings and writings of grid and fields to format MED. They are the orders IMPR_RESU, LIRE_CHAMP and LIRE_MAILLAGE with key word MED like format,*
- *writing of the data file for LOBSTER: order IMPR_FICO_HOMA,*
- *launching of the procedure managing the LOBSTER execution. It is the order EXEC_LOGICIEL; it calls a script with a variable number of arguments,*
- *piloting of the whole of the process by the python: macr_adap_mail_ops.py.*

The process is a priori insensitive with modeling considered. The two important points which cause different treatments in the data exchange between LOBSTER and Code_Aster are the types of elements and the update of fields on the new grid. We consider thus 4 modelings which are distributed as follows:

Modeling	*Dimension*	*Update of fields*
With	*2D triangles*	*Not*
B	*3D tetrahedrons*	*Not*
C	*2D triangles*	*Yes*
D	*2D quadrangles*	*Not*

The not-regression is tested on the value of the field of displacement, constraint or temperature in a free node. The test takes place for two resolutions, those with the grids resulting from the first and of another adaptation. Indeed, the data transmissions and LOBSTER piloting are not the same ones for the first adaptation and the following ones. At least two passages thus should be tested.

Handbook of Validation
V1.01 booklet: Tests of validity of orders

2
Problem of reference

2.1 Geometry

2.1.1 The two-dimensional case of modelings A and C

The two-dimensional case is a square on side unit. It is divided into two parts according to the diagonal
of equation X + y = 1.

J (0; 1)
OPPOSE (1; 1)
Half 2
Half 1
ORIGIN (0; 0)
I (1; 0)

2.1.2 The three-dimensional case of modeling B

The three-dimensional case is a cube on side unit. It is divided into two parts according to the diagonal plan of equation X + y = 1.

Z
K (0; 0; 1)
HALF 1
OPPOSE (1; 1; 1)
ORIGIN (0; 0; 0)
I (1; 0; 0)
J (0; 1; 0)
X
y
HALF 2

Titrate:
ZZZZ121 - Adaptation of grid with LOBSTER

Date:

2.1.3 The two-dimensional case of modeling D

This case is a copy of case-test SSLV111.

B (0; 4)
C (4; 4)
= / 3
To (0; 1)
= / 6
D (4; 0)
E (1; 0)

2.2
Properties of material

Two distinct materials are used. This difference makes it possible to make sure that the under-fields are well reconstituted after the adaptation of the grid.

Material 1
:
E: 180.000 Pa

= 0,3 IF

= 1,5 105 IF

= 7.700 kg.m3

= 400 W.K1 m1

Material 2

:
E: 220.000 Pa

= 0,33 IF

= 1,6 105 IF

= 8.300 kg.m3

= 600 W.K1 m1

In each case of modelings A, B and C, material 1 is affected with half 1 and material
2 is affected with half 2. In the case of modeling D, the field is homogeneous and is made up
material 1.

2.3
Boundary conditions and changes

2.3.1 The two-dimensional case of modelings A and C

Imposed displacement:

The part is blocked in translation and rotation around the origin.
Segment ORIGINE_J: DNOR = 0
ORIGIN: DY = 0

Mechanical loading:

One applies a pressure to the higher edge.
Segment J_OPPOSE: CLOSE = -1000.

For a thermomechanical calculation:

The temperature is imposed at the origin:
ORIGIN: TEMP = 200.

Thermal loading:

One applies a convectif exchange with outside to the flat rim.

Segment I-OPPOSE: COEFF_H = 500. TEMP_EXT = 310.

A voluminal source is applied:

HALF 1: SOUR = 18 000
HALF 2: SOUR = 22 000

2.3.2 The three-dimensional case of modeling B

Imposed displacement:

The part is blocked in translation and rotation around the origin.

ORIGIN: DX = DY= DZ = 0

I: DY = DZ = 0
J: DZ = 0

Mechanical loading:

Account of gravity is taken.

GRAVITY = 9,81 according to OZ

One applies a surface force equal to the weight of the cube, opposite higher.

FORCE_FACE = 78.480 according to OZ

2.3.3 The two-dimensional case of modeling D

To represent symmetries, the part is blocked in translation on the edges of cut:
Vertical edge AB: DX = 0
Horizontal edge ED: DY = 0
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

Code_Aster ®
Version
8.2

Titrate:
ZZZZ121 - Adaptation of grid with LOBSTER

Date:
01/09/05
Author (S):
G. Key NICOLAS
:
V1.01.121-C Page:
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Mechanical loading:

F
= (X = 4)

F
X = xy (y = 4)
X
xx
.
.
On CD tractions
On BC tractions

F
= (X = 4)

y
xy

.
F

y = yy (y = 4).

These constraints are calculated by the analytical solution, described in the document [V3.04.111].

2.4 Conditions initial

Purely mechanical calculations are stationary in time.

Thermomechanical calculation is transitory, with adaptation of grid all the 2 steps of time. very first thermal calculation is initialized by a stationary calculation. Following thermal calculations are initialized by the field of temperature obtained with the calculation preceding and updated on the new one grid.

3 Reference solution

3.1 Method of calculation used for the reference solution

These case-tests are case-tests of nonregression. The reference solution is that obtained with a Code_Aster calculation.

3.2 Results of reference

3.2.1 Modelings A, B and C

.

Mechanical a: in 2D:

After adaptation 4
After adaptation 5
DX
5,093375 10-3 5,0939774
10-3
DY
-2,763497 10-2 -3,158715

10-2

.

Mechanical b: in 3D:

After adaptation 1
After adaptation 2
DX
2,66755 10-2 9,195670
10-2
DY
1,658803 10-1 3,511732
10-1
DZ
-6,575036 10-2 -2,510371
10-1

The results are the same ones after adaptation 2 and 3 bus the 3rd adaptation does not change it grid.

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C: thermomechanical in 2D:

After adaptation 1
After adaptation 2
TEMP
3,097832 10-2 3,113811
102
DX
1,267359 10-2 1,271608
10-2
DY
- 2,511801 10-2
- 2,715298 10-2

3.2.2 Modeling D

The reference is established on the value of the stress field on the two nodes placed on the arc intern, with the angles 30 and 60 degrees. The test is made in nonregression after the first and after second adaptation. One compares with the analytical solution after the third adaptation.

	Node 30 degrees	***Node 60 degrees***
Adaptation 1	*8.364656 10-1*	*1.576383*
Adaptation 2	*5.125268 10-1*	*1.911567*
Adaptation 3	*-1,110223 10-16*	*1,500000*

One also tests on the node with 30 degrees, the projection of the field of displacement between 1st and 2nd adaptation: Ux = 7,733 106.

3.3 Uncertainties on the solution

Without object.

3.4 References

bibliographical

See the document [V3.04.111] for the analytical solution of modeling D.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

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4 Modeling With

4.1 Characteristics of modeling

Modeling A tests the coupling between LOBSTER and Code_Aster for a problem of mechanics statics in dimension 2. It is checked that the groups of nodes are preserved at identical and that them groups of elements are regenerated.

4.2 Characteristics of the grid

The structure is with a grid in "British flag", with elements TRIA6. The edges are with a grid in SEG3. One notes on the sketch the number of under-field allotted to each triangle.

y
J (0; 1)
OPPOSE (1; 1)

2
2
1
2
1
2
1
1
ORIGIN (0; 0)
I (1; 0)
X

4.3 Functionalities tested

Orders Key word factor
Key words
MACR_INFO_MAIL
VERSION_HOMARD

GRID

QUALITY

INTERPENETRATION

CONNEXITY

CUT
MACR_ADAP_MAIL
VERSION_HOMARD

QUALITY

INTERPENETRATION
ADAPTATION
FREE

MAILLAGE_N

MAILLAGE_NP1

RESULTAT_N

INDICATOR

NOM_CMP_INDICA

CRIT_RAFF_PE

NIVE_MAX

5
Results of modeling A

5.1 Values
tested

After adaptation n° 1:

Identification Moments
Reference
***Code_Aster** %*
difference
DX
1 5,093375
10-3 5,093375
10-3 -1,45

10-6
DY
1 -2,763497
10-2 -2,763497
10-2 3,38
10-8

After adaptation n° 2:

Identification Moments
Reference
***Aster** %*
difference
DX
1 5,0939774
10-3 5,0939774
10-3 1,17
10-7
DY
1 -3,158715
10-2 -3,158715
10-2 -4,63
10-6

5.2 Remarks

One can note that total sizes (masses, centre of gravity,…) are well preserved by the process of adjustment.

6 Modeling B

6.1 Characteristics of modeling

Modeling B tests the coupling between LOBSTER and Code_Aster for a mechanical problem statics in dimension 3. It is checked that the groups of nodes are preserved at identical and that them groups of elements are regenerated.

6.2 Characteristics of the grid

The cube is cut out in six tetrahedrons of the type TETR10. The technique is as follows. It is initially half-compartment in two prisms by the diagonal plan of equation X = y = 1. That corresponds to the two halves defined in the problem. Each prism is then divided into three tetrahedrons.

The edges of the cube are with a grid in triangle TRIA6.

Z
K (0; 0; 1)
OPPOSE (1; 1; 1)
ORIGIN (0; 0; 0)
I (1; 0; 0)
J (0; 1; 0)
X
y

6.3 Functionalities
tested

Orders Key word
factor
Key words
MACR_INFO_MAIL
GRID

QUALITY

INTERPENETRATION

CONNEXITY

CUT

NUMBERS
MACR_ADAP_MAIL
LANGUAGE

QUALITY

INTERPENETRATION
ADAPTATION
FREE

UNIFORM

MAILLAGE_N

MAILLAGE_NP1

RESULTAT_N

CHAMP_GD

INDICATOR

NOM_CMP_INDICA

CRIT_RAFF_REL

CRIT_DERA_REL

NIVE_MAX

NIVE_MIN
MAJ_CHAM
CHAM_GD

TYPE_CHAM

NOM_CHAM

RESULT

NUME_ORDRE

CHAM_MAJ

7
Results of modeling B

7.1 Values
tested

After adaptation n° 1:

Identification Moments Reference
Code_Aster %
difference
DX
1 2,66755
10-2 2,66755
10-2 -8,74

10-5
DX
1 1,658803
10-1 1,658803
10-1 1,52
10-5
DZ
1 -6,575036
10-2 -6,575036
10-2 2,28
10-6

After adaptation n° 2:

Identification Moments Reference
Aster %
difference
DX
1 9,195670
10-2 9,195671
10-2 6,47
10-6
DX
1 3,511732
10-1 3,511732
10-1 1,87
10-6
DY
1 -2,510371
10-1 -2,510371
10-1 1,12
10-5

7.2 Remarks

One can note that total sizes (masses, centres of gravity,…) are well preserved by the process of adjustment.

8 Modeling C

8.1 Characteristics of modeling

Modeling C tests the coupling between LOBSTER and Code_Aster for a problem 2D of thermomechanical transient. One checks the update of the fields on the successive grids.

8.2 Characteristics of the grid

The grid is the same one as that of modeling A.

8.3 Functionalities tested

Orders Key word factor
Key words
MACR_INFO_MAIL
VERSION_HOMARD

GRID

QUALITY

INTERPENETRATION

CUT

CONNEXITY
MACR_ADAP_MAIL
VERSION_HOMARD

QUALITY

INTERPENETRATION
ADAPTATION
FREE

MAILLAGE_N

MAILLAGE_NP1

RESULTAT_N

INDICATOR

NOM_CMP_INDICA

CRIT_RAFF_PE

CRIT_DERA_PE

NUME_ORDRE

INST
MAJ_CHAM
RESULT

NOM_CHAM

TYPE_CHAM

NUME_ORDRE

INST

CHAM_MAJ

9
Results of modeling C

9.1 Values tested

After adaptation n° 1:

Identification Moments
Reference
Aster %
difference
TEMP
2 3,097832
102 3,097832
102 -1,2110-5
DX
3 1,267359
10-2 1,267359
10-2 -2,47
10-5
DY
3 -2,511801
10-2 -2,511801
10-2 1,29
10-5

After adaptation n° 2:

Identification Moments
Reference
Aster %
difference
TEMP
2 3,113811
102 3,113811
102 -8,45
10-6
DX
3 1,271608
10-2 1,271608
10-2
1, 00 10-5
DY
3 -2,715298
10-2 -2,71529810-2 5,60
10-6

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10 Modeling
D

10.1 Characteristics of modeling

Modeling D tests the coupling between LOBSTER and Code_Aster for a problem of mechanics linear statics in dimension 2. The arc of circle which models the hole of the plate is followed to the wire of adaptations.

10.2 Characteristics of the grid

The field is with a grid with 11 quadrangles QUAD4 and 1 triangle TRIA3.

The edges of the field are with a grid in segments SEG2.

The arc of circle of the curved border is with a grid with 299 SEG2. Being rectilinear, other edges are not represented.

10.3 Functionalities tested

Orders Key word

factor
Key words
MACR_ADAP_MAIL
QUALITY

INTERPENETRATION

CONNEXITY

CUT
ADAPTATION
FREE

MAILLAGE_N

MAILLAGE_NP1

RESULTAT_N

INDICATOR

NOM_CMP_INDICA

CRIT_RAFF_PE

CRIT_DERA_PE

MAILLAGE_FRONTIERE
MAJ_CHAM
RESULT

NOM_CHAM

TYPE_CHAM

NUME_ORDRE

CHAM_MAJ

11 Results of modeling D

11.1 Values tested

After adaptation n° 1:

Identification Moments
Reference
Code_Aster %
difference
SIXX 30 degrees
1 8.364656
10-1 8.364656
10-1 -2,92
10-5
SIXX 30 degrees
1 1.576383 1.576383
4,47
10-7

After adaptation n° 2:

Identification Moments
Reference
Code_Aster %
difference
SIXX 30 degrees
1 5.125268
10-1 5.125268
10-1 4,22
10-6
SIXX 30 degrees
1 1.911567 1.911567
2,75
10-7
DX 30 degrees
7,733
10-6 7,733
10-6 -2,92
10-5

After adaptation n° 3:

Identification Moments
Reference

Code_Aster %
difference
SIXX 30 degrees
1 -1,110223
10-16 5,115904
10-1 0,512
SIXX 30 degrees
1 1.500000 1,790507
0,19367

---

12 Summary of the results

This case-test having for simple objective the control of nonthe regression, no remark is to be made on the value of the results. The reference is that of Code_Aster calculation at the day of the first restitution and must be found thereafter.

By examining the files orders, one will note that the loadings must be done on entities with suitable dimension.

·
a node for a specific loading; for example a displacement imposed on a corner,
·
a segment for a linear loading; for example, a pressure divided into 2D,
·

a triangle for a surface loading; for example, a force in 3D.

In addition, it will be noted that these loadings must be expressed on groups of nodes or of meshs and not on the nodes or and the meshs. Indeed after adaptation of the grid, groups are reconstituted. The ordering of loading is thus the same one, whatever the grid.

By complying with these two rules on the loadings, the adaptation of grid is possible.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

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5.0

Titrate:
ZZZZ126 Validation of order CREA_CHAMP

Date:
15/10/01
Author (S):
J.** Key **PELLET
:
V1.01.126-A Page:
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Organization (S): EDF/MTI/MMN

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.126

ZZZZ126 - Validation of order CREA_CHAMP
OPERATION: "ADZE"

Summary:

This test validates the operation "ADZE" of the order CREA_CHAMP which makes it possible to

manufacture a field (with
nodes or with the elements) by "assembly" of ends of existing fields.

The test consists in affecting on geometrical entities (meshs and nodes), quantities (displacements, internal constraints or variables). One then combines with order ASSE_CHAMP the fields obtained by
assignment and one check that the field result contains the good values.

1
Problem of reference

1.1 Geometry

The geometry of the problem is of no importance. It is enough to know that the grid contains at least:

· 3 named meshs: M1, m2 and m3,
· 3 named nodes: A1, A2 and A3.

1.2 Properties

material

Of no importance. One chose the law of behavior VMIS_ISOT_CINE which has at least 3

internal variables.

1.3
Boundary conditions and loadings

Of no importance.

1.4 Conditions
initial

Of no importance

2
Reference solution

2.1
Method of calculation used for the reference solution

That is to say a size G having 3 components X, Y, Z
The grid has 3 geometrical entities (meshs or nodes): X1, X2, X3

One first of all manufactures 2 fields ch1 and ch2 by assignment of the size G on the entities geometrical X1, X2 and X3.

Entity
X1 X2 X3
Component
X Y Z X Y Z X Y Z
ch1
1. 3. 1. 3. 1. 3.
ch2
4. 2. 4. 2. 4. 2.

One defines then the fields ch3 and ch4 by:

ch3 = CREA_CHAMP
(OPERATION: "ADZE"…

ADZE: (ALL: "YES"
CHAM_GD: ch1)

ADZE: (ENTITY: X2
CHAM_GD: ch2

COEF_R: 2.)

ADZE: (ENTITY: X3
CHAM_GD: ch2

COEF_R: 3.
OFFICE PLURALITY: "YES"));

ch4 = CREA_CHAMP
(OPERATION: "ADZE"…

ADZE: (
ALL: "YES" CHAM_GD: ch3 COEF_R: 2.
NOM_CMP: "X3"
NOM_CMP_RESU: "X1")

);

One must then obtain:

Entity
X1 X2 X3
Component
X Y Z X Y Z X Y Z
ch1
1. 3. 1. 3. 1. 3.
ch2
4. 2. 4. 2. 4. 2.
ch3
1. 3. 1. 8. 4. 1. 12. 9.
ch4
6. 8. 18.

To test the various cases of figure of order ASSE_CHAMP, this calculation is made for 5 types fields:

With
cham_no
displacements
B
cham_elem /ELNO
constraints
C
cham_elem /ELGA
constraints
D
cham_elem /ELNO
internal variables
E
cham_elem /ELGA
internal variables

2.2
Results of reference

For the 5 preceding cases of figure, one tests the lubricated and underlined values table below:

Entity
X1 X2 X3
Component
X Y Z X Y Z X Y Z
ch3

1. 3. 1.
8. 4. 1. 12. 9.
ch4
6.

8.

18.

2.3 Uncertainties on the solution

No uncertainty.

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3 Modeling With

3.1 Characteristics of modeling

Of no importance

3.2 Characteristics

grid

Of no importance

3.3 Functionalities
tested

Orders Key word
factor
Key word
Keys
CREA_CHAMP ADZE ALL: “YES”

/NOEUD/MESH
CREA_CHAMP ADZE COEF_R

CREA_CHAMP ADZE OFFICE PLURALITY: “YES”

CREA_CHAMP ADZE NOM_CMP

NOM_CMP_RESU

4
Results of modeling A

4.1 Values
tested

Identification Reference Aster %
difference
ch3/X2/X
1.0 1.0 0.0
ch3/X3/X
1.0 1.0 0.0
ch3/X3/Y
12.0 12.0 0.0
ch3/X3/Z
9.0 9.0 0.0
ch4/X3/X
18.0 18.0 0.0

4.2 Parameters
of execution

Version: 5.3.11

Machine: Origin 2000

Obstruction memory: 32 Mo
Time CPU To use: 3.5 seconds

5
Summary of the results

The results are exactly those awaited.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.127

ZZZZ127 - Validation of key word LIAISON_MAIL
order AFFE_CHAR_MECA

Summary:

This test validates key word LIAISON_MAIL of order AFFE_CHAR_MECA. This key word generates them
linear relations between the degrees of freedom of the nodes of 2 edges which one puts in opposite.
programming is validated in 2D and 3D by intercomparison with similar an Aster calculation where relations between degrees of freedom directly entered by key word LIAISON_DDL. One also validates geometrical transformation (rotation/translation) applied to the one of the edges.

1
Problem of reference

1.1 Geometry

The dealt with problem is plane. The studied structure is 1 rectangle cut out in 2 squares ABCD and BEFC.
The solution is established with a network using 2 QUAD4 corresponding to the 2 squares.

y
D
C
F
10.
Q1
Q2
With
B
E
0.
S1
20.
X

1.2
Properties of material

elastic material:

E = 10.0 u.s.i.
NAKED = 0.0

NAKED = 0 are taken. so that one can deal with this plane problem with a layer of elements 3D in having the plane solution.

1.3
Boundary conditions and loadings

1) One applies a specific force to the point F: FY= 4.0 u.s.i.

2) Blockings
:
not a: DX=DY=0.
not D: DX=0.

3) Linear relations between degrees of freedom:

loading case: cas1
1.0 DX (E) - 0.5 DY (D) - 0.5 DY (C) = 0.0
1.0 DY (E) + 0.5 DX (D) + 0.5 DX (C) = 0.0

loading case: cas2
1.0 DY (E) + 0.5 DY (D) + 0.5 DY (C) = 0.0
1.0 DY (B) + 0.5 DY (C) + 0.5 DY (F) = 0.0

1.4 Conditions
initial

Of no importance.

2
Reference solution

2.1

Method of calculation used for the reference solution

In each case, one carries out a preliminary calculation with key word LIAISON_DDL to introduce them linear relations between degrees of freedom. This calculation is used as reference to calculation with the key word LIAISON_MAIL which generates these linear relations.

To obtain the desired linear relations with LIAISON_MAIL, one writes:

Cas1:

LIAISON_MAIL: (
NOEUD_2: E

MAILLE_1: Q1
CENTER:
B
ANGL_NAUT:
90.
TRAN: (
-5.

0.)

)

What wants to say that one eliminates the 2 ddls from the node E according to the ddls of the E' point obtained when one subjects to E a rotation of 90 degrees around B then a translation of vector (5,0). E' is thus in the middle of CD. The vector displacement of E is identified (after rotation of 90 degrees) with that of E'. The 2 equations are thus obtained:

DX (E) = DY (E') = 0.5 DY (C) + 0.5 DY (D)
DY (E) = - DX (E') = -0.5 DX (C) - 0.5 DX (D)

Cas2:

LIAISON_MAIL: (
MAILLE_2: S1

MAILLE_1: (Q1, Q2)
DDL_2: “DNOR”

DDL_1: “DNOR”
CENTER:
B
ANGL_NAUT:
180.
TRAN: (
+5.

+10.)

)

What wants to say that one eliminates normal displacement from the nodes B and E (nodes of the S1 segment)
according to the ddls of the points B' and E' obtained when one subjects to B and E a rotation of 180 degrees around B then a translation of vector (+5, +10). B' is thus in the middle of CF and E' with medium of cd. The normal displacement of B is identified (after rotation of 180 degrees) with that of B'.
One makes in the same way for B'. The 2 equations then are obtained:

DY (E) = - DY (E') = - 0.5 DY (C) - 0.5 DY (D)
DY (B) = - DY (B') = - 0.5 DY (C) - 0.5 DY (F)

2.2
Results of reference

One observes displacement DY of the point F:

cas1: DY (F) =1.4153582447720D+00
cas2: DY (F) =1.0561898652983D+00

These displacements are obtained with linear relations enter ddls introduced by the key word LIAISON_DDL.

2.3
Uncertainties on the solution

No uncertainty.

3 Modeling
With

3.1
Characteristics of modeling

The problem is solved with modeling D_PLAN.

3.2
Characteristics of the grid

The grid is made of:

2 QUAD4: Q1 = ABCD and Q2 = BEFC
1 SEG2: S1 = BE

3.3 Functionalities
tested

Orders Key word
factor
Key word
Keys
AFFE_CHAR_MECA LIAISON_MAIL
MAILLE_2

NOEUD_2

MAILLE_1
AFFE_CHAR_MECA LIAISON_MAIL
CENTER
ANGL_NAUT
TRAN
AFFE_CHAR_MECA LIAISON_MAIL
DDL_1: “DNOR”

DDL_2: “DNOR”

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
cas1: DY (F)
1.4153582447720D+00
1.4153582447720D+00
0.
cas2: DY (F)
1.0561898652983D+00
1.0561898652983D+00
0.

4.2 Parameters
of execution

Version: 5.07.01

Machine: Origin 2000 - R12000

Obstruction memory: 64 Mo
Time CPU To use: 4 seconds

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

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5 Modeling B

5.1 Characteristics of modeling

The problem is solved with modeling 3D.

5.2 Characteristics of the grid

The grid is made of:

2 HEXA8: Q1 and Q2
1 QUAD4: S1

5.3 Functionalities tested

The same ones as for modeling A but in 3D.

6 Results of modeling B

6.1 Values tested

Identification Reference
Aster %
difference
cas1: DY (F)
1.4153582447720D+00
1.4153582447720D+00
0.
cas2: DY (F)
1.0561898652983D+00
1.0561898652983D+00
0.

6.2 Remarks
(possibly)

6.3 Parameters
of execution

Version: 5.3.11

Machine: Origin 2000 - R12000

Obstruction memory: 32 Mo
Time CPU To use: 4 seconds

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HT-66/02/001/A

7
Summary of the results

The numerical results, displacement in a point, are rigorously identical between the two calculations Aster, with key word LIAISON_MAIL, or key word LIAISON_DDL.

Organization (S): EDF/AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.128

ZZZZ128 - Validation of orders LIRE_TABLE and IMPR_TABLE

Summary:

This test validates orders LIRE_TABLE and IMPR_TABLE (with the format "ASTER").

1
Problem of reference

One reads on an ASCII file a table (thus known in advance!). One rewrites this table on new file, then this new file is read again. One can then test that the read again table still has the contents initial. This test thus makes it possible to validate the impression and the reading of a table on a file with the format
“ASTER”.

2
Reference solution

2.1
Method of calculation used for the reference solution

The value of reference is not calculated: it is a value written in a data file.

2.2
Results of reference

One observes the cell corresponding to the parameter “VALUE” and corresponding to line NOEUD=N2.

The value of the table is then 21.0D+00

2.3
Uncertainties on the solution

No uncertainty.

3 Modeling
B

3.1
Characteristics of modeling

This test has only one modeling which is called “B”.

3.2 Functionalities
tested

Orders Key word
factor

Key word

IMPR_TABLE

FORMAT=' ASTER'
LIRE_TABLE

FORMAT=' ASTER'

SEPARATOR

4
Results of modeling B

4.1 Value
tested

Identification Reference
Aster %
difference
VALUE (N2)
21.0+00
21.0+00
0.

5
Summary of the results

R.A.S: the read again table is rigorously identical to the original table.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/03/008/A

Code_Aster ®
Version
6.3

Titrate:
SENSM01 - Sensitivity in thermics, data-processing control

Date:
03/06/03
Author (S):

G. Key NICOLAS
:

Organization (S): EDF-R & D /SINETICS

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.144

SENSM01 - Sensitivity in static mechanics,
control data-processing

Summary:

This case test validates nonthe regression of the basic commands of calculation of sensitivity in static mechanics. It
acts to make sure that the insertion of the key word SENSITIVITY in the principal orders remains operational.

For that, one studies a static phenomenon of mechanics in a field 2D, only controlled by
boundary conditions of Dirichlet. The solution in field of displacement is analytical. In the same way, derivation
this field compared to one of the boundary conditions is analytical. The comparison calculation/ reference is
thus simple to establish.

One analyzes orders MECA_STATIQUE and CALC_ELEM.

Count

matters

1
Problem of reference

1.1 Geometry

y

OPPOSE
J
y=1,5

CENTER
X
X
x=1
x=11

I
y=1,5 ORIGIN

The four corners and the center are particularized:

Name X
y
ORIGIN
1 -1,5
I
11 -1,5
J
1 1,5
OPPOSE
11 1,5
CENTER
6 0

The various zones are indicated. Each internal rectangle is indicated under its name: MOITIE1 and MOITIE2.
Each frontier segment bears a name. The vertical segments on the left and on the right are named BORD_GAU and BORD_DRO. The lower horizontal segments are named BORD_IN1 and BORD_IN2; in the same way, the higher horizontal segments are named BORD_SU1 and BORD_SU2.

BORD_SU1
BORD_SU2

BORD_GAU
BORD_DRO
MOITIE1
MOITIE2

BORD_IN1
BORD_IN2

1.2
Material properties

The Young modulus is the same one in all the field:

E = 200 000

The Poisson's ratio is the same one in all the field:

= 3
,
0

1.3
Boundary conditions and loadings

All operation is controlled by the displacements imposed on the two corners.

With the corner ORIGIN, displacement is null.
To the corner OPPOSES, displacement is imposed on U X = 10 and U y = 3.

All the external edges are with null loading.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solutions

By reason of symmetry, one deduces that each component of displacement in the center is worth the average
identical components two displacements imposed in the corners.

1
UCENTRE = (UORIGINE +UOPPOSE)
2

To calculate the sensitivity compared to the displacement imposed in a corner amounts deriving the formula
analytical. Thus in the center, we have:

UCENTRE 1
=
U
2
OPPOSE

The results for the strains and the stresses are obtained by comparison between two calculations ASTER.

2.2
Results of reference

By numerical application, we have with the node CENTERS:

U X
U y
Displacement 5
1,5
Derived compared to U
0,5 0
X of the node

opposed
Derived compared to U
0 0,5
y of the node
opposed

2.3
Uncertainty on the solutions

Analytical solutions

---

3 Modeling
With

3.1
Characteristics of modeling

Calculation is made in static mechanics.

3.2
Characteristics of the grid

The grid is carried out with elements of the type TRIA3. The frontier segments are with a grid with elements SEG2. There are 55 nodes, 80 triangles and 28 segments of edge.

3.3 Functionalities tested

Orders

AFFE_CHAR_MECA_F DDL_IMPO

PLANE AFFE_MODELE THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

MECA_STATIQUE SENSITIVITY

CALC_ELEM SENSITIVITY

TEST_RESU SENSITIVITY

4 Results of modeling A

4.1 Values tested

We test the values of the field of displacement and its derivative on the central node. The tolerance is 10 6%.

Analytical identification
Calculated
Relative variation in %

U
X
CENTER

5
5
1,4 10-12
U

CENTER
X
0,5
0,5
1,4 10-12
U
OPPOSE

U
y
CENTER

1,5
1,5

1,0 10-12
U

CENTER
y
0,5
0,5
1,0 10-12

5
Summary of the results

No particular comment is to be made on this case-test. It is only used to ensure the perenniality of options of sensitivity in the orders handling the results.

1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.145

SENSM02 - Sensitivity to the imposed pressure in linear mechanics

Summary:

One tests the calculation of sensitivity to the loading pressure. The sensitivity is calculated by direct differentiation
discrete equations. The reference comes from a commonplace analytical solution (compactness uniaxial).

1
Problem of reference

1.1 Geometry

BORD_DRO

3. mm
BORD_GAU

CENTER

ORIGIN

y

10. mm
Z

1. < X <11

1.5 < Y <1.5
X

1.2
Properties of material

E = 200.000 MPa

= 0.3

= 8. 106 kg/mm3

1.3
Boundary conditions and loadings

Surface BORD_GAU is blocked according to X.
The line ORIGIN is blocked according to X and Y.
A pressure of 10. MPa is imposed on BORD_DRO.

2
Reference solution

2.1
Method of calculation

The reference solution comes from an analytical solution:

xx (X, y, Z) = p (imposed pressure)
yy (X, y, Z) = 0

ux (X, y, Z) = X p/E
uy (X, y, Z) = (y+1.5) p/E

xx (X, y, Z) = p/E
yy (X, y, Z) = p/E

That is to say:
D xx/d p (X, y, Z) = 1
D yy/d p (X, y, Z) = 0

D ux/d p (X, y, Z) = x/E
D uy/d p (X, y, Z) = (y+1.5) /E

D xx/d p (X, y, Z) = 1/E
D yy/d p (X, y, Z) = /E

2.2
Sizes and results of reference

Displacement following X to the point CENTERS:
ux (6, 0, Z) = 2.5 E-4
Displacement following y to the point CENTERS:
uy (6, 0, Z) = 2.25 E-5

Sensitivity of displacement following X to the pressure p to the point CENTERS:
D ux/d p (6, 0, Z) = 2.5 E-5
Sensitivity of displacement following there to the pressure p to the point CENTERS:
D uy/d p (6, 0, Z) = 2.25 E-6

Deformation according to xx at the point CENTERS:
xx (6, 0, Z) = 5. E-5
Deformation according to yy at the point CENTERS:
yy (6, 0, Z) = 1.5 E-5

Sensitivity of the deformation according to xx to the pressure p to the point CENTERS:
D xx /d p (6, 0, Z) = -5. E-6
Sensitivity of the deformation according to yy to the pressure p to the point CENTERS:
D yy /d p (6, 0, Z) = 1.5 E-6

Constraint according to xx at the point CENTERS:

xx (6, 0, Z) = 10.
Constraint according to yy at the point CENTERS:
yy (6, 0, Z) = 0.

Sensitivity of the constraint according to xx to the pressure p to the point CENTERS:
D xx /d p (6, 0, Z) = 1.
Sensitivity of the constraint according to yy to the pressure p to the point CENTERS:
D yy /d p (6, 0, Z) = 0.

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling in plane constraints on the grid following 2D:

Surface BORD_GAU becomes a line, the lines ORIGIN and OPPOSES become points.

3.2
Characteristics of the grid

A number of nodes: 55
Numbers and types of meshs: 28 SEG2, 80 TRIA3

3.3 Functionalities tested

Orders

MEMO_NOM_SENSI NOM_UN

NOM_ZERO

NAME
NOM_SD

PARA_SENSI

NOM_COMPOSE

MECA_STATIQUE SENSITIVITY

CALC_ELEM SENSITIVITY

TEST_RESU SENSITIVITY

3.4 Sizes tested and results

Size tested
Theory
Code_Aster
Difference (%)
DX at the point CENTERS
2.5 E-4 2.5 E-4 0.

DY at the point CENTERS
2.25 E-5 2.25 E-5 0.

Sensitivity of DX to the pressure p
2.5 E-5
2.5 E-5
0.

at the point CENTERS

Sensitivity of DY to the pressure p
2.25 E-6
2.25 E-6
0.
at the point CENTERS

EPXX at the point CENTERS
5. E-5
5. E-5
0.
EPYY at the point CENTERS
1.5 E-5
1.5 E-5
0.
Sensitivity of EPXX to the pressure
5. E-6
5. E-6
0.
p at the point CENTERS
Sensitivity of EPYY to the pressure
1.5 E-6
1.5 E-6
0.
p at the point CENTERS
SIXX at the point CENTERS
-10.
-10.
0.
SIYY at the point CENTERS
0.
1.15 E-14

Sensitivity of SIXX to the pressure
-1. -1. 0.
p at the point CENTERS
Sensitivity of SIYY to the pressure
0. 5.
E-16

p at the point CENTERS

3.5 Notice

One tests also the derivation of displacements, the strains and the stresses compared to one insensitive parameter: the numerical result obtained is exactly 0.

4
Summary of the results

The numerical results of sensitivity are in triad with those of the theory.

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Handbook of Validation
V1.01 booklet: Tests of validity of the orders
HT-66/03/008/A

Code_Aster ®
Version
6.2

Titrate:
SENSM03 - Sensitivity to the nodal forces imposed in linear mechanics Dates:
19/08/02
Author (S):
NR. TARDIEU *Key*
:
V1.01.150-A Page:
1/4

Organization (S): EDF/AMA

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.150

SENSM03 - Sensitivity to the nodal forces
imposed in linear mechanics

Summary

One tests the calculation of sensitivity to an imposed nodal force. The sensitivity is calculated by differentiation
direct of the discrete equations. The reference comes from a calculation by finished differences.

1
Problem of reference

1.1 Geometry

OPPOSE

3. mm
BORD_GAU

CENTER

ORIGIN

y

10. mm
Z

1. < X <11
-1.5
<
Y
<1.5
X

1.2
Properties of material

E = 200.000 MPa

= 0.3

= 8. 106 kg/mm3

1.3
Boundary conditions and loadings

Surface BORD_GAU is blocked according to X.
The line ORIGIN is blocked according to X and Y.
A nodal force of components (10. , 3.) is imposed on the line OPPOSES.

2
Reference solution

2.1
Method of calculation

For the field of displacement, the solution is that of calculation Aster (it thus acts of tests of not regression).
For the sensitivity of the field displacement to the imposed nodal force, the solution comes from

finished differences (approximation of derived with order 1) carried out with Aster. These finished differences
express themselves in the form:

F (X, y)
F (X + dx, y) - F (X, y)

X
dx

F (X, y)
F (X, y + Dy) - F (X, y)

y
dx

2.2
Sizes and results of reference

Displacement following X to the point CENTERS:
ux (6, 0, Z) = 8.1094117774520 E-05

Displacement following y to the point CENTERS:
uy (6, 0, Z) = 3.0721034884009 E-04

Sensitivity of displacement following X to component FX to the point CENTERS:
D ux/d FX (6, 0, Z) 8.4412600000000E-06

Sensitivity of displacement following there to component FX to the point CENTERS:
D uy/d FX (6, 0, Z) -3.3819900000000E-05

Sensitivity of displacement following X to component FY to the point CENTERS:
D ux/d FX (6, 0, Z) -1.1061700000000E-06

Sensitivity of displacement following there to component FY to the point CENTERS:
D uy/d FX (6, 0, Z) 2.1513600000000E-04

---

3 Modeling With

3.1 Characteristics of modeling

Modeling in plane constraints on the grid following 2D:

Surface BORD_GAU becomes a line, the lines ORIGIN and OPPOSES become points.

3.2 Characteristics of the grid

A number of nodes: 55
Numbers and types of meshs: 28 SEG2, 80 TRIA3

3.3 Functionalities tested

Orders

MEMO_NOM_SENSI
NOM_UN
NOM_ZERO
NAME
NOM_SD
PARA_SENSI
NOM_COMPOSE
MECA_STATIQUE
SENSITIVITY
TEST_RESU

SENSITIVITY

3.4
Sizes tested and results

Size tested
Reference:
Code_Aster
Difference (%)
DX at the point CENTERS
8.1094117774520 E-05
8.1094117774520E-05
0.

DY at the point CENTERS
3.0721034884009 E-04
3.0721034884009 E-04
0.

Sensitivity of DX to
8.4412600000000E-06 8.4412639288501
E-06 4.65E-05
component FX at the point
CENTER

Sensitivity of DY to
3.3819900000000E-05 3.3819874780225E-05 7.46E-05
component FX at the point
CENTER

Sensitivity of DX to
1.1061700000000E-06 1.1061738379937E-06 3.47E-04
component FY at the point
CENTER

Sensitivity of DY to
2.1513600000000E-04 2.1513636554745E-04 1.70E-04
component FY at the point
CENTER

4
Summary of the results

The results of sensitivity per direct differentiation are in very good agreement with those given by *finished differences.*

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.151

SENST01 - Sensitivity in thermics, control data processing

Summary

This case test validates nonthe regression of the basic commands of calculation of sensitivity in thermics. It is about to make sure that the insertion of the key word SENSITIVITY in the principal orders remains operational.

For that, one studies a phenomenon of thermics in a field 2D, only controlled by conditions with the limits of Dirichlet. The solution in field of temperature is analytical. In the same way, the derivation of it field compared to one of the boundary conditions is analytical. The comparison calculation/reference is thus simple to establish.

One analyzes orders THER_LINEAIRE, EXTR_RESU, CREA_CHAMP. It is checked that a calculation in CONTINUATION functions.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-23/02/017/A

Count

matters

1
Problem of reference

1.1 Geometry

y

OPPOSE
J
y=1,5

CENTER
X
X
x=1
x=11

I
y=1,5 ORIGIN

The four corners and the center are particularized:

Name X
y
ORIGIN
1 -1,5
I
11 -1,5
J
1 1,5
OPPOSE
11 1,5
CENTER
6 0

The various zones are indicated. Each internal rectangle is indicated under its name: MOITIE1 and MOITIE2.
Each frontier segment bears a name. The vertical segments on the left and on the right are named BORD_GAU and BORD_DRO. The lower horizontal segments are named BORD_IN1 and BORD_IN2; in the same way, the higher horizontal segments are named BORD_SU1 and BORD_SU2.

BORD_SU1
BORD_SU2

BORD_GAU
BORD_DRO
MOITIE1
MOITIE2

BORD_IN1
BORD_IN2

1.2
Material properties

Thermal conductivity is the same one in all the field:
- 1 - 1
=

400 W.m
K
.

The specific heat is the same one in all the field:
- 1
- 3
. C p = 1 J.K. m

1.3 Boundary conditions and loadings

All operation is controlled by temperatures imposed on the two corners.

T (ORIGIN) = 0 K
T (OPPOSES) = 100 K

All the external edges are with null flow.

Calculation is transitory, but no boundary condition nor no loading changes with the course time

1.4 Conditions initial

The transient is initialized by a stationary calculation.

2
Reference solution

2.1
Method of calculation used for the reference solutions

The field of temperature is solution of a null Laplacian on the field. By reason of symmetry, one deduced that the temperature in the center is worth the average of the two temperatures imposed in the corners.

1
CENTER
T
= (ORIGIN
T
+ OPPOSES
T
)
2

To calculate the sensitivity compared to the temperature imposed in a corner amounts deriving the formula
analytical. Thus in the center, we have:

CENTER
T
1
=
T
2
OPPOSE

As no condition changes during the transient, these results are true at any moment.

2.2
Results of reference

By numerical application, we have the two results of reference:

T

=
K
CENTER
50

CENTER
T
= 5
,
0
OPPOSE
T

2.3
Uncertainty on the solutions

Analytical solutions
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HI-23/02/017/A

Code_Aster ®
Version
6.2

Titrate:
SENST01 - Sensitivity in thermics, data-processing control

Date:
23/09/02
Author (S):
G. *Key* ***NICOLAS***
:
V1.01.151-A Page:
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3 Modeling
With

3.1
Characteristics of modeling

Calculation is made in transitory linear thermics. The step of times is 0,5 S. the first calculation goes

T = 0 to T = 1 S. the second calculation, established by a CONTINUATION, goes from T = 1 to T = 2,5 S.

3.2 Characteristics of the grid

The grid is carried out with elements of the type TRIA3. The frontier segments are with a grid with elements SEG2. There are 55 nodes, 80 triangles and 28 segments of edge.

3.3 Functionalities tested

Orders

AFFE_CHAR_THER_F
TEMPS_IMPO

AFFE_MODELE
PLAN
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_LINEAIRE
SENSITIVITY

EXTR_RESU
SENSITIVITY

CREA_CHAMP
SENSITIVITY

CONTINUATION

4
Results of modeling A

4.1 Values
tested

We test the values of the field of temperature and its derivative on the central node before and afterwards
the recovery. These values result either from the result produced by THER_LINEAIRE, or of the result which in
is extracted, that is to say field which is created. The tolerance is 10 6%.

Analytical identification
Calculated
Relative variation in %

CENTER
T
with T = 0,5
50
50
1,4 10-12

CENTER
T
with T = 0,5

0,5
0,5
1,4 10-12
OPPOSE
T

CENTER
T
with T = 1
50
50
1,0 10-12

CENTER
T
with T = 1

0,5
0,5
1,0 10-12
OPPOSE
T

CENTER
T
with T = 2,5
50
50
1,2 10-12

CENTER
T
with T = 2,5

0,5
0,5
1,2 10-12
OPPOSE
T
Handbook of Validation
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5
Summary of the results

No particular comment is to be made on this case-test. It is only used to ensure the perenniality of options of sensitivity in the orders handling the results.

Organization (S): EDF/SINETICS

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.152

SENST02 - Sensitivities compared to the temperature imposed and on normal flow

Summary:

In this case-test, it is a question of making sure of the validity of the sensitivities compared to the temperature imposed and on normal flow, in isotropic transitory linear thermics (key word SENSITIVITY of THER_LINEAIRE and of THER_NON_LINE). It is based on the grid of case-test SENST01A treating the transitory thermal answer of a plate 2D_PLAN subjected to various thermal requests.
One tests the good adequacy of the sensitivities sought with their approximation by finished differences, in several points of the grid and at the last moment of the transient. Strategy of calculation by finished differences, more expensive, harder to implement and less robust, is not of course to privilege and does not have virtue that as a test…
One carries out these calculations of transitory linear thermics:

· with THER_LINEAIRE (modeling A with not lumpés isoparametric elements),
· with THER_NON_LINE (modeling B with lumpés isoparametric elements).

They make it possible to check the correct operation of these two operators in the presence of the loadings EXCHANGE, TEMP_IMPO, SOURCE and FLUX-REP, on meshs 2D lumpées or not, in both

following configurations:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operators and TEST_RESU).

The results of these two configurations agree quasi-parfaitement what, although logic in theory, is reassuring as for the robustness of programming of these two operators. Especially that they treat differently identical problems (resolution of a linear system for A and algorithm of Newton for B) being also based on distinct modelings (resp. PLAN and PLAN_DIAG).

1
Problem of reference

One takes again here the geometry of the case-test SENST01A on which one will affect materials and loadings corresponding to no real case. It is here only about one functional validation, numerical and of data-processing not-regression of calculations of sensitivity in a situation very penalizing (many loadings in little space and with dependences in time polynomial!)

1.1 Geometry

y

OPPOSE
J

y=1,5

CENTER
X
X
x=1
x=11

I
y=1,5 ORIGIN

The four corners and the center are particularized:

Name
X
Y
ORIGIN
1 -1,5
I
11 -1,5
J
1 1,5
OPPOSE
11 1,5
CENTER
6 0

The various zones are indicated. Each internal rectangle is indicated under its name: MOITIE1 and MOITIE2.
Each frontier segment bears a name. The vertical segments on the left and on the right are named BORD_GAU and BORD_DRO. The lower horizontal segments are named BORD_IN1 and BORD_IN2; in the same way, the higher horizontal segments are named BORD_SU1 and BORD_SU2.

BORD_SU1
BORD_SU2

BORD_GAU
BORD_DRO
MOITIE1
MOITIE2

BORD_IN1
BORD_IN2

1.2
Material properties

One applies to all the structure the characteristics material:

= 0 75
.
W/m C
°

C = 2 J m3

/
C
°
p

1.3 Boundary conditions and loadings

By noting T the moment considered, one can synthesize the decomposition of the loadings by zone under the shape of the following table:

Geometrical zones
Loadings Sensitivities
(GROUP_NO/GROUP_MA)
sought
BORD_GAU
COEF_H = 30 (1+0.3 T) W/m2°C
T_EXT = 140 (1+0.3 T) °C

BORD_DRO
FLUX_REP = 120 W/m2
PS2
ORIGIN
TEMP = 100 °C
PS1
OPPOSE
TEMP = 200 (1+0.1 T) °C
MOITIE2
SOURCE = 10 (1+0.4 T) J/m3s

1.4 Condition initial

Transitory thermal calculation on two steps of time (T1 = 5 S and t2 = 10 S) initialized by a calculation stationary (TEMP_INIT=_F (STATIONNAIRE=' OUI')).

Version
6.0

Titrate:
SENST02 - Sensitivities compared to the imposed temperature
Date:
14/10/02
Author (S):
O. BOITEAU Key
:
V1.01.152-A Page:
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2
Reference solution

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution! Calculations of sensitivity validated by centered differences are finished (what allows also at the same time to validate standard calculation).
This good adequacy of the sensitivities with their approximation by finished differences is tested in several points of the grid (I, J and CENTER), and at every moment of the transient (t0, T1 and t2), in structures of control PYTHON of the command file. It is traced in the file message (one tolerate a maximum variation of 107%). In the file result one retained only the part of this test concerning the point CENTERS at the last moment of the transient (the sensitivities via a TEST_RESU and them differences finished via a TEST_FONCTION, with a relative tolerance of 106%).
In the event of disagreement on results (NOOK), one can thus refine the diagnosis, that is to say in direction of standard problem, either of the derived problem, or of both.
Strategy of calculation by differences finished, more expensive, harder to implement and less robust, is not of course to privilege and has virtue only as a test…

2.2
Result of reference

Without object.

2.3
Uncertainty on the solutions

Parameter of shift of the finished difference (= 0.1) and convergence of the grid.

---

3 Modeling
With

3.1
Characteristics of modeling

The grid is carried out with elements of the type TRIA3.
Calculation is made in linear thermics with operator THER_LINEAIRE (= 0.57).
One takes 2 steps of times from 0 to 10 S. the results are examined in t2= 10 S.
In this case-test, it is a question of making sure of the validity of the sensitivities compared to the temperature
imposed at ORIGIN (noted PS1 in the command file) and on normal flow on the BORD_DRO (resp. PS2). These sensitivities are estimated at the last moment of the transient and at the point CENTERS.

3.2
Characteristics of the grid

80 TRIA3, 28 SEG2, 55 nodes

3.3 Functionalities

tested

Orders

DEFI_MATERIAU
THER

AFFE_CHAR_THER_F
EXCHANGE
TEMP_IMPO
FLUX_REP

SOURCE

AFFE_MODELE
PLAN
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_LINEAIRE
SENSITIVITY

4
Results of modeling A

4.1 Values
tested

One tests the validity of the calculated sensitivities, on the one hand, via the option SENSITIVITY of THER_LINEAIRE
(TEST_RESU "NON_REGRESSION"), and, in addition, by finished differences
centered (TEST_FONCTION "AUTRE_ASTER"). The relative tolerance is 1.10 6%.

Identification SENSITIVITY Variation
relative Differences
Relative variation
(in %)
finished

(in %)
T

(
5.18799009 102
*-8.43 1013**
5.18799009 102
1.1 10-9
,
CENTER T

2)
~ 0%
T
impo

T
(
*1.64143604 -1.061012**
1.64143604
1.72 10-11
,
CENTER T

2)
~ 0%
flow

*** Taking into account the precision machine, this value is an approximation into arithmetic finished the zero value.***

Handbook of Validation
Booklet V1.01 Tests of validity of orders
HI-23/02/017/A

---

5 Modeling B

5.1 Characteristics of modeling

Idem that for [§3.1] but with operator THER_NON_LINE and in modeling PLAN_DIAG.

5.2 Characteristics of the grid

Idem that for [§3.2].

5.3 Functionalities tested

Orders

DEFI_MATERIAU
THER_NL

AFFE_CHAR_THER_F
EXCHANGE
TEMP_IMPO
FLUX_REP

SOURCE

AFFE_MODELE
PLAN_DIAG
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_NON_LINE
SENSITIVITY

6
Results of modeling B

6.1 Values
tested

One tests the validity of the calculated sensitivities, on the one hand, via the option SENSITIVITY of THER_NON_LINE
(TEST_RESU "NON_REGRESSION"), and, in addition, by finished differences
centered (TEST_FONCTION "AUTRE_ASTER"). The relative tolerance is 1.10 6%.

Identification SENSITIVITY Variation
relative
Finished differences relative Variation
(in %)
(in %)
T

(
5.18164923 102 3.48
*1013**
5.18164923 102
1.21 10-13
,
CENTER T

2)
~ 0%
~ 0%
T

impo

T
(
*1.64140056 -2.571013**
1.64140056
1.91 10-12
,
CENTER T

2)
~ 0%
~ 0%
flow

***** *Taking into account the precision machine, this value is an approximation into arithmetic finished the zero value.*

---

7 *Summary of the results*

One checks the excellent adequacy of the calculated sensitivities, via the option SENSITIVITY of THER_LINEAIRE and of THER_NON_LINE, with the values by finished differences (the variation is lower than
10-10%).
By crossing the results, it appears that the two thermal operators provide the same ones sensitivities and same finished differences. This variation could besides be tiny room while being more severe on the parameters of convergence of the process of optimization of THER_NON_LINE (with with less 3.102% near). What is, in logical theory since the same matrix is assembled and them same second members. And what is also extremely reassuring as for the programming of these assemblies since they are carried out via distinct data-processing routes: one treats differently identical problems (resolution of a linear system for THER_LINEAIRE and algorithm of Newton for THER_NON_LINE) being also based on distinct modelings (resp. PLAN and PLAN_DIAG).

These results make it possible to check the correct operation of the two operators, with EXCHANGE, TEMP_IMPO, SOURCE and FLUX-REP, on meshs 2D lumpées or not, in both following configurations:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operators and TEST_RESU).

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Titrate:
SENST03 - Sensitivities compared to a source and at the temperature
Date:
14/10/02
Author (S):
O. BOITEAU *Key*
:
V1.01.153-A Page:
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Organization (S): EDF/SINETICS

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SENST03 - Sensitivities compared to a source and at the outside temperature

Summary:

In this case-test, it is a question of making sure of the validity of the sensitivities compared to a source imposed and on
outside temperature of a condition of exchange, in isotropic transitory linear thermics (key word SENSITIVITY of THER_LINEAIRE and THER_NON_LINE). It is based on the grid of case-test SENST01A
treating the transitory thermal response of a plate 2D_PLAN subjected to various thermal requests.
One tests the good adequacy of the sensitivities sought with their approximation by finished differences, in
several points of the grid and at the last moment of the transient. Strategy of calculation by finished differences,
more expensive, harder to implement and less robust, is not of course to privilege and does not have virtue that as a test…
One carries out these calculations of transitory linear thermics:

· with THER_LINEAIRE (modeling A with not lumpés isoparametric elements),
· with THER_NON_LINE (modeling B with lumpés isoparametric elements).

They make it possible to check the correct operation of these two operators in the presence of the loadings
EXCHANGE, TEMP_IMPO, SOURCE and FLUX-REP, on meshs 2D lumpées or not, in both following configurations:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operators and TEST_RESU).

The results of these two configurations agree quasi-parfaitement what, although logic in theory, is reassuring as for the robustness of programming of these two operators. Indeed, they treat differently identical problems (resolution of a linear system for A and algorithm of resting Newton for B) also on distinct modelings (resp. PLAN and PLAN_DIAG).

1
Problem of reference

One takes again here the geometry of the case-test SENST01A on which one will affect materials and loadings corresponding to no real case. It is here only about one functional validation, numerical and of data-processing not-regression of calculations of sensitivity in a situation very penalizing (many loadings in little space and with dependences in time polynomial!)

1.1 Geometry

y

OPPOSE
J
y=1,5

CENTER
X
X
x=1
x=11

I
y=1,5 ORIGIN

The four corners and the center are particularized:

Name
X
Y
ORIGIN
1 -1,5
I
11 -1,5
J
1 1,5
OPPOSE
11 1,5
CENTER
6 0

The various zones are indicated. Each internal rectangle is indicated under its name: MOITIE1 and MOITIE2.
Each frontier segment bears a name. The vertical segments on the left and on the right are named BORD_GAU and BORD_DRO. The lower horizontal segments are named BORD_IN1 and BORD_IN2; in the same way, the higher horizontal segments are named BORD_SU1 and BORD_SU2.

BORD_SU1
BORD_SU2

BORD_GAU

BORD_DRO
MOITIE1
MOITIE2

BORD_IN1
BORD_IN2

1.2
Material properties

One applies to all the structure the characteristics material:

= 0 75
.
W/m C
°

C = 2 J m3
/
C
°

p

1.3 Boundary conditions and loadings

By noting T the moment considered, one can synthesize the decomposition of the loadings by zone under the shape of the following table:

Geometrical zones
Loadings Sensitivities
(GROUP_NO/GROUP_MA)
sought
BORD_GAU
COEF_H = 30 (1+0.3 T) W/m2°C
T_EXT = 140 °C
PS2

BORD_DRO
FLUX_REP = -120 (1+0.2 T) W/m2
ORIGIN
TEMP = 100 (1+0.1 T) °C
OPPOSE
TEMP = 200 (1+0.1 T) °C
MOITIE2
SOURCE = 10 J/m3s
PS1

1.4 Condition initial

Transitory thermal calculation on two steps of time (T1 = 5 S and t2 = 10 S) initialized by a calculation stationary (TEMP_INIT=_F (STATIONNAIRE=' OUI')).

2
Reference solution

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution! Calculations of sensitivity validated by centered differences are finished (what allows also at the same time to validate standard calculation).
This good adequacy of the sensitivities with their approximation by finished differences is tested in several points of the grid (I, J and CENTER), and at every moment of the transient (t0, T1 and t2), in structures of control PYTHON of the command file. It is traced in the file message (one tolerate a maximum variation of 107%). In the file result one retained only the part of this test concerning the point CENTERS at the last moment of the transient (the sensitivities via a TEST_RESU and them differences finished via a TEST_FONCTION, with a relative tolerance of 106%).
In the event of disagreement on results (NOOK), one can thus refine the diagnosis, that is to say in direction of standard problem, either of the derived problem, or of both.
Strategy of calculation by differences finished, more expensive, harder to implement and less robust, is not of course to privilege and has virtue only as a test…

2.2
Result of reference

Without object.

2.3
Uncertainty on the solutions

Parameter of shift of the finished difference (= 0.1) and convergence of the grid.

---

3 Modeling With

3.1 Characteristics of modeling

The grid is carried out with elements of the type TRIA3.
Calculation is made in linear thermics with operator THER_LINEAIRE (= 0.57).
One takes 2 steps of times from 0 to 10 S. the results are examined in t2= 10 S.
In this case-test, it is a question of making sure of the validity of the sensitivities compared to the imposed source
on MOITIE2 (noted PS1 in the command file) and at the outside temperature of the condition
of exchange imposed on the BORD_GAU (resp. PS2). These sensitivities are estimated at the last moment of
transient and at the point CENTERS.

3.2 Characteristics of the grid

80 TRIA3, 28 SEG2, 55 nodes

3.3 Functionalities tested

Orders

DEFI_MATERIAU
THER

AFFE_CHAR_THER_F
EXCHANGE
TEMP_IMPO
FLUX_REP

SOURCE

AFFE_MODELE
PLAN
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_LINEAIRE
SENSITIVITY

4
Results of modeling A

4.1 Values
tested

One tests the validity of the calculated sensitivities, on the one hand, via the option SENSITIVITY of
THER_LINEAIRE
(TEST_RESU "NON_REGRESSION"), and, in addition, by finished differences
centered (TEST_FONCTION "AUTRE_ASTER"). The relative tolerance is 1.10 6%.

Identification SENSITIVITY Variation
relative
Finished differences
Relative variation
(in %)
(in %)
T

(
1.44655568 101 2.93
*1012**
1.44655568 101 1.51
*1012**
,
CENTER T

2)
~ 0%
~ 0%
S
impo

T
(
5.69857831 2.73
*1013**
5.69857831
-1.29 10-11
,
CENTER T

2)
~ 0%
T
ext.

*** Taking into account the precision machine, it is value is an approximation into arithmetic finished the zero value.***

---

5 Modeling B

5.1 Characteristics of modeling

Idem that for [§3.1] but with operator THER_NON_LINE and in modeling PLAN_DIAG.

5.2 Characteristics of the grid

Idem that for [§3.2].

5.3 Functionalities tested

Orders

DEFI_MATERIAU
THER_NL

AFFE_CHAR_THER_F
EXCHANGE
TEMP_IMPO
FLUX_REP

SOURCE

AFFE_MODELE
PLAN_DIAG
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_NON_LINE
SENSITIVITY

6
Results of modeling B

6.1 Values
tested

One tests the validity of the calculated sensitivities, on the one hand, via the option SENSITIVITY of
THER_NON_LINE
(TEST_RESU “NON_REGRESSION”), and, in addition, by finished differences
centered (TEST_FONCTION “AUTRE_ASTER”). The relative tolerance is 1.10- 6%.

Identification SENSITIVITY Variation
relative
Finished differences relative Variation
(in %)
(in %)
T

(
1.44652441 101 7.12
*1013**
1.44652441 101 1.6
*1013**
,
CENTER T

2)
~ 0%
~ 0%
S
impo

T
(
5.69929415 8.38
*1013**
5.69929415 2.34
*1013**
,
CENTER T

2)
~ 0%
~ 0%
T
ext.

** Taking into account the precision machine, it is value is an approximation into arithmetic finished the zero value.*

7
Summary of the results

One checks the excellent adequacy of the calculated sensitivities, via the option SENSITIVITY of THER_LINEAIRE and of THER_NON_LINE, with the values by finished differences (the variation is lower than
10-10%).

By crossing the results, it appears that the two thermal operators provide the same ones sensitivities and same finished differences. This variation could besides be tiny room while being more severe on the parameters of convergence of the process of optimization of THER_NON_LINE (with with less 2.103% near). What is, in logical theory since the same matrix is assembled and them same second members. And what is also extremely reassuring as for the programming of these assemblies since they are carried out via distinct data-processing routes: one treats differently identical problems (resolution of a linear system for THER_LINEAIRE and algorithm of Newton for THER_NON_LINE) being also based on distinct modelings (resp. PLAN and PLAN_DIAG).

These results make it possible to check the correct operation of the two operators, with EXCHANGE, TEMP_IMPO, SOURCE and FLUX-REP, on meshs 2D lumpées or not, in the two configurations following:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operators and TEST_RESU).

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Titrate:
SENST04 - Sensitivities compared to the coefficient of exchange-wall Dates
:

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SENST04 - Sensitivities compared to the coefficient of exchange-wall and with thermal conductivity

Summary:

In this analytical case-test, it is a question of making sure of the validity of the sensitivities of the field of temperature and of its flow compared to the coefficient of exchange-wall and conductivity, in isotropic transitory linear thermics (key word SENSITIVITY of THER_LINEAIRE, THER_NON_LINE, CALC_ELEM and CALC_NO). It rests on

configuration of case-test TTLP100 treating the linear transitory thermal response of two separate plates
by a play in which one carries out a transfer of heat.
The problem is two-dimensional, but the limiting conditions make that the field of temperature reached
quickly the stationary state and depends analytically only on the X-coordinate and the data. One deduces some
then easily analytical expressions of the sensitivities of the temperature and its flow compared to
thermal parameters which interest us: the coefficient of exchange-wall and conductivity.
One thus tests the good adequacy of the sensitivities sought with their analytical values in several
points of the grid and at the last moment of the transient. To facilitate later maintenance and by concern of
complétude, one also calculates and one tests (via the functionalities PYTHON) the values obtained by differences
finished (only in temperature). But this last strategy, more expensive, harder to put in
work and less robust, is not of course to privilege and has virtue only as a test…
One carries out these calculations of transitory linear thermics:
· with THER_LINEAIRE (modeling A),
· with THER_NON_LINE (modeling B).
They make it possible to check the correct operation of the two thermal operators and their postprocessings
associated loadings ECHANGE_PAROI and TEMP_IMPO on isoparametric meshs 2D not
lumpées (modeling PLAN), in the two following configurations:
· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operators and TEST_RESU).
The results of these two configurations agree quasi-parfaitement what, although logic in theory, is
reassuring as for the robustness of programming of these two operators. Especially that they treat
differently identical problems (resolution of a linear system for A and an algorithm of Newton
for B).

1
Problem of reference

One takes again here quasi-intégralement the description of case-test TTLP100 "Exchange-wall in thermics transient".

1.1 Geometry

y
1
0
X
l1 = l2 = 0.495 m
0
0.495 0.505
1
L = 1 m
l1
l2

1.2
Material properties

= W
40/m C
°

C =
-4
10
3
.
7
J/m3 C
°
p

1.3
Boundary conditions and loadings

T (X = 0) = 100°C = T0
T (X = L) = 300°C = TL

Heat transfer enters the walls located in x= 0.495 and x= 0.505, with a coefficient of exchange-wall of 80 W/m2 °C.

1.4 Conditions
initial

T (T = 0) =
T0 in the plate of left

TL in the plate of right-hand side

2
Reference solutions

2.1
Method of calculation used for the temperature

The stationary field of temperature is obtained by solving a null Laplacian analytically on *each of the two plates, on the basis of a field solution of the form T (X) = ax + B. 4 coefficients (2 per plate) are obtained by clarifying the boundary conditions of Dirichlet and exchange:*

H (T - T
L
O)
0. X 0 495
.
: T = To + + H (l1 + 2) X
L

éq
2.1-1
H (T - T
L
O)
0 505
.
X.
1: T = TL -
-
+ H (l1 + l2) (L X)

From where analytical expressions of the sensitivities of the thermal field compared to the coefficient of exchange-wall and compared to isotropic conductivity:
T

(T - T
L
O)
T

H (T - T
L
O)
0. X
:
495
.
0
=
and
= -
H

(+ H (L

1 + 2)
X
L
2

(+ H (l1 +) X
L
2
2
éq
2.1-2
T

(T - T
L
O)

-
505
.
0
X:.
1
= -
(L - X)
T
H (T
T
L
O)
and
=
(L - X)
H

(+ H (L

1 + l2) 2

(+ H (l1 + L) 2
2

2.2
Method of calculation used for flow

Field of temperature, one deduces the heat flux easily, answering the Fourier analysis:
F X
- *H (TL - To) 1*
F *(*
X
F *=*
=
X*, T) = - T (****X****, T)*
0.
0.
:
495

F y
+ H (

éq
2.2-1
1
L + l2) 0
0.505 X 1:. Idem

From where analytical expressions of the sensitivities of the heat flux compared to the coefficient of exchange-wall and compared to isotropic conductivity:
fx
2
F
H
- *H TL - T 1*
F *(*
T ***X*** *T*
X
=
=
O
X*, T)*
(,)
(
)
0.

0.
:
495
= **-**

H
F y
(+ H (
éq 2.2-2
H
H
1
L + l2) 2 0

H
0.505 X 1:. Idem
fx
2
F

- *H TL* **-** *H T*
O
+ L 1
F *(*
1
2
T ***X*** *T*
X
=
=
X*, T) =* **-** *T (****X****, T)*
(,)
(
)(
)
0.
0.
:
495
-

F

y
(+ H (

1
L + l2) 2
0

0.505 X 1:. Idem
éq 2.2-3
It is noticed that the commutation of these derivations with the operator gradient makes it possible to find
two different manners these formulas: via [éq 2.1-1] or [éq 2.1-2].
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SENST04 - Sensitivities compared to the coefficient of exchange-wall Dates
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2.3
Results of reference

Sensitivities sought on the line y = 0, with the X-coordinates X = 0.25 (N3), X = 0.495 (N5), X = 0.505 (N101) and X = 0.75 (N103); these points being symmetrical compared to the axis of symmetry of the structure
(
L
X = 2), the sensitivities of the field of temperature are identical there in absolute value but
opposite signs:

T () T
T
T
N3 = -
(
)
N103
and
( )
N3 = -
(
)
N103
H
H

T () T
T
T
N5 = -
(
)
N101
and
( )
N5 = -
(
)
N101
H
H

Those in flow are constant on this line with a null component y.

2.4
Uncertainty on the solutions

Analytical solutions.
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3 Modeling
With

3.1
Characteristics of modeling

N24
N4
N46
N124 N104 N146
N2
N6
N102
N106
N12
N34
N56
N112
N34
N156
N1
N5
N101
N105
N13
N3

N35
N113 N103 N135

The grid is carried out with elements of the type QUAD8.
Calculation is made in linear thermics, with = 0.57.
One takes 50 steps of times from 0 to 5 102 S. the results are examined in T = 5 102 S.

In this analytical case-test, it is a question of making sure of the validity of the sensitivities of the field of temperature and of its flow compared to the coefficient of exchange-wall (noted PS1 in the file of order) and with conductivity (resp. PS2), in isotropic transitory linear thermics. These functionalities are accessible via the key word SENSITIVITY from THER_LINEAIRE (cf [R4.03.02]) and
CALC_ELEM/CALC_NO.
The problem is two-dimensional, but the limiting conditions make that the field of temperature reached quickly the stationary state and depends analytically only on the X-coordinate and the data. One in then deduced easily the analytical expressions from the sensitivities of the temperature and its flow by report/ratio with the thermal parameters which interest us: the coefficient of exchange-wall and conductivity (cf [§2.1]).
One thus tests the good adequacy of the sensitivities sought with their analytical values in several points of the grid (cf [§2.2]) and at the last moment of the transient (via TEST_RESU). For to facilitate later maintenance and by concerns for complétude, one also calculates and one tests (via functionalities PYTHON and TEST_FONCTION) values obtained by finished differences (only in temperature). But this last strategy, more expensive, harder to implement and less robust, is not of course to privilege and has virtue only as a test…

Tests of not-regression being already set up for the field of temperature (via the differences finished and TEST_FONCTION) one did not believe good to reproduce them for flows. In the same order of idea, since CALC_ELEM and CALC_NO carry out the same treatment on a EVOL_THER as it comes from THER_LINEAIRE or THER_NON_LINE, these tests on flows were not carried in modeling B.

3.2 Characteristics of the grid

4 QUAD8, 4 SEG3, 26 nodes

3.3 Functionalities tested

Orders

DEFI_MATERIAU
THER
AFFE_CHAR_THER_F
ECHANGE_PAROI
TEMP_IMPO
AFFE_MODELE
PLAN
THERMICS
DEFI_PARA_SENSI
MEMO_NOM_SENSI
THER_LINEAIRE
SENSITIVITY
CALC_ELEM
SENSITIVITY
FLUX_ELNO_TEMP
CALC_NO
SENSITIVITY
FLUX_NOEU_TEMP
TEST_RESU
SENSITIVITY

4 Results of modeling A

4.1
Values tested in temperature

One tests the validity of the sensitivities of the field of temperature calculated on the one hand via the option
SENSITIVITY of THER_LINEAIRE, and, in addition, by decentred finished differences, with respect to transitory analytical solutions (TEST_RESU and "ANALYTICAL" TEST_FONCTION). The tolerance relative is 1.10 4%.

Analytical identification Sensitivity
Variation
relative
Finished differences relative Variation
(in %)
(in %)
T

1.40759425 101 1.40759321 101 7.35
105 1.40759308 101 8.26
10-5
in N3
H

T

2.78703661 101 2.78703433 101 8.21
105 2.78703407 101 9.12
10-5
in N5
H

T

2.78703661 101 2.78703433 10
8.21 105 2.78703407 101 9.12
10-5
in N101
1
H

T

1.40759425 101 1.40759321 10
7.35 105 1.40759294 101 9.27
10-5

in N103
1
H

T
2.81518850 101 2.81518757 10
3.29 105 2.81518754 101 3.42
10-5
in
1

N3

T
5.57407323 101 5.57406975 10
6.25 105 5.57406957 101 6.57
10-5
in
1

N5

T
5.57407323 101 5.57406975 101 6.25
105 5.57406897 101 7.64
10-5
in

N101
T
2.81518850 101 2.81518757 101 3.29
105 2.81518697 101 5.44
10-5
in

N103

4.2
Values tested in flow

One tests the validity of the sensitivities of the heat flux calculated via the option SENSITIVITY of CALC_ELEM and of CALC_NO ("ANALYTICAL" TEST_RESU). The relative tolerance, for the component
in X, is 1.103% and that absolute, for the component in y, is 1.1011%. One is relatively
less severe than previously because of approximation made in CALC_NO (average
arithmetic simple of the fields to the nodes by element).

Component identification Sensitivity of *F*
Component
Sensitivity
X ***Relative variation***
analytical of *F*
(in %)
X
analytical of *fy*
of *fy*
F
2.25215080 101 2.25214904 101 7.79
10-5 0. -1.23
10-14

in N3
H

F
2.25215080 101 2.25218459 101 1.04
10-4 0. 1.92
10-14
in N5
H

F
2.25215080 101 2.25218459 101 1.04
10-4 0. -4.09
10-14
in N101
H

F
2.25215080 101 2.25214904 101 7.79
10-5 0. -8.11
10-15
in N103
H

F
8.91851718 101 8.91851062 101 7.36
10-5 0. -1.53
10-13
in

N3
F
8.91851718 101 8.91851154 101 6.32
10-5 0. 3.17
10-13
in

N5
F
8.91851718 101 8.91851154101 6.32
10-5 0. -3.23
10-13
in

N101
F
8.91851718 101 8.91851062 101 7.36
10-5 0. -7.60
10-14
in

N103

---

5 Modeling
B

5.1
Characteristics of modeling

Idem that for [§3.1] with THER_NON_LINE cf [U4.54.02].

5.2
Characteristics of the grid

Idem that for [§3.2].

5.3 Functionalities tested

Orders

DEFI_MATERIAU
THER_NL

AFFE_CHAR_THER_F
ECHANGE_PAROI
TEMP_IMPO

AFFE_MODELE
PLAN
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_NON_LINE
SENSITIVITY

TEST_RESU
SENSITIVITY

6
Results of modeling B

6.1 Values
tested

One tests the validity of the sensitivities calculated on the one hand via the option SENSITIVITY of THER_NON_LINE, and, in addition, by eccentric finished differences, with respect to the analytical solutions
transients (TEST_RESU and "ANALYTICAL" TEST_FONCTION). The relative tolerance is 1.10 4%.

Analytical identification
Sensitivity
Variation
Differences
Relative variation
relative
finished
(in %)
(in %)
T

1.40759425 101
1.40759321 101 7.35
105 1.40759308 101 8.26
10-5
in N3
H

T

2.78703661 101
2.78703433 101 8.21

105 2.78703421 101 8.61
10-5
in N5
H

T

2.78703661 101 2.78703433 101 8.21
105 2.78703407 101 1.06
10-4
in N101
H

T

1.40759425 101 1.40759321 101 7.35
105 1.40759289 101 9.68
10-5
in N103
H

T
2.81518850 101 2.81518757 101 3.29
105 2.81518711 101 4.93
10-5
in

N3
T
5.57407323 101 5.57406975 101 6.25
105 5.57406923 101 7.19
10-5
in

N5
T
5.57407323 101
5.57406975 101 6.25

105 5.57406926 101 7.13
10-5
in

N101
T
2.81518850 101
2.81518757 101 3.29
105 2.81518725 101 4.43
10-5
in

N103

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7
Summary of the results

One checks the good adequacy of the calculated sensitivities (in temperature and flow), via the option SENSITIVITY of THER_LINEAIRE, THER_NON_LINE, CALC_ELEM and CALC_NO, with the solutions
analytical. In particular, they respect strictly the properties of awaited symmetries.
It of in the same way sensitivities exhumed by finished differences (in temperature), which were not added here mainly that to meet later needs for maintenance and by concern
of complétude.
Moreover the difference between the finished differences and the analytical sensitivities is lower than 105%.
By crossing the results, it appears that the two thermal operators provide rigorously
same sensitivities (with a margin of at least 108%). What is, in theory, logic since one assembles even matrix and same second members. And what is also extremely reassuring as for
programming of these assemblies since they are carried out via data-processing routes
often distinct.
Linear" and "non-linear" finished differences the "are slightly different (with a margin of 105%!), because
the field of temperature results, in the first case, of the resolution of a linear system, in
the other case, of a non-linear solvor (phase of prediction + algorithm of Newton). But the difference is anecdotic (and could be reduced besides while being more severe on the parameters of
convergence of the process of optimization) and confers the same feeling as for calculations of
sensitivity: one is trustful as for the robustness of programming of these two operators, for it
type of configuration.
These two modelings thus make it possible to check the correct operation of the thermal operators, with ECHANGE_PAROI and TEMP_IMPO on not lumpées meshs 2D (ECHANGE_PAROI is not available in lumpé, although this modeling is rather that recommended in thermics!

modeling PLAN), in the two following configurations:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operators and TEST_RESU).

One tests also the correct operation of the operators of postprocessings CALC_ELEM and CALC_NO for the calculation of the heat fluxes and their sensitivities.

Organization (S): EDF/AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.155

SENSM04 - Sensitivity to the data materials
in linear elasticity orthotropic 2D

Summary:

One tests the calculation of sensitivity to the parameters materials in orthotropic linear elasticity. The sensitivity is
calculated by direct differentiation of the discrete equations. The reference comes from a calculation by differences
finished.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

I

OPPOSE

3. mm
BORD_GAU

CENTER

J

ORIGIN

y

10. mm
Z
1. < X <11
1.5 < Y <1.5

X

1.2
Properties of material

E_L
= 2.E5 MPa
E_T
= 1.E5 MPa
E_N
= 3.E5 MPa
NU_LT = 0.2 MPa
NU_LN = 0.3 MPa
NU_TN = 0.4 MPa
G_LT
= 2.E5 MPa
G_LN = 1.E5 MPa
G_TN = 3.E5 MPa

1.3
Boundary conditions and loadings

Surface BORD_GAU is blocked according to X.
The line ORIGIN is blocked according to X and Y.
A nodal force of components (10. , 3.) is imposed on the line OPPOSES.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

2
Reference solution

2.1
Method of calculation

For the sensitivity of the field displacement to the imposed nodal force, the solution comes from finished differences (approximation of derived with order 1) carried out with Aster. These finished differences
express themselves in the form:

F (X, y)
F (X + dx, y) - F (X, y)

X
dx

F (X, y)
F (X, y + Dy) - F (X, y)

y
Dy

2.2
Sizes and results of reference

Sensitivity of displacement following y to parameter E_L to item I:
D uy/d E_L (1, 1.5, Z) -2.8790892731628E-09

Sensitivity of displacement following y to parameter E_T to item I:
D uy/d E_T (1, 1.5, Z) -1.0802159291247E-11

Sensitivity of displacement following y to parameter NU_LT to item I:
D uy/d NU_LT (1, 1.5, Z) -2.2822247794372E-04

Sensitivity of displacement following y to parameter NU_LN to item I:
D uy/d NU_LN (1, 1.5, Z) 0.00

Sensitivity of displacement following y to parameter NU_TN to item I:
D uy/d NU_TN (1, 1.5, Z) 0.00

Sensitivity of displacement following y to parameter G_LT to item I:
D uy/d G_LT (1, 1.5, Z) -3.4017574169407E-10

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling in plane constraints on the grid following 2D:

Surface BORD_GAU becomes a line, the lines ORIGIN and OPPOSES become points.

3.2
Characteristics of the grid

A number of nodes: 181
Numbers and types of meshs: 80 SEG3, 50 QUAD8

3.3 Functionalities
tested

Orders

MEMO_NOM_SENSI
NOM_UN
NOM_ZERO
NAME
NOM_SD
PARA_SENSI
NOM_COMPOSE
MECA_STATIQUE
SENSITIVITY
TEST_RESU
SENSITIVITY

3.4
Sizes tested and results

Size tested
Reference:
Code_Aster
Difference (%)
D uy/d E_L (Node I)
2.8790892731628E-09
2.8790892731628E-09
0.0

D uy/d E_T (Node I)
1.0802159291247E-11
1.0802159291247E-11
0.0
D uy/d NU_LT (Node I)
2.2822247794372E-04
2.2822247794372E-04
0.0
D uy/d NU_LN (Node I)
0.00
0.00
0.0
D uy/d NU_TN (Node I)
0.00
0.00
0.0
D uy/d G_LT (Node I)
3.4017574169407E-10
3.4017574169407E-10
0.0

4
Summary of the results

The results of sensitivity per direct differentiation are in very good agreement with those given by finished differences.

Organization (S): EDF/AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.156

SENSM05 - Sensitivity to the data materials
in linear elasticity orthotropic 3D

Summary:

One tests the calculation of sensitivity to the parameters materials in orthotropic linear elasticity. The sensitivity is
calculated by direct differentiation of the discrete equations. The reference comes from a calculation by differences
finished.

Titrate:
SENSM05 - Sensitivity to the data materials in linear elasticity
Date:
19/08/02
Author (S):
NR. TARDIEU Key
:
V1.01.156-A Page:
2/6

1
Problem of reference

1.1 Geometry

I

OPPOSE

3. mm
BORD_GAU

CENTER

ORIGIN
J

y

10. mm
Z
1. < X <11
1.5 < Y <1.5
0 < Z < 1
X

1.2
Properties of material

E_L
= 2.E5 MPa
E_T
= 1.E5 MPa
E_N
= 3.E5 MPa
NU_LT = 0.2 MPa
NU_LN = 0.3 MPa
NU_TN = 0.4 MPa
G_LT
= 2.E5 MPa
G_LN = 1.E5 MPa
G_TN = 3.E5 MPa

1.3
Boundary conditions and loadings

Line BORD_GAU is blocked according to X, y and Z.
Item I is blocked according to X, y and Z.
A nodal force of components (100. , 30. , 10.) is imposed on the point OPPOSES.

2
Reference solution

2.1
Method of calculation

For the sensitivity of the field displacement to the imposed nodal force, the solution comes from finished differences (approximation of derived with order 1) carried out with Aster. These finished differences
express themselves in the form:

F (X, y)
F (X + dx, y) - F (X, y)

X
dx

F (X, y)
F (X, y + Dy) - F (X, y)

y
Dy

2.2
Sizes and results of reference

Sensitivity of displacement following y to parameter E_L to the point OPPOSES:
D uy/d E_L (11, 1.5, 0) 7.4460837925563E-10

Sensitivity of displacement following y to parameter E_T to the point OPPOSES:
D uy/d E_T (11, 1.5, 0) -4.1930886371059E-09

Sensitivity of displacement following y to parameter E_N to the point OPPOSES:
D uy/d E_N (11, 1.5, 0) -2.9508876027760E-10

Sensitivity of displacement following y to parameter NU_LT to the point OPPOSES:
D uy/d NU_LT (11, 1.5, 0) -1.6847821550311E-03

Sensitivity of displacement following y to parameter NU_LN to the point OPPOSES:
D uy/d NU_LN (11, 1.5, 0) 1.0775321899662E-05

Sensitivity of displacement following y to parameter NU_TN to the point OPPOSES:
D uy/d NU_TN (11, 1.5, 0) 2.0653103649623E-05

Sensitivity of displacement following y to parameter G_LT to the point OPPOSES:

D uy/d G_LT (11, 1.5, 0) -2.5910680787136E-09

Sensitivity of displacement following y to parameter G_LN to the point OPPOSES:
D uy/d G_LN (11, 1.5, 0) 5.6274647519574E-10

Sensitivity of displacement following y to parameter G_TN to the point OPPOSES:
D uy/d G_TN (11, 1.5, 0) -1.1579216129805E-09

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling in plane constraints on the grid following 3D:

3.2
Characteristics of the grid

A number of nodes: 331
Numbers and types of meshs: 930 SEG2, 970 QUAD4, 200 HEXA8

3.3 Functionalities

tested

Orders

MEMO_NOM_SENSI
NOM_UN
NOM_ZERO
NAME
NOM_SD
PARA_SENSI
NOM_COMPOSE
MECA_STATIQUE
SENSITIVITY
TEST_RESU
SENSITIVITY

3.4
Sizes tested and results

Size tested
Reference
Code_Aster
Difference (%)
D uy/d E_L (Node OPPOSES)
7.4460837925563E-10 7.4460837925563E-10
0.0
D uy/d E_T (Node OPPOSES)
-4.1930886371059E-09 -4.1930886371059E-09
0.0
D uy/d E_N (Node OPPOSES)
-2.9508876027760E-10 -2.9508876027760E-10
0.0
D uy/d NU_LT (Node OPPOSES) -1.6847821550311E-03 -1.6847821550311E-03
0.0
D uy/d NU_LN (Node OPPOSES) 1.0775321899662E-05 1.0775321899662E-05
0.0
D uy/d NU_TN (Node OPPOSES) 2.0653103649623E-05 2.0653103649623E-05
0.0
D uy/d G_LT (Node OPPOSES)
-2.5910680787136E-09 -2.5910680787136E-09
0.0

D uy/d G_LN (Node OPPOSES)
5.6274647519574E-10 5.6274647519574E-10
0.0
D uy/d G_TN (Node OPPOSES)
-1.1579216129805E-09 -1.1579216129805E-09
0.0

4
Summary of the results

The results of sensitivity per direct differentiation are in very good agreement with those given by finished differences.

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Code_Aster ®
Version
6.2

Titrate:
SENSD01 - Sensitivity to the loading and C.L in dyna_line_harm
Date:
23/10/02
Author (S):
Key ***S. CAMBIER***
:
V1.01.158-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.158

SENSD01 - Sensitivity to the loading and C.L in dyna_line_harm

Summary:

This case test takes again the geometry and the materials of the case test SDLD21 "System mass-arises to 8 ddl with viscous shock absorber " [V2.01.021]. Calculation carried out is the harmonic response of a dynamic system linear discrete.

The functionality tested is the derivation of the fields of displacement, speed and acceleration compared to
boundary conditions and with the loadings. These boundary conditions and loadings differ compared to
case test SDLD21. Indirectly, functionality of calculation with a real loading in entry of dyna_lina_harm is tested.

The reference calculated using the formal computation software MAPLE is semi-analytical.

1
Problem of reference

1.1 Geometry

U1
U2
U3
U8
K
K
K
K
With
m

m
m
m
B
X, U
P1
P2
P3
P8
C
C
C
C

1.2
Properties of material

Stiffness in translation
K = 105 N/m
Specific mass
m = 10 kg
Viscous damping
C = 50 N (m/s)

1.3
Boundary conditions and loadings

Boundary conditions:
Points A and B (nodes 1 and 10): null displacements:
uPi = 0

Not P1 (node 2):
imposed displacement: U
5 Hz F 40 Hz
1=
1
D sin (2 F T)
1
D =2.m

,
,

Loading:

Not P4 (node 5): nodal force according to X: FP4= 1
F sin (2 F T),
1
F =2.N, 5 Hz F 40 Hz

Not P5 (node 6): nodal force according to X: FP5= 2
F sin (2 F T),
2
F =0.N, 5 Hz F 40 Hz

1.4 Conditions
initial

Without object

2
Reference solution

2.1

Method of calculation

The reference is calculated using the formal computation software MAPLE v6 with the orders following:

Generic elementary matrices
> precision: =double:
> Kelem: =array ([[K, - K], [- K, K]]):
> Celem: =array ([[C, - C], [- C, C]]):
> Melem: =array ([[Mg, 0], [0, Mandelevium]]) /2:
> Zelem: =evalm (Kelem+I*omega*Celem-omega^2*Melem):
Associated matrices has each element
> valK: =1e5:
> valC: =50:
> valM: =10:
> regle1: = {k=kA1, c=cA1, mg=valM, md=m1}:
> ZA1: =subs (regle1, evalm (Zelem)):
> regle2: = {k=k12, c=c12, mg=m1, md=valM}:
> Z12: =subs (regle2, evalm (Zelem)):
> reglegen: = {k=valK, c=valC, mg=valM, md=valM}:
> Zgen: =subs (reglegen, evalm (Zelem)):
Assembly
> Ai1: =array ([[0,0,0,0,0,0,0,0], [1,0,0,0,0,0,0,0]]):
> Ai2: =array ([[1,0,0,0,0,0,0,0], [0,1,0,0,0,0,0,0]]):
> Ai3: =array ([[0,1,0,0,0,0,0,0], [0,0,1,0,0,0,0,0]]):
> Ai4: =array ([[0,0,1,0,0,0,0,0], [0,0,0,1,0,0,0,0]]):
> Ai5: =array ([[0,0,0,1,0,0,0,0], [0,0,0,0,1,0,0,0]]):
> Ai6: =array ([[0,0,0,0,1,0,0,0], [0,0,0,0,0,1,0,0]]):
> Ai7: =array ([[0,0,0,0,0,1,0,0], [0,0,0,0,0,0,1,0]]):
> Ai8: =array ([[0,0,0,0,0,0,1,0], [0,0,0,0,0,0,0,1]]):
> Ai9: =array ([[0,0,0,0,0,0,0,1], [0,0,0,0,0,0,0,0]]):
>
Z: =evalm (transposes (Ai1) &*ZA1&*Ai1+transpose (Ai2) &*Z12&*Ai2+transpose (Ai3) &*Zgen&*A
i3+transpose (Ai4) &*Zgen&*Ai4+transpose (Ai5) &*Zgen&*Ai5+transpose (Ai6) &*Zgen&*Ai6+transpose (Ai7) &*Zgen&*Ai7+transpose (Ai8) &*Zgen&*Ai8+transpose (Ai9) &*Zgen&*Ai9):
> with (linalg):
Resolution and calculation of the derivatives
> affect_p: = {kA1=valK, k12=valK, cA1=valC, c12=valC, m1=valM}:
> Z_w: =map (evalf, subs (affect_p, evalm (Z)));
> om: =40*2*evalf (pi):
> affect: = {omega=om}:
> Z_num: =Matrix (subs (affect, evalm (Z_w))):

> Zll: = Z_num [2..8, 2..8]:
> Zli: = Matrix (7,1, Z_num [2..8, 1]):
> affect_F: = {F1=2, F2=0}:
> CH: =Vector (7, [0,0,0, F1, F2,0,0]);
> CH_impo: =evalm (CH-evalm (D1*Zli)):
> CH_num: =subs (affect_F, evalm (CH_impo));
> depl_D1: =evalm (linsolve (Zll, CH_impo)):
derived compared to 1
D
> DdeplDimpo: =map (simplify, evalm (map (diff, evalm (depl_D1), D1)));
derived compared to 1
F
> DdeplDF1: =map (simplify, evalm (map (diff, evalm (depl_D1), F1)));
derived compared to 2
F
> DdeplDF2: =map (simplify, evalm (map (diff, evalm (depl_D1), F2)));
affect_impo: = {D1=2, F1=2, F2=0}:
nonderived displacements
> depl_D1_num: =subs (affect_impo, evalm (depl_D1));

2.2
Results of reference

To 40 Hz:
displacements of node 3,
derived compared to 1

D of displacements of node 3,
derived compared to 1
F of displacements of node 5,
derived compared to 2
F of displacements of node 5.

2.3 Uncertainties

Semi-analytical solution

3 Modeling
With

3.1
Characteristics of modeling

Modeling identical to that of the SDLD25A

y
With
P
P
B
X
1
2
P3
P4
P5
P6
P7
P8

Characteristics of the elements:

DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity

K_T_D_L

and matrices of damping
A_T_D_L

Limiting conditions:

in all the nodes
DDL_IMPO:
(ALL: “YES”
DY: 0. , DZ: 0.)
with the nodes ends

(GROUP_NO: AB
DX: 0.)

Names of the nodes:

Not A = N1
P1 = N2
Not B = N10
P2 = N3
....

P8 = N9

3.2
Characteristics of the grid

A number of nodes: 10

A number of meshs and types: 9 SEG2

3.3 Functionalities
tested

The functionality tested is the derivation of the fields of displacement, speed and acceleration by report/ratio in the boundary conditions and with the loadings. These boundary conditions and loadings
differ compared to the case test SDLD21. Indirectly, functionality of calculation with one
real loading in entry of dyna_lina_harm is also tested.

Orders

DYNA_LINE_HARM
SENSITIVITY

EXCIT
CHARGE

3.4 Values
tested

Parts real and imaginary of component DX of the displacement of node 3

Frequency Reference
Aster %
Difference
40 Hz
4.8176281E01
4.8176312957349E01
7.58E 05%
1.0074952E01
1.0074971204938E01

Derived compared to 1
F of the parts real and imaginary of component DX of displacement of

node 5

Frequency Reference
Aster %
Difference
40 Hz
2.5695869E06
2.5694461510682E06
0.020 %
2.7550424E07
2.7501154222522E07

Derived compared to 2
F of the parts real and imaginary of component DX of displacement of node 5

Frequency Reference
Aster %
Difference
40 Hz
6.0508111E07
6.0508111466796E07
1.22E 06%
1.9567292E07
1.9567292616373E07

Derived compared to 1
D of the parts real and imaginary of component DX of displacement of node 5

Frequency Reference
Aster %
Difference
40 Hz
2.4088143E01
2.4088143455385E01
1.89E 06%
5.0374785E02
5.0374785980418E02

Handbook of Validation
V1.01 booklet: Tests of validity of the orders

4
Summary of the results

The precision of the results is coherent with the method of resolution used and the method of direct derivation "exact".

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.159

ZZZZ159 - Retiming of a law of behavior
elastoplastic on a tensile test

Summary:

One tests macro retiming MACR_RECAL on the simple case of the identification of a law of behavior elastoplastic of Von Mises on a simple tensile test controlled in displacements. Readjusted parameters are the Young modulus, the elastic limit and the slope of work hardening starting from the knowledge of
constraints and of the plastic deformation cumulated in the test-tube.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/03/008/A

Code_Aster ®
Version
6.4

Titrate:
ZZZZ159 - Retiming of an elastoplastic law of behavior
Date:
03/06/03

1
Problem of reference

1.1 Geometry

Traction of 5.E-3 mm

1.2
Properties of material

The initial values of the parameters are as follows:

E=100000. MPa
y=1000. MPa
ET=30. MPa

The values which one wishes to obtain are (see method of calculation of the reference solution):

E=200000. MPa
y=200. MPa
ET=2000. MPa

1.3
Boundary conditions and loadings

A homogeneous state of stresses is sought: one imposes only one vertical displacement of
5.E-3 Misters.

2
Reference solution

2.1
Method of calculation

This calculation is a validation macro MACR_RECAL. With this intention, the step is as follows:

· one chooses a value (known as "value to be identified") for each parameter and one does it calculation. One thus obtains a history of constraint and cumulated plastic deformation,
· one supposes now that the values to be identified preceding are unknown for us. Our only information is the history of constraint and cumulated plastic deformation that us will thus considèrerons like an experimental measurement,
· one then launches optimization to this pseudo experimental measure while taking for each one parameters an arbitrary value,
· one checks that the values identified by the algorithm are well the values to be identified.

This step is very traditional in optimization where it makes it possible to validate the algorithms.

2.2
Sizes and results of reference

The reference variables are the values of the parameters with convergence is:

E=200000. MPa
y=200. MPa
ET=2000. MPa

---

3 Modeling
With

3.1
Characteristics of modeling

Axisymmetric modeling on the following grid:

In this modeling, initial values and acceptable fields of the various parameters are:

· Modulus Young:

100000 [50000.,500000.]
.
· Pente of work hardening: 1000. [500. , 10000.]
· Limit elastic:

30.
[5.,500.]

3.2
Characteristics of the grid

A number of nodes: 4
Numbers and types of meshs: 4 SEG2, 1 QUAD4

3.3 Functionalities
tested

Orders

MACR_RECAL UNITE_ESCL

RESU_EXP

RESU_CALC

LIST_PARA

ITER_MAXI

RESI_GLOB_RELA

UNITE_RESU

GRAPH
UNIT

INTERACTIVE

3.4
Sizes tested and results

Sizes tested
Values obtained
Analytical values
Variation (%)
Young modulus
199999.89
200000.00
5.61E-05
Elastic limit
1999.96
2000.00
-0.002
Slope of work hardening
200.00
200.00
1.39E-04

4 Modeling B

4.1 Characteristics of modeling

Axisymmetric modeling on the following grid:

In this modeling, initial values and acceptable fields of the various parameters are:

· Modulus Young:

100000 [50000.,150000.]
.
· Pente of work hardening: 2000. [500. , 10000.]
· Limit elastic:

30.
[5.,500.]

As one can note it, the solution of the problem does not belong to the acceptable field. It is it this modeling drank which validates the management of the terminals.

4.2
Characteristics of the grid

A number of nodes: 4
Numbers and types of meshs: 4 SEG2, 1 QUAD4

4.3 Functionalities
tested

Orders

MACR_RECAL UNITE_ESCL

RESU_EXP

RESU_CALC

LIST_PARA

ITER_MAXI

RESI_GLOB_RELA

UNITE_RESU

GRAPH
UNIT

INTERACTIVE

4.4
Sizes tested and results

Sizes tested
Values obtained
Analytical values
Variation (%)
Young modulus
150000.00
150000.00

0.0
Elastic limit
1000.00
1000.00
0.0
Slope of work hardening
158.50
158.50
0.003

5
Summary of the results

The results of optimization are obtained in a small iteration count (5) and are of very good quality.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.160

SENST05 - Sensitivities compared to heat voluminal and with emissivity

Summary:

In this case-test, it is a question of making sure of the validity of the sensitivities compared to voluminal heat and to
the emissivity of a radiation, in isotropic transitory non-linear thermics lumpée (key word SENSITIVITY of
THER_NON_LINE). It is based on the grid of case-test SENST01A treating the transitory thermal answer
of a plate 2D_PLAN subjected to various thermal requests.
One tests the good adequacy of the sensitivities sought with their approximation by finished differences, in
several points of the grid and at the last moment of the transient. Strategy of calculation by finished differences,
more expensive, harder to implement and less robust, is not of course to privilege and does not have virtue that as a test…

One thus checks the correct operation of THER_NON_LINE with loadings EXCHANGE, TEMP_IMPO and
RADIATION, on lumpées isoparametric meshs 2D, in the two following configurations:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operator and TEST_RESU).

Version
6.0

Titrate:
SENST05 - Sensitivities compared to voluminal heat

Date:
14/10/02
Author (S):
O. BOITEAU Key
:
V1.01.160-A Page:
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1
Problem of reference

One takes again here the geometry of the case-test SENST01A on which one will affect materials and loadings corresponding to no real case. It is here only about one functional validation, numerical and of data-processing not-regression of calculations of sensitivity in a situation very penalizing (many loadings in little space and with dependences in time polynomial!)

1.1 Geometry

y

OPPOSE
J
y=1,5

CENTER
X
X
x=1
x=11

I
y=1,5 ORIGIN

The four corners and the center are particularized:

Name
X
Y
ORIGIN
1 -1,5
I
11 -1,5
J
1 1,5
OPPOSE
11 1,5
CENTER
6 0

The various zones are indicated. Each internal rectangle is indicated under its name: MOITIE1 and MOITIE2.
Each frontier segment bears a name. The vertical segments on the left and on the right are named BORD_GAU and BORD_DRO. The lower horizontal segments are named BORD_IN1 and BORD_IN2; in the same way, the higher horizontal segments are named BORD_SU1 and BORD_SU2.

BORD_SU1
BORD_SU2

BORD_GAU
BORD_DRO
MOITIE1
MOITIE2

1.2
Material properties

To all the structure one applies the characteristics material:

= 75
.
0
W/°
m C

C
3
2
/
p =
J m °C sensibilit
PS1

sought

é

1.3
Boundary conditions and loadings

By noting T the moment considered, one can synthesize the decomposition of the loadings by zone under
the shape of the following table:

Geometrical zones
Loadings Sensitivity
(GROUP_NO/GROUP_MA)
sought
BORD_GAU
COEF_H = 30 W/m2°C
T_EXT = 140 °C

BORD_DRO
SIGMA = 1.108 W/m2 (°C) 4
EPSILON = 0.3

PS2
TEMP_EXT = 500 °C
ORIGIN
TEMP = 100 (1+0.1 T) °C

1.4 Condition
initial

Transitory thermal calculation on two steps of time (T1 = 5 S and t2 = 10 S) initialized by a calculation
stationary (TEMP_INIT=_F (STATIONNAIRE=' OUI')).
Handbook of Validation
Booklet V1.01 Tests of validity of orders
HI-23/02/017/A

Code_Aster ®
Version
6.0

Titrate:
SENST05 - Sensitivities compared to voluminal heat

Date:
14/10/02

2
Reference solution

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution! Calculations of sensitivity validated by centered differences are finished (what allows also at the same time to validate standard calculation).
This good adequacy of the sensitivities with their approximation by finished differences is tested in several points of the grid (I, J and CENTER), and at every moment of the transient (t0, T1 and t2), in structures of control PYTHON of the command file. It is traced in the file message (one tolerate a maximum variation of 107%). In the file result one retained only the part of this test concerning the point CENTERS at the last moment of the transient (the sensitivities via a TEST_RESU and them differences finished via a TEST_FONCTION, with a relative tolerance of 106%).
In the event of disagreement on results (NOOK), one can thus refine the diagnosis, that is to say in direction of standard problem, either of the derived problem, or of both.
Strategy of calculation by differences finished, more expensive, harder to implement and less robust, is not of course to privilege and has virtue only as a test…

2.2
Result of reference

Without object.

2.3
Uncertainty on the solutions

Parameters of shift of the finished difference (1 = 104, 2 = 106) and convergence of the grid.

---

3 Modeling With

3.1 Characteristics of modeling

The grid is carried out with elements of the type TRIA3.
Calculation is made in linear thermics with operator THER_NON_LINE (= 0.57).
One takes 2 steps of times from 0 to 10 S. the results are examined in t2= 10 S.
In this case-test, it is a question of making sure of the validity of the sensitivities compared to voluminal heat
on all structure (noted PS1 in the command file) and with the emissivity of the radiation
imposed on the BORD_DRO (resp. PS2). These sensitivities are estimated at the last moment of the transient and
at the point CENTERS.

3.2 Characteristics of the grid

80 TRIA3, 28 SEG2, 55 nodes

3.3 Functionalities tested

Orders

DEFI_MATERIAU
THER_NL

AFFE_CHAR_THER_F
EXCHANGE
TEMP_IMPO
RADIATION

AFFE_MODELE
PLAN_DIAG
THERMICS

DEFI_PARA_SENSI

MEMO_NOM_SENSI

THER_NON_LINE
SENSITIVITY

4
Results of modeling A

4.1 Values
tested

One tests the validity of the calculated sensitivities, on the one hand, via the option SENSITIVITY of
THER_NON_LINE
(TEST_RESU "NON_REGRESSION"), and, in addition, by finished differences
centered (TEST_FONCTION "AUTRE_ASTER"). The relative tolerance is 1.10 6%.

Identification SENSITIVITY Variation
relative
Finished differences relative Variation
(in %)
(in %)
T

2.16993453 10-1
*8.7 10-13**
2.16993453 101
*-8.83 10-13**

(
CENTER

~ 0%
~ 0%
C p) (
, t2)

T
(
8.12296002
*8.75 10-14**
8.12296002
*4.15 10-13**
,
CENTER T

2)

~ 0%
~ 0%

*** Taking into account the precision machine, it is value is an approximation into arithmetic finished the zero value.***

5
Summary of the results

One checks the excellent adequacy of the calculated sensitivities, via the option SENSITIVITY of THER_NON_LINE, with the values by finished differences (the variation is lower than 1010%).

These results make it possible to check the correct operation of the operator with the loadings EXCHANGE, TEMP_IMPO and RADIATION, on lumpées isoparametric meshs 2D, in two following configurations:

· in standard calculation (via the finished differences and TEST_FONCTION),
· of sensitivity (via the suitable option of the thermal operator and TEST_RESU).

Titrate:
ZZZZ161 - Exchange with the format MED, data-processing control

Date:
03/06/03
Author (S):
G. Key NICOLAS

Organization (S): EDF-R & D /SINETICS

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.161

ZZZZ161 - Exchange with the format MED, control
data processing

Summary:

This case test controls the writings of fields to format MED and their second reading by ASTER. It validates in particular
the writing of fields nondefinite on the complete field or definite on several types of elements. It controls
also the exchange of fields of size.

It should be noted that mechanical calculation is only one pretext and does not have any ambition of validation in oneself.

1
Problem of reference

1.1 Geometry

The field is a rectangle of size 10x20, separate in 4 sections of 10x5. 3 points are associated this rectangle: M, NR and O.

J
OPPOSE

11

O

WITH B C
D
6

NR

1

MR. ORIGIN
I

0 2
7
12
17
22

1.2
Properties of material

Two materials are used:

Material 1 has the following characteristics:

E = 180.000 N.m2
= 0,3
= 1,5 10-7
L = 7700 kg.m3

It is applied in the sections A and B.

The second material has the following characteristics:

E = 220.000 N.m2
= 0,3
= 1,6 10-7
L = 8300 kg.m3

It is applied in sections C and D.

1.3
Boundary conditions and loadings

At the point "ORIGIN", displacement is null according to Y.

On all the left edge, i.e. between the points "ORIGIN" and "I it normal displacement is no one.
On the higher edge, i.e. between the points "I and "OPPOSE", the pressure is imposed on 1000.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solutions

Calculation is in static mechanics. It is only one pretext required a result.

2.2
Results of reference

To the node "OPPOSES", displacement has the following values:

ux = 0,4183044
uy = 1,639849

2.3
Uncertainty on the solutions

Without object.

---

3 Modeling
With

3.1
Characteristics of modeling

Calculation is made in two-dimensional static mechanics, in plane deformation.

3.2
Characteristics of the grid

The sections A and B are with a grid with 8 triangles TRIA3. They form the group of meshs named "SORTED". The sections C and D are with a grid with 4 quadrangles QUAD4. They form the group of meshs named "QUAD".

The 4 triangles of the section B and the 2 quadrangles of the section C are gathered in the group "MEDIUM".

The external frontier segments are with a grid with 12 segments SEG2. They are gathered in 4 named groups "BORD_INF", "BORD_DRO", "BORD_SUP" and "BORD_GAU".

"I
"OPPOSES"

11 "O"

6

“

1

“Me
“ORIGIN”
“I”

0 2
7
12
17
22

3.3 Functionalities tested

Orders

IMPR_RESU FORMAT “MED”

LIRE_CHAMP FORMAT “MED”

TYPE_CHAM “CHAM_NO_DEPL_R”

This case tests the various options of writing to format “MED” via order IMPR_RESU. For that we calculate various options complementary to the only displacement and we create a field of size are equivalent to the field of displacement to the nodes. The impressions are successively those:

· the field of displacement to the nodes and the stress field at the points of Gauss, expressed on all the grid. That starts the creation of a profile for displacement because it

is not defined everywhere: the three nodes "Me, "and "O" do not comprise a value,
· the field of size. It uses the same profile as the field of displacement of the result standard,
· components "SIXY" and "SIYY" of the stress field to the nodes by element "SIGM_ELNO_DEPL",
· the indicator of error "ERRE_ELGA_NORE" on the meshs of the group "MEDIUM". That start the creation of two profiles because the written values are not it on all them meshs. The first profile relates to the 4 triangles out of the 8 of the total; the second relates to the 2 quadrangles on the 4 of the total.

The second reading since format "MED" is that of the field of displacement to the nodes contained in field of size.

---

4 Results of modeling A

4.1 Values tested

The comparison takes place on the value of displacement to the node "OPPOSES" with a relative tolerance from 104%.

Identification
Value

Relative variation in %
ux 0,4183044
1,55
10-7
uy 1,639849 2,71
10-5

5
Summary of the results

No particular comment is to be made on this case test. It is only used to ensure the perenniality of writings and readings with format MED.

Author (S):
Key ***S. CAMBIER***
:
V1.01.162-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.162

SENSD02 Sensitivity to materials in dynamics isotropic harmonic 3D

Summary

This case test relates to the derivation of the harmonic response of an isotropic parallépipède.

The functionality tested is the derivation of the fields of displacement, speed and acceleration compared to
properties materials modulus Young and Poisson's ratio.
The reference is calculated by finished differences.

1
Problem of reference

1.1 Geometry

OPPOSE

CENTER
BORD_GAU
3. m

I

y

10. m

1 m < X < 11 m
1.5 m < Y < 1.5 m

X
0 m < Z < 1 m
Z

1.2
Properties of material

E = 105 Pa

= 0.3

AND = 2000 MPa

Viscous damping, matrix of damping: K + M, = 0.002 S and = 0.3 s1

1.3
Boundary conditions and loadings

Boundary conditions:
Line "BORD_GAU" is blocked according to X, y and Z.
The node "I" is blocked according to X, y and Z.

Loading:
The line "OPPOSES":

nodal force according to X: Fx= 1
F sin (2 F T)
1
F =100 NR,
10 Hz F 40 Hz

nodal force according to y: Fy= 2
F sin (2 F T)
2
F =30 NR,
10 Hz F 40 Hz

nodal force according to Z: Fz= 3
F sin (2 F T) F =10 NR,
10 Hz F 40 Hz
3

1.4 Conditions
initial

Initial displacement no one and null initial speed.

2
Reference solution

2.1
Method of calculation

The sensitivities of the fields of displacement, speed and acceleration to the data materials are calculated by finished differences. These calculations by finished differences are carried out inside even case test by Code_Aster. The diagram of finished differences used is as follows (diagram of order 1 not centered):

F (,
X)
y
F (x+,)
y - F (,
X)
y

X

The field of solution displacement of the standard problem (i.e nonderived) is subjected to a test of not regression. Tests of nonregression are also carried out on the sensitivities.

2.2 Sizes and results of reference

The parameters of sensitivity are the Young modulus E and the Poisson's ratio.

By finished differences:
derived compared to E from displacement following y to the node OPPOSES to the frequency of 10 Hz,
derived compared to displacement following y to the node OPPOSES to the frequency of 10 Hz.

By nonregression:
displacement following Z of the node OPPOSES to the frequency of 10 Hz,
derived compared to E of acceleration following y to the node OPPOSES to the frequency of 40 Hz,
derived compared to acceleration according to X with the node OPPOSES to the frequency of 40 Hz.

2.3 Uncertainties

Results depending amongst other things on the convergence of calculations (what can disturb the values of reference calculated by difference-finished); uncertainty on the solution can be estimated order from 0.5% for the values tested significant (not too small).

---

3 Modeling With

3.1 Characteristics of modeling

Modeling in voluminal element.

BORD_GAU

F

I

y

X

Z

Characteristic of the elements: 3D

Boundary conditions: line BORD_GAU and node I are blocked according to X, y and Z.

3.2 Characteristics of the grid

A number of nodes: 330
Numbers and type of mesh: 200 HEXA8

3.3 Functionalities tested

The functionality tested is the derivation of the fields of displacement and acceleration compared to properties materials modulus Young and Poisson's ratio.

Orders

MEMO_NOM_SENSI NOM_UN

NOM_ZERO

NAME
NOM_SD

PARA_SENSI

DYNA_LINE_HARM SENSITIVITY

EXCIT
CHARGE

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

The results are obtained on the machine Compaq clayastr.

References obtained by finished differences:

derived compared to E of the parts real and imaginary of the component dx of displacement with node OPPOSES

Frequency Reference
***Aster** %*
Difference
10 Hz
-2.71212249354850-19 -2.7146051236211D-19
0.094 %
6.5418838140065D-20
6.5507314799724D-20

derived compared to parts real and imaginary of the component dx of displacement with node OPPOSES

Frequency Reference
***Aster** %*
Difference
10 Hz
-2.8882101730469D-09 -2.8851572867471D-09
1.22E 06%
8.7757452912573D-10
8.7730320078234D-10

References obtained by nonregression:

Parts real and imaginary of the component dz of displacement to the node OPPOSES

Frequency Reference
***Aster** %*

Difference
10 Hz
1.4126470000000D-07
1.4126477736023D-07
5.42E- 05%
-2.0512020000000D-08
-2.0512021300347D-08

derived compared to E of the parts real and imaginary of the component Dy of acceleration with node OPPOSES

Frequency Reference
***Aster** %*
Difference
40 Hz
6.6827140000000D-15
6.6827148301820D-15
1.18E- 05%
-3.4841000000000D-15
-3.4841003202926D-15

derived compared to parts real and imaginary of the component dx of acceleration with node OPPOSES

Frequency Reference
***Aster** %*
Difference
40 Hz
-4.6447430000000D-04 -4.6447437730561D-04
1.22E 06%
6.4057980000000D-04
6.4057985074844D-04

4
Summary of the results

Precision evaluated by comparison of the results of the method of resolution by direct derivation “exact” with those obtained by finished differences is completely satisfactory.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.163

SENSD03 - Sensitivity to materials in dynamics
isotropic harmonic 2D

Summary

This case test takes again the geometry and the materials of test SENSM03 but calculation carried out here is the answer
harmonic of the system.

The functionality tested is the derivation of the fields of displacement, speed and acceleration compared to
properties materials modulus Young and Poisson's ratio. A simultaneous calculation of the sensitivities by report/ratio
with the loading is also tested.

The reference is calculated by finished differences.

1
Problem of reference

1.1 Geometry

OPPOSE

3. mm
BORD_GAU

CENTER

ORIGIN

y

10. mm
Z

1. < X < 11

1.5 < Y < 1.5
X

1.2
Properties of material

E = 36.000 MPa

= 0.2

= 2400 kg/m3

1.3
Boundary conditions and loadings

Boundary conditions:
Surface "BORD_GAU" is blocked according to X.
The line "ORIGIN" is blocked according to X and Y.

Loading:
The line "OPPOSES":
nodal force according to X: Fx= 1
F sin (2 F T), 1
F = 10. NR, 10 Hz F 40 Hz
nodal force according to y: Fy= 2
F sin (2 F T), 2
F = 3. NR, 10 Hz F 40 Hz

1.4 Conditions
initial

Without object.
Handbook of Validation
V1.01 booklet: Tests of validity of the orders
HT-66/02/001/A

Code_Aster ®
Version
6.3

Titrate:
SENSD03 - Sensitivity to materials in isotropic harmonic dynamics

2 *Reference solution*

2.1 *Method of calculation*

The sensitivities of the fields displacement, speed and acceleration with the data materials are calculated by finished differences. These calculations by finished differences are carried out inside even case test by Code_Aster. The diagram of finished differences used is as follows (diagram of order 1 not centered):

F (,
X)
y
F (x+,)
y - F (,
X)
y

X

The field of solution displacement of the standard problem (i.e nonderived) is subjected to a test of not regression. Tests of nonregression are also carried out on the sensitivities.

2.2 *Sizes and results of reference*

By finished differences:
To 10 Hz:
derived compared to E from displacements in y to the group from nodes OPPOSES,
derived compared to displacements in y with the group from nodes OPPOSES,
derived compared to 1

F of displacements in y to the group of nodes OPPOSES,
derived compared to 2
F of displacements in y to the group of nodes OPPOSES.

By nonregression:
To 10 Hz:
displacements in X with the group of nodes OPPOSES
To 25 Hz:
derived compared to E from accelerations in y to the group from nodes OPPOSES,
derived compared to accelerations in X with the group from nodes OPPOSES,
To 40 Hz:
derived compared to 1
F speeds in X to the group of nodes OPPOSES,
derived compared to 2
F of displacements in X to the group of nodes OPPOSES.

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling in plane constraints on the grid following 2D:

Surface BORD_GAU becomes a line, the lines ORIGIN and OPPOSES become points.

3.2 Characteristics of the grid

A number of nodes: 55
Numbers and types of meshs: 28 SEG2, 80 TRIA3

3.3 Functionalities tested

The functionality tested is the derivation of the fields of displacement, speed and acceleration by report/ratio with the properties materials (Young modulus and Poisson's ratio). A simultaneous calculation of sensitivities compared to the loading is also tested.

Orders

MEMO_NOM_SENSI
NOM_UN
NOM_ZERO
NAME
NOM_SD
PARA_SENSI
NOM_COMPOSE
DYNA_LINE_HARM
SENSITIVITY
EXCIT
CHARGE
TEST_RESU
SENSITIVITY

3.4 Sizes tested and results

By finished differences:

Derived compared to E of the parts real and imaginary of displacements in y, line OPPOSES
Frequency Reference
***Aster** %*
Difference
10 Hz
2.6060024120854E19 2.6100392585269E19

0.155 %
2.6060024120854E19
2.6100392585269E19

Derived compared to parts real and imaginary of displacements in y, line OPPOSES
Frequency Reference
***Aster** %*
Difference
10 Hz
2.5599564694851E10 2.5598652812905E10
0.004 %
2.5599564694851E10
2.5598652812905E10

Derived compared to F1 of the parts real and imaginary of displacements in y, line OPPOSES
Frequency Reference
***Aster** %*
Difference
10 Hz
1.4005526375796E09 1.4005526375796E09
2.30E 10%
1.4005526375796E09
1.4005526375796E09

Derived compared to F2 of the parts real and imaginary of displacements in y, line OPPOSES
Frequency Reference
***Aster** %*
Difference
10 Hz
6.6511780281604E09 6.6511780281527E09
1.17E 10%
6.6511780281604E09
6.6511780281527E09

By nonregression:

Displacements in X with the group of nodes OPPOSES
Frequency Reference
***Aster** %*
Difference
10 Hz
1.3016840000000E09 1.3016840539066E09
4.14E 06%
1.3016840000000E09
1.3016840539066E09

Derived compared to E of the parts real and imaginary of accelerations in y, line OPPOSES
Frequency Reference
***Aster** %*
Difference
25 Hz
2.0057540000000E15 2.0057545862003E15
0.155 %
2.0057540000000E15
2.0057545862003E15

Derived compared to parts real and imaginary of accelerations in X, line OPPOSES
Frequency Reference
***Aster** %*
Difference
25 Hz
7.1521020000000E08 7.1521029915851E08
1.39E 05%
7.1521020000000E08

7.1521029915851E08

Derived compared to F1 of the parts real and imaginary speeds in X, line OPPOSES
Frequency Reference
***Aster** %*
Difference
40 Hz
8.2114210000000E08 8.2114212686221E08
3.27E 06%
8.2114210000000E08
8.2114212686221E08

Derived compared to F2 of the parts real and imaginary of displacements in X, line OPPOSES
Frequency Reference
***Aster** %*
Difference
40 Hz
5.6196830000000E11 5.6196830401657E11
7.15E07%
5.6196830000000E11
5.6196830401657E11

---

4 Summary of the results

The precision of the results is coherent with the method of resolution used and the method of direct derivation “exact”.

ZZZZ164 - Validation of the key words TRANSLATION, ROTATION, MODI_BASE and SCALE of order MODI_MAILLAGE

Summary:

This test validates the key words TRANSLATION, ROTATION, MODI_BASE and SCALE of MODI_MAILLAGE. In
this goal, one will impose on two grids, one 3D and the other 2D two combinations of these key words. The first
is made up of a translation, two unspecified rotations and a scaling. One thus will test them
two possibilities of definition of the axis of rotation: either by two points, or by a point and the direction.
second will combine a basic change and a scaling. One will thus have tested all the cases thus of figures authorized by these key words.

1

Problem of reference

1.1 Geometry

The problem is 3D, it acts of a right-angled parallelepiped:

3

Z

P5
P8

1

P6
P7

5

y

P1
P4

P2
P3

X

One will net this volume with a solid element of type HEXA8.
A modeling 2D is deduced from it, with a grid with a solid element QUAD4:

1

y

P4 P3

3

X
P1
P2

1.2
Properties of material

Place does not have to be here.

1.3
Boundary conditions and loadings

Nondefinite.

1.4 Conditions
initial

Nondefinite.

:
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2
Reference solution

2.1
Method of calculation

The reference solution is analytical.
Either M (X, y, Z) a point of space, one imposes a translation T of vector (tx, ty, tz), and one to him rotation R of angle (in radians) whose axis passes by P (px, py, pz) and has as a direction
(
D dx, Dy, dz).
Then M becomes MT after the translation: MT (X + tx, y + ty, Z + tz).
MT becomes MTR after rotation:

M
= P + cos PM
TR
T + (1 - cos) (PM
D
T
) D + sin (D PMT)
With M

= M + T
T

The scaling of a factor ech, gives:

MTRE = ech MTR

The functionality of basic change awaits in entry the data by the user of two vectors
orthogonal in 3D (only one vector in 2D). One comes to supplement these data in order to generate one
base orthogonal direct, in 3D or 2D. Tests are carried out in order to check if the data
of entry will allow to define a direct orthogonal base. A standardization of the vectors of
base is then carried out.
In 3D, one thus awaits the data of U and V, the first two vectors of the new base:

W (X, y, Z) = U (X, y, Z) V (X, y, Z)
B = (U, V, W)

formed

stamp
:

by

base

of

vectors

M (U, V, W) BT
=
M (X, y, Z)

In 2D, one generates the second vector of the base by rotation of 90° of the vector seized by the user.
This basic change can be combined with a scaling and a translation, for example.
The programming of these transformations is done differently in 3D and 2D, so as to optimize each one of these two cases.

2.2
Sizes and results of reference

One will control the new co-ordinates of the P1 point, P7 and P8 in 3D (P1, P3 and P4 in 2D).

2.3
Uncertainties on the solution

Uncertainties come from the numerical precision in Code_Aster (dependence of the platform) and in the calculation of the analytical solution of reference. One can thus consider a criterion of precision relative about 1.E-13 in the tests.

2.4 References bibliographical

Without use.

3 Modeling With

3.1 Characteristics of modeling

One places oneself within a framework massive 3D. One will impose successively:

· a translation of vector (2,5 3,9 -12,3),
· a rotation of angle 33 degrees and axis passing by the items (10 0,5.3,8) and (0 10 0),
· the second rotation of angle -161 degrees and axis passing by (- 3 0,5.3,8) and from direction (0 1 0),
· a scaling of a factor 5.

One thus tests all the cases of figure authorized by the syntax of the key words TRANSLATION, ROTATION and SCALE.

Then, one sets out again of the initial grid and one imposes to him successively:

· a basic change of vectors (1,23 0,23 0) and (- 2.3 12,3 0),
· a scaling of a factor 5.

One tests together thus the key words MODI_BASE and SCALE.

3.2 Characteristics of the grid

The grid comprises only one element of the type HEXA8.

3.3 Functionalities tested

Orders

MODI_MAILLAGE
TRANSLATION

ROTATION
POIN_1

POIN_2

DIR

ENG

SCALE
VECT_X

VECT_Y

SCALE

3.4 Sizes tested and results

For the first part, with TRANSLATION, ROTATION and SCALE:

Points
Co-ordinates
Reference
Code_Aster Variation
observed
relative
P1
X
5.2501368890123E+00
5.2501368890123E+00
2.03E-15

Y
2.1551486020681E+00
2.1551486020680E+00 3.71E-15
Z
7.8600118786924E+01
7.8600118786924E+01
3.62E-16
P7
X
1.3714414455621E+01
1.3714414455621E+01 1.42E-15
Y
1.9199906921638E+01
1.9199906921638E+01
9.25E-16
Z
7.0898989267417E+01
7.0898989267417E+01
0.
P8
X
9.9168576521849E+00
9.9168576521850E+00 8.96E-16
Y
2.0297577804345E+01
2.0297577804345E+01
8.75E-16
Z
6.7837342495183E+01
6.7837342495183E+01
2.09E-16

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

Code_Aster ®
Version
6.3

Titrate:
ZZZZ164 - Validation of MODI_MAILLAGE/TRANSLATION

Date:

For the second part, with MODI_BASE and SCALE:

Points
Co-ordinates
Reference
Code_Aster Variation
observed
relative
P1
X
4.9148126952461E+00
4.9148126952461E+00
3.61E-16
Y
9.1903001618423E-01
9.1903001618423E-01
3.62E-15
Z
0.0000000000000E+00
0.0000000000000E+00
0.
P7
X
7.6719027437988E+00
7.6719027437988E+00
2.32E-16
Y
1.3825408069554E+01
1.3825408069554E+01
1.28E-16
Z
2.5000000000000E+01
2.5000000000000E+01
1.42E-16
P8
X

2.7570900485527E+00
2.7570900485527E+00
1.61E-16
Y
1.4744438085738E+01
1.4744438085738E+01
2.41E-16
Z
2.5000000000000E+01
2.5000000000000E+01
1.42E-16

4 Modeling
B

One places oneself within a framework 2D. One will impose successively:

· a translation of vector (2,5 3,9),
· a rotation of angle 33 degrees and axis passing by the item (10 0,5),
· the second rotation of angle -161 degrees and axis passing by the point (- 3 0,5),
· a scaling of a factor 5.

One thus tests all the cases of figure authorized by the syntax of the key words TRANSLATION, ROTATION
and SCALE.

Then, one sets out again of the initial grid and one imposes to him successively:

· a change of reference mark of vectors (1,23 0,23),
· a scaling of a factor 5.

One tests thus together the key words MODI_BASE and SCALE.

4.1
Characteristics of the grid

The grid comprises only one element of the type QUAD4.

4.2 Functionalities
tested

Orders

MODI_MAILLAGE
TRANSLATION

ROTATION
POIN_1

POIN_2

DIR

ENG

SCALE
VECT_X

VECT_Y

SCALE

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4.3
Sizes tested and results

For the first part, with TRANSLATION, ROTATION and SCALE:

Points
Co-ordinates
Reference
Code_Aster *Variation*
relative
observed
P1
X
3.9975219277929E+01 3.9975219277929E+01 5.33E-16
Y
4.2222814000070E-01
4.2222814000070E-01
2.63E-15
P3
X
3.1233365350457E+01 3.1233365350457E+01 1.14E-16
Y
1.2752747757918E+01 1.2752747757918E+01 9.75E-16
P4
X
2.8155057973828E+01 2.8155057973828E+01 1.26E-16
Y
8.8126939898842E+00 8.8126939898842E+00 2.62E-15

For the second part, with MODI_BASE and SCALE:

Points
Co-ordinates
Reference
Code_Aster *Variation*
relative
observed
P1
X
0.0000000000000E+00
0.0000000000000E+00
0.
Y
0.0000000000000E+00
0.0000000000000E+00
0.
P3
X
7.6719027437988E+00
7.6719027437988E+00
2.32E-16
Y
1.3825408069554E+01
1.3825408069554E+01
1.28E-16
P4
X
2.7570900485527E+00
2.7570900485527E+00
1.61E-16
Y
1.4744438085738E+01
1.4744438085738E+01
2.41E-16

5
Summary of the results

Numerical results for the translation, rotation, the change of reference mark and the scaling grid are identical to the analytical results of reference, in 3D or 2D, with the precision *numerical near.*

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.165

ZZZZ165 - LIRE_RESU with format "IDEAS"

Summary:

One reads with format IDEAS a field with the nodes as well as a field by elements with nodes (ELNO).
It is checked that the values read are correctly stored in the structure of data RESULT (SD_RESULTAT) produced.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

1

1

2 Reference solution

The case test consists in reading again a file with format "IDEAS". The test consists in checking that the values read are correctly stored in the SD_RESULTAT.

3 Modeling With

3.1 Characteristics of modeling

Grid IDEAS associated with this test consists of 4 meshs of the type QUAD8.

These meshs have labels 1,2,3,4. But they are given in order 4,1,2,3.

The nodes of the grid have as labels: [1-5] and [7-22]. Node 12 is given in 1st.

y

NO18
NO13

NO12
MA1

X

NO1
NO3
NO4

3.2 Functionalities validated

4
Results of modeling A

4.1 Values tested

Field
Node
CMP
Reference
Found value
Difference (%)
DEPL:
NO12
DX
0.75
0.75

0

VARI_ELNO:

NET MA1 NO3
V1
0.50
0.50
0
NET MA1 NO4
V1
1.00
1.00
0

5
Summary of the results

This case test makes it possible to check the correct operation of order LIRE_RESU to the format "IDEAS" when the numbers of entities IDEAS are different from the Aster numbers.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/02/001/A

Code_Aster ®
Version
6.4

Titrate:
ZZZZ166 - Calculation of flow in thermics

Date:
03/06/03
Author (S):
J. PELLET, Key P. HERMAN
:
V1.01.166-A Page:
1/18

Organization (S): EDF-R & D /AMA, CS IF

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
V1.01.166 document

ZZZZ166 - Calculation of flow in thermics

Summary:

This test has as an aim the validation of the options of calculation of flow in thermics: FLUX_ELGA_TEMP and FLUX_ELNO_TEMP.

6 modelings tested are:

· A In PLANE 2D: triangles of degree 1, quadrangles of degree 1 and 2 and quadrangles with 9 nodes,
· B In 2D PLAN_DIAG: triangles of degree 1 and 2, quadrangles of degree 1 and quadrangles with 9 nodes,
· C In 2D AXIS: triangles of degree 1, quadrangles of degree 1 and 2 and quadrangles with 9 nodes,
· D In 2D AXIS_DIAG: triangles of degree 1 and 2, quadrangles of degree 1 and quadrangles with 9 nodes,
· E In 3D: hexahedrons, pentahedrons, pyramids and tetrahedrons of degree 1 and 2, hexahedrons with 27 nodes,
· F In 3D_DIAG: hexahedrons, pentahedrons, pyramids and tetrahedrons of degree 1.

1
Problem of reference

1.1 Geometry

Each square is with a grid with a type of distinct element.

Y
Y
Each volume is included/understood
between Z=1.0 and Z=1.1
7.5
C7
D7
C8
D8
C9
D9
5.0
J
K
L
A7
B7
A8
B8
A9
B9
5.5
5.0
G
H
I
C4
D4
C5
D5
C6
D6
3.0
2.5
A4
B4

A5
B5
A6
B6
D
E
F
3.0
2.5
C1
D1
C2
D2
C3
D3
With
B
C
0.5
A1
B1
A2
B2
A3
B3
0.5
O
1.0
3.0
5.0
O 0.5
2.5 3.0
5.0 5.5
7.5
X
X

For all modelings 2D.

For modelings 3D.

(Note:: in AXIS and AXIS_DIAG, the axis
(Note:: in 3D_DIAG, only them

of rotation is OY and X-coordinate X corresponds
4
hexahedrons in bottom on the left are

thus with the ray).
with a grid).

1.2
Material properties

The thermal properties applied to the model are:
· = 1.0 W/m °C

1.3
Boundary conditions and loadings

Nondefinite.

1.4
Field of temperature

The field of temperature is directly affected with the model starting from a function. For each modeling, the calculation of flow is tested for a linear thermal field and a thermal field quadratic.

For modelings PLANE 2D and PLAN_DIAG (modelings A and B), the two fields successively affected are:
· T (X, Y) = 2.X + 3.Y
· T (X, Y) = 2.X2 + 3.Y2

For modelings 2D AXIS and AXIS_DIAG (modelings C and D), the two fields successively affected are:
· T (X, Y, Z) = 2.R + 3.Y (with R =
2
2
X + Z = X in the plan of grid (OXY))
· T (X, Y, Z) = 2.R2 + 3.Y2

For modelings 3D and 3D_DIAG (modelings E and F), the two fields successively affected are:
· T (X, Y, Z) = 2.X + 3.Y + 4.Z
· T (X, Y, Z) = 2.X2 + 3.Y2 + 4Z2

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution is analytical:

T
X = -.

X

T
y = -.

Y

T
Z = -.
(

only

3D

in
)

Z

Taking into account the value (=1), the flow obtained for each configuration is thus:

For modelings PLANE 2D and PLAN_DIAG (modelings A and B):
· T (X, Y) = 2.X + 3.Y X (X, Y) = 2 and y (X, Y) = 3
· T (X, Y) = 2.X2 + 3.Y2 X (X, Y) = 4.X and y (X, Y) = 6.Y

For modelings 2D AXIS and AXIS_DIAG (modelings C and D):
· T (X, Y, Z) = 2.R + 3.Y (R=X in plan (OXY)) X (X, Y, Z) = 2 and y (X, Y, Z) = 3
· T (X, Y, Z) = 2.R2 + 3.Y2 (R=X in plan (OXY)) X (X, Y, Z) = 4.X and y (X, Y, Z) = 6.Y

For modelings 3D and 3D_DIAG (modelings E and F):
· T (X, Y, Z) = 2.X + 3.Y + 4.Z X (X, Y, Z) = 2, y (X, Y, Z) = 3 and Z (X, Y, Z) = 4
· T (X, Y, Z) = 2.X2 + 3.Y2 + 4Z2 X (X, Y, Z) = 4.X, y (X, Y, Z) = 6.Y and Z (X, Y, Z) = 8.Z

2.2
Results of reference

For modelings 2D (PLANE, PLAN_DIAG, AXIS and AXIS_DIAG), the values tested are:
· With the linear field of temperature: the temperature with the nodes A, C, J and L, flow according to X and Y by element with nodes A, C, J and L and flow at the first point of Gauss of same elements,
· With the quadratic field of temperature: the temperature with nodes A, C, J and L, and flow according to X and Y by element with nodes A, C, J and L.

For modelings 3D (3D and 3D_DIAG), the values tested are:
· With the linear field of temperature: the temperature with the Di nodes, flow following X and Y by element with the Di nodes and flow at the first point of Gauss of the same elements,
· With the quadratic field of temperature: the temperature with the Di nodes, and following flow X and Y by element with the Di nodes.
With I = 1 to 9 for modeling 3D and I = 1 to 4 for modeling 3D_DIAG.

---

3 Modeling
With

3.1
Characteristics of modeling

Elements 2D modeling PLAN

3.2
Characteristics of the grid

A number of nodes: 3382
A number of meshs and types: 2000 meshs including 400 QUAD8, 400 QUAD9, 400 QUAD4 and 800 TRIA3.

The grid includes/understands 4 squares SQU8, SQU9, SQU4 and STR3 with a grid respectively with elements QUAD8, QUAD9, QUAD4 and TRIA3. Each square is discretized with 20 elements according to X
and following Y.

Y

5.0

J
K
L

Name of
Type

SQU4
STR3
GROUP_MA
of element

G
H
I
3.0
SQU8 QUAD8

SQU9 QUAD9

2.5
D
E
F
SQU4 QUAD4

STR3 TRIA3

SQU8
SQU9

With
B
C

0.5

O
1.0
3.0
5.0
X

The nodes used for postprocessing are:

Name of

Co-ordinates
Number of the node
Name of a mesh
Type of the mesh
node
containing this node
With
(1.0 ; 0.5)
N1
M1
QUAD8
C
(5.0 ; 0.5)
N1620
M420
QUAD9
J
(1.0 ; 5.0)
N3001
M1181
QUAD4
L
(5.0 ; 5.0)
N3440
M2000
TRIA3

The whole of the grid is affected by a thermal modeling PLAN.

3.3 Functionalities
tested

Orders

“THERMAL” AFFE_MODELE “PLAN”

CREA_MAILLAGE MODI_MAILLAGE “QUAD8_9”

CREA_CHAMP “NOEU_TEMP_F”

CREA_RESU "EVOL_THER"

CALC_ELEM "FLUX_ELGA_TEMP"

"FLUX_ELNO_TEMP"

4
Results of modeling A

4.1 Values
tested

· With a linear field of temperature (constant flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
With
T 3.5 3.5
0%
M1 (QUAD8)
Node A
X (ELNO)
-2.0
-2.0
0%
M1 (QUAD8)
Node A
y (ELNO) -3.0
-3.0
0%
M1 (QUAD8)
Point 1
X (ELGA)
-2.0
-2.0
0%
M1 (QUAD8)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
C
T 11.5 11.5 0%
M420 (QUAD9)
Node C
X (ELNO)
-2.0
-2.0
0%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.0
0%

M420 (QUAD9)
Point 1
X (ELGA)
-2.0
-2.0
0%
M420 (QUAD9)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
J
T 17.0 17.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-2.0
-2.0
0%
M1181 (QUAD4)
Node J
y (ELNO) -3.0
-3.0
0%
M1181 (QUAD4)
Point 1
X (ELGA)
-2.0
-2.0
0%
M1181 (QUAD4)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
L
T 25.0 25.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-2.0

-2.0
0%
M2000 (TRIA3)
Node L
y (ELNO) -3.0
-3.0
0%
M2000 (TRIA3)
Point 1
X (ELGA)
-2.0
-2.0
0%
M2000 (TRIA3)
Point 1
y (ELGA) -3.0
-3.0
0%

· With a quadratic field of temperature (linear flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
With
T 2.75 2.75 0%
M1 (QUAD8)
Node A
X (ELNO)
-4.0
-4.0
0%
M1 (QUAD8)
Node A
y (ELNO) -3.0
-3.0

0%
Node
C
T 50.75
50.75 0%
M420 (QUAD9)
Node C
X (ELNO)
-20.0
-20.0
0%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.0
0%
Node
J
T 77.0 77.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-4.0
-4.2
5%
M1181 (QUAD4)
Node J
y (ELNO) -30.0
-29.7
-1%
Node
L
T 125.0
125.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-20.0
-19.8
-1%
M2000 (TRIA3)
Node L
y (ELNO) -30.0

-29.7
-1%

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---

5 Modeling B

5.1 Characteristics of modeling

Elements 2D modeling PLAN_DIAG

5.2 Characteristics of the grid

A number of nodes: 3782.
A number of meshs and types: 2400 meshs including 800 TRIA6, 400 QUAD9, 400 QUAD4 and 800 TRIA3.

The grid includes/understands 4 squares STR6, SQU9, SQU4 and STR3 with a grid respectively with elements TRIA6, QUAD9, QUAD4 and TRIA3. Each square is discretized with 20 elements according to X and following Y.

Y

5.0
J

K
L

SQU4
STR3
Name of
Type

GROUP_MA
of element

G
H
I
3.0
STR6 TRIA6

SQU9 QUAD9

2.5
D
E
F
SQU4 QUAD4

STR3 TRIA3

STR6
SQU9

With
B
C
0.5

O
1.0
3.0
5.0
X

The nodes used for postprocessing are:

Name of
Co-ordinates
Number of the node
Name of a mesh
Type of the mesh
node
containing this node
With
(1.0 ; 0.5)
N1
M1
TRIA6
C
(5.0 ; 0.5)
N2481
M820
QUAD9
J
(1.0 ; 5.0)
N3401
M1581
QUAD4
L
(5.0 ; 5.0)
N3840
M2400
TRIA3

The whole of the grid is affected by a thermal modeling PLAN_DIAG.

5.3 Functionalities
tested

Orders

“THERMAL” AFFE_MODELE “PLAN_DIAG”

CREA_MAILLAGE MODI_MAILLAGE “QUAD8_9”

CREA_CHAMP "NOEU_TEMP_F"

CREA_RESU "EVOL_THER"

CALC_ELEM "FLUX_ELGA_TEMP"

"FLUX_ELNO_TEMP"

6
Results of modeling B

6.1 Values tested

· With a linear field of temperature (constant flow):

Localization Size
Reference

***Aster** %*
difference
Net
Node or PG

Node
With
T 3.5 3.5
0%
M1 (TRIA6)
Node A
X (ELNO)
-2.0
-2.0
0%
M1 (TRIA6)
Node A
y (ELNO) -3.0
-3.0
0%
M1 (TRIA6)
Point 1
X (ELGA)
-2.0
-2.0
0%
M1 (TRIA6)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
C
T 11.5 11.5 0%
M420 (QUAD9)
Node C
X (ELNO)
-2.0
-2.0
0%
M420 (QUAD9)

Node C
y (ELNO) -3.0
-3.0
0%
M420 (QUAD9)
Point 1
X (ELGA)
-2.0
-2.0
0%
M420 (QUAD9)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
J
T 17.0 17.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-2.0
-2.0
0%
M1181 (QUAD4)
Node J
y (ELNO) -3.0
-3.0
0%
M1181 (QUAD4)
Point 1
X (ELGA)
-2.0
-2.0
0%
M1181 (QUAD4)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
L
T 25.0 25.0 0%

M2000 (TRIA3)
Node L
X (ELNO)
-2.0
-2.0
0%
M2000 (TRIA3)
Node L
y (ELNO) -3.0
-3.0
0%
M2000 (TRIA3)
Point 1
X (ELGA)
-2.0
-2.0
0%
M2000 (TRIA3)
Point 1
y (ELGA) -3.0
-3.0
0%

· With a quadratic field of temperature (linear flow):

Localization Size
Reference
Aster *%*
difference
Net
Node or PG

Node
With
T 2.75 2.75 0%
M1 (QUAD8)
Node A
X (ELNO)
-4.0
-4.2
5%

M1 (QUAD8)
Node A
y (ELNO) -3.0
-3.3
10%
Node
C
T 50.75
50.75 0%
M420 (QUAD9)
Node C
X (ELNO)
-20.0
-19.8
-1%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.3
10%
Node
J
T 77.0 77.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-4.0
-4.2
5%
M1181 (QUAD4)
Node J
y (ELNO) -30.0
-29.7
-1%
Node
L
T 125.0
125.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-20.0
-19.8

-1%
M2000 (TRIA3)
Node L
y (ELNO) -30.0
-29.7
-1%

---

7 Modeling C

7.1 Characteristics of modeling

Elements 2D modeling AXIS

7.2 Characteristics of the grid

A number of nodes: 3382.
A number of meshs and types: 2000 meshs including 400 QUAD8, 400 QUAD9, 400 QUAD4 and 800 TRIA3.

The grid includes/understands 4 squares SQU8, SQU9, SQU4 and STR3 with a grid respectively with elements QUAD8, QUAD9, QUAD4 and TRIA3. Each square is discretized with 20 elements according

to X
and following Y.

Y

5.0

J
K
L

SQU4
STR3
Name of
Type

G
H
I
GROUP_MA
of element
3.0

SQU8 QUAD8

2.5
D
E
F
SQU9 QUAD9

SQU4 QUAD4

SQU8
SQU9
STR3 TRIA3

With
B
C

0.5

O
1.0
3.0
5.0
X

The nodes used for postprocessing are:

Name of
Co-ordinates
Number of the node
Name of a mesh
Type of the mesh
node
containing this node
With
(1.0 ; 0.5)
N1
M1
QUAD8
C
(5.0 ; 0.5)
N1620
M420
QUAD9
J
(1.0 ; 5.0)
N3001
M1181
QUAD4
L
(5.0 ; 5.0)
N3440
M2000
TRIA3

The whole of the grid is affected by a thermal modeling AXIS.

7.3 Functionalities tested

Orders

"THERMAL" AFFE_MODELE "AXIS"

CREA_MAILLAGE MODI_MAILLAGE "QUAD8_9"

CREA_CHAMP "NOEU_TEMP_F"

CREA_RESU "EVOL_THER"

CALC_ELEM "FLUX_ELGA_TEMP"

"FLUX_ELNO_TEMP"

8
Results of modeling C

8.1 Values
tested

· With a linear field of temperature (constant flow):

Localization Size
Reference
***Aster** %*
difference
Net
Node or PG

Node
With
T 3.5 3.5
0%
M1 (QUAD8)
Node A
X (ELNO)
-2.0
-2.0
0%
M1 (QUAD8)
Node A
y (ELNO) -3.0
-3.0
0%
M1 (QUAD8)
Point 1
X (ELGA)
-2.0
-2.0
0%
M1 (QUAD8)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
C

T 11.5 11.5 0%
M420 (QUAD9)
Node C
X (ELNO)
-2.0
-2.0
0%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.0
0%
M420 (QUAD9)
Point 1
X (ELGA)
-2.0
-2.0
0%
M420 (QUAD9)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
J
T 17.0 17.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-2.0
-2.0
0%
M1181 (QUAD4)
Node J
y (ELNO) -3.0
-3.0
0%
M1181 (QUAD4)
Point 1
X (ELGA)
-2.0
-2.0
0%

M1181 (QUAD4)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
L
T 25.0 25.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-2.0
-2.0
0%
M2000 (TRIA3)
Node L
y (ELNO) -3.0
-3.0
0%
M2000 (TRIA3)
Point 1
X (ELGA)
-2.0
-2.0
0%
M2000 (TRIA3)
Point 1
y (ELGA) -3.0
-3.0
0%

· With a quadratic field of temperature (linear flow):

Localization Size
Reference
***Aster** %*
difference
Net
Node or PG

Node

With
T 2.75 2.75 0%
M1 (QUAD8)
Node A
X (ELNO)
-4.0
-4.0
0%
M1 (QUAD8)
Node A
y (ELNO) -3.0
-3.0
0%
Node
C
T 50.75
50.75 0%
M420 (QUAD9)
Node C
X (ELNO)
-20.0
-20.0
0%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.0
0%
Node
J
T 77.0 77.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-4.0
-4.2
5%
M1181 (QUAD4)
Node J
y (ELNO) -30.0
-29.7
-1%
Node

L
T 125.0
125.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-20.0
-19.8
-1%
M2000 (TRIA3)
Node L
y (ELNO) -30.0
-29.7
-1%

---

9 Modeling D

9.1 Characteristics of modeling

Elements 2D modeling AXIS_DIAG

9.2

Characteristics of the grid

A number of nodes: 3782
A number of meshs and types: 2400 meshs including 800 TRIA6, 400 QUAD9, 400 QUAD4 and 800 TRIA3.

The grid includes/understands 4 squares STR6, SQU9, SQU4 and STR3 with a grid respectively with elements TRIA6, QUAD9, QUAD4 and TRIA3. Each square is discretized with 20 elements according to X
and following Y.

Y

5.0

J
K
L

SQU4
STR3
Name of
Type

GROUP_MA
of element

G
H
I
3.0
STR6 TRIA6

SQU9 QUAD9

2.5
D
E
F
SQU4 QUAD4

STR3 TRIA3

STR6
SQU9

With
B
C
0.5

O
1.0
3.0
5.0

X

The nodes used for postprocessing are:

Name of
Co-ordinates
Number of the node
Name of a mesh
Type of the mesh
node
containing this node
With
(1.0 ; 0.5)
N1
M1
TRIA6
C
(5.0 ; 0.5)
N2481
M820
QUAD9
J
(1.0 ; 5.0)
N3401
M1581
QUAD4
L
(5.0 ; 5.0)
N3840

M2400
TRIA3

The whole of the grid is affected by a thermal modeling AXIS_DIAG.

9.3 Functionalities tested

Orders

“THERMAL” AFFE_MODELE “AXIS_DIAG”

CREA_MAILLAGE MODI_MAILLAGE “QUAD8_9”

CREA_CHAMP “NOEU_TEMP_F”

CREA_RESU “EVOL_THER”

CALC_ELEM “FLUX_ELGA_TEMP”

“FLUX_ELNO_TEMP”

---

10 Results of modeling D

10.1 Values tested

· With a linear field of temperature (constant flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
With
T 3.5 3.5
0%
M1 (TRIA6)
Node A
X (ELNO)
-2.0
-2.0
0%
M1 (TRIA6)
Node A
y (ELNO) -3.0
-3.0
0%
M1 (TRIA6)
Point 1
X (ELGA)
-2.0
-2.0
0%

M1 (TRIA6)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
C
T 11.5 11.5 0%
M420 (QUAD9)
Node C
X (ELNO)
-2.0
-2.0
0%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.0
0%
M420 (QUAD9)
Point 1
X (ELGA)
-2.0
-2.0
0%
M420 (QUAD9)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
J
T 17.0 17.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-2.0
-2.0
0%
M1181 (QUAD4)
Node J
y (ELNO) -3.0
-3.0

0%
M1181 (QUAD4)
Point 1
X (ELGA)
-2.0
-2.0
0%
M1181 (QUAD4)
Point 1
y (ELGA) -3.0
-3.0
0%
Node
L
T 25.0 25.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-2.0
-2.0
0%
M2000 (TRIA3)
Node L
y (ELNO) -3.0
-3.0
0%
M2000 (TRIA3)
Point 1
X (ELGA)
-2.0
-2.0
0%
M2000 (TRIA3)
Point 1
y (ELGA) -3.0
-3.0
0%

· With a quadratic field of temperature (linear flow):

Localization Size
Reference
Aster %

difference
Net
Node or PG

Node
With
T 2.75 2.75 0%
M1 (QUAD8)
Node A
X (ELNO)
-4.0
-4.2
5%
M1 (QUAD8)
Node A
y (ELNO) -3.0
-3.3
10%
Node
C
T 50.75
50.75 0%
M420 (QUAD9)
Node C
X (ELNO)
-20.0
-19.8
-1%
M420 (QUAD9)
Node C
y (ELNO) -3.0
-3.3
10%
Node
J
T 77.0 77.0 0%
M1181 (QUAD4)
Node J
X (ELNO)
-4.0
-4.2

5%
M1181 (QUAD4)
Node J
y (ELNO) -30.0
-29.7
-1%
Node
L
T 125.0
125.0 0%
M2000 (TRIA3)
Node L
X (ELNO)
-20.0
-19.8
-1%
M2000 (TRIA3)
Node L
y (ELNO) -30.0
-29.7
-1%

---

11 Modeling

E

11.1 Characteristics of modeling

Elements 3D modeling 3D

11.2 Characteristics of the grid

A number of nodes: 17281.
A number of meshs and types: 5268 meshs including 400 HEXA8, 400 HEXA20, 400 HEXA27, 800 PENTA6, 800 PENTA15, 600 PYRAM5, 600 PYRAM13, 634 TETRA4 and 634 TETRA10.

The grid includes/understands 9 hexahedrons VHE8, VHE20, VHE27, VPE6, VPE15, VPY5, VPY13, VTE4 and
VTE10 with a grid respectively with elements HEXA8, HEXA20, HEXA27, PENTA6, PENTA15, PYRAM5, PYRAM13, TETRA4 and TETRA10.

Y

Each volume is included/understood

between Z=1.0 and Z=1.1
Name of
Type
Discretization
GROUP_MA
of element
according to:
7.5
C7
D7
C8
D8
C9
D9

X Y Z

VPY13
VHE20
VHE27
VHE8 HEXA8
20
20

1
A7
A9

B7
A8
B8
B9
5.5
VHE20 HEXA20 20
20 1

5.0
VHE27 HEXA27 20
20 1
C4
D4
C5
D5
C6
D6
VPE6 PENTA6 20
20
1
VPY5
VTE4
VTE10
VPE15 PENTA15 20 20 1
A4
B4
A5
B5
A6
B6

3.0
VPY5 PYRAM5
10
10
1
2.5
C1
D1
C2

D2
C3
D3
VPY13 PYRAM13 10 10 1
VHE8
VPE6
VPE15
VTE4 TETRA4
10
10
1
A1
B1
A2
B2
A3
B3
VTE10 TETRA10 10 10 1
0.5

O 0.5
2.5 3.0
5.0 5.5
7.5
X

The nodes used for postprocessing are:

Name of
Co-ordinates
Number of the node
Name of a mesh
Type of the mesh
node
containing this node
D1
(2.5 ; 2.5 ; 1.0)
N440
M400
HEXA8
D2
(5.0 ; 2.5 ; 1.0)
N1322

M1200
PENTA6
D3
(7.5 ; 2.5 ; 1.0)
N11453
M4034
PENTA15
D4
(2.5 ; 5.0 ; 1.0)
N1995
M1795
PYRAM5
D5
(5.0 ; 5.0 ; 1.0)
N2323
M1838
TETRA4
D6
(7.5 ; 5.0 ; 1.0)
N16603
M4672
TETRA10
D7
(2.5 ; 7.5 ; 1.0)
N14756
M4629
PYRAM13
D8
(5.0 ; 7.5 ; 1.0)
N3596
M2834
HEXA20
D9
(7.5 ; 7.5 ; 1.0)
N6599
M3234
HEXA27

The whole of the grid is affected by a thermal modeling 3D.

11.3 Functionalities tested

Orders

"THERMAL" AFFE_MODELE "3D"

CREA_CHAMP "NOEU_TEMP_F"

CREA_RESU "EVOL_THER"

CALC_ELEM "FLUX_ELGA_TEMP"

"FLUX_ELNO_TEMP"

---

12 Results of modeling E

12.1 Values tested

· With a linear field of temperature (constant flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
D1
T
16.5
16.5 0%
M400 (HEXA8)
D1 node
X (ELNO)
-2.0
-2.0
0%
M400 (HEXA8)
D1 node
y (ELNO) -3.0
-3.0
0%
M400 (HEXA8)
D1 node
Z (ELNO)
-4.0
-4.0
0%
M400 (HEXA8)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D2
T
21.5
21.5 0%

M1200 (PENTA6)
D2 node
X (ELNO)
-2.0
-2.0
0%
M1200 (PENTA6)
D2 node
y (ELNO) -3.0
-3.0
0%
M1200 (PENTA6)
D2 node
Z (ELNO)
-4.0
-4.0
0%
M1200 (PENTA6)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D3
T
26.5
26.5 0%
M4034 (PENTA15)
D3 node
X (ELNO)
-2.0
-2.0
0%
M4034 (PENTA15)
D3 node
y (ELNO) -3.0
-3.0
0%
M4034 (PENTA15)
D3 node
Z (ELNO)
-4.0
-4.0

0%
M4034 (PENTA15)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D4
T
24.0
24.0 0%
M1795 (PYRAM5)
D4 node
X (ELNO)
-2.0
-2.0
0%
M1795 (PYRAM5)
D4 node
y (ELNO) -3.0
-3.0
0%
M1795 (PYRAM5)
D4 node
Z (ELNO)
-4.0
-4.0
0%
M1795 (PYRAM5)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D5
T
29.0
29.0 0%
M1838 (TETRA4)
D5 node
X (ELNO)
-2.0
-2.0

0%
M1838 (TETRA4)
D5 node
y (ELNO) -3.0
-3.0
0%
M1838 (TETRA4)
D5 node
Z (ELNO)
-4.0
-4.0
0%
M1838 (TETRA4)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D6
T
34.0
34.0 0%
M4672 (TETRA10)
D6 node
X (ELNO)
-2.0
-2.0
0%
M4672 (TETRA10)
D6 node
y (ELNO) -3.0
-3.0
0%
M4672 (TETRA10)
D6 node
Z (ELNO)
-4.0
-4.0
0%
M4672 (TETRA10)
Point 1
X (ELGA) -2.0
-2.0

0%
Node
D7
T
31.5
31.5 0%
M4629 (PYRAM13)
D7 node
X (ELNO)
-2.0
-2.0
0%
M4629 (PYRAM13)
D7 node
y (ELNO) -3.0
-3.0
0%
M4629 (PYRAM13)
D7 node
Z (ELNO)
-4.0
-4.0
0%
M4629 (PYRAM13)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D8
T
36.5
36.5 0%
M2834 (HEXA20)
D8 node
X (ELNO)
-2.0
-2.0
0%
M2834 (HEXA20)
D8 node
y (ELNO) -3.0
-3.0

0%
M2834 (HEXA20)
D8 node
Z (ELNO)
-4.0
-4.0
0%
M2834 (HEXA20)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D9
T
41.5
41.5 0%
M3234 (HEXA27)
D9 node
X (ELNO)
-2.0
-2.0
0%
M3234 (HEXA27)
D9 node
y (ELNO) -3.0
-3.0
0%
M3234 (HEXA27)
D9 node
Z (ELNO)
-4.0
-4.0
0%
M3234 (HEXA27)
Point 1
X (ELGA) -2.0
-2.0
0%

· With a quadratic field of temperature (linear flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
D1
T
35.25
35.25 0%
M400 (HEXA8)
D1 node
X (ELNO)
-10.0
-9.8
-2%
M400 (HEXA8)
D1 node
y (ELNO) -15.0
-14.7
-2%

M400 (HEXA8)
D1 node
Z (ELNO) -8.0
-8.4
5%
Node
D2
T
72.75
72.75 0%
M1200 (PENTA6)
D2 node
X (ELNO)
-20.0
-19.8
-1%
M1200 (PENTA6)
D2 node
y (ELNO) -15.0
-14.7
-2%
M1200 (PENTA6)
D2 node
Z (ELNO) -8.0
-8.4
5%
Node
D3
T
135.25
135.25 0%
M4034 (PENTA15)
D3 node
X (ELNO)
-30.0
-30.0
0%
M4034 (PENTA15)
D3 node
y (ELNO) -15.0
-15.0
0%
M4034 (PENTA15)

D3 node
Z (ELNO) -8.0
-8.0
0%
Node
D4
T
91.50
91.50 0%
M1795 (PYRAM5)
D4 node
X (ELNO)
-10.0
-9.6
-4%
M1795 (PYRAM5)
D4 node
y (ELNO) -30.0
-29.4
-2%
M1795 (PYRAM5)
D4 node
Z (ELNO) -8.0
-7.2
-10%
Node
D5
T
129.00
129.00 0%
M1838 (TETRA4)
D5 node
X (ELNO)
-20.0
-19.6
-2%
M1838 (TETRA4)
D5 node
y (ELNO) -30.0
-29.4
-2%
M1838 (TETRA4)
D5 node

Z (ELNO) -8.0
-8.4
5%
Node
D6
T
191.5
191.5 0%
M4672 (TETRA10)
D6 node
X (ELNO)
-30.0
-30.0
0%
M4672 (TETRA10)
D6 node
y (ELNO) -30.0
-30.0
0%
M4672 (TETRA10)
D6 node
Z (ELNO) -8.0
-8.0
0%
Node
D7
T
185.25
185.25 0%
M4629 (PYRAM13)
D7 node
X (ELNO)
-10.0
-10.0
0%
M4629 (PYRAM13)
D7 node
y (ELNO) -45.0
-45.0
0%
M4629 (PYRAM13)
D7 node
Z (ELNO) -8.0

-8.0
0%
Node
D8
T
222.75
222.75 0%
M2834 (HEXA20)
D8 node
X (ELNO)
-20.0
-20.0
0%
M2834 (HEXA20)
D8 node
y (ELNO) -45.0
-45.0
0%
M2834 (HEXA20)
D8 node
Z (ELNO) -8.0
-8.0
0%
Node
D9
T
285.25
285.25 0%
M3234 (HEXA27)
D9 node
X (ELNO)
-30.0
-30.0
0%
M3234 (HEXA27)
D9 node
y (ELNO) -45.0
-45.0
0%
M3234 (HEXA27)
D9 node
Z (ELNO) -8.0
-8.0

0%

---

13 Modeling
F

13.1 Characteristics of modeling

Elements 3D modeling 3D_DIAG

13.2 Characteristics of the grid

A number of nodes: 2356.
A number of meshs and types: 2434 meshs including 400 HEXA8, 800 PENTA6, 600 PYRAM5 and 634
TETRA4.

The grid includes/understands 4 hexahedrons VHE8, VPE6, VPY5 and VTE4 with a grid respectively with
elements HEXA8, PENTA6, PYRAM5 and TETRA4.

Y

Each volume is included/understood

between Z=1.0 and Z=1.1

Name of
Type
Discretization

GROUP_MA
of element
according to:

X Y Z
5.0

C4
D4
VHE8 HEXA8
20
20
1
C5
D5

VPE6 PENTA6
20
20
1
VPY5
VTE4

A4
B4
A5
B5
VPY5 PYRAM5
10
10
1
3.0

VTE4 TETRA4
10
10

1
2.5

C1
D1
C2
D2

VHE8
VPE6

A1
B1
A2
B2
0.5

O 0.5
2.5 3.0
5.0

X

The nodes used for postprocessing are:

Name of
Co-ordinates
Number of the node
Name of a mesh
Type of the mesh
node
containing this node
D1
(2.5 ; 2.5 ; 1.0)
N440
M400
HEXA8
D2
(5.0 ; 2.5 ; 1.0)
N1322
M1200
PENTA6
D3

(7.5 ; 2.5 ; 1.0)
N11453
M4034
PENTA15
D4
(2.5 ; 5.0 ; 1.0)
N1995
M1795
PYRAM5

The whole of the grid is affected by a thermal modeling 3D_DIAG.

13.3 Functionalities tested

Orders

"THERMAL" AFFE_MODELE "3D_DIAG"

CREA_CHAMP "NOEU_TEMP_F"

CREA_RESU "EVOL_THER"

CALC_ELEM "FLUX_ELGA_TEMP"

"FLUX_ELNO_TEMP"

---

14 Results of modeling F

14.1 Values tested

· With a linear field of temperature (constant flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
D1
T 16.5
16.5 0%
M400 (HEXA8)
D1 node
X (ELNO)
-2.0
-2.0
0%
M400 (HEXA8)

D1 node
y (ELNO) -3.0
-3.0
0%
M400 (HEXA8)
D1 node
Z (ELNO)
-4.0
-4.0
0%
M400 (HEXA8)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D2
T 21.5
21.5 0%
M1200 (PENTA6)
D2 node
X (ELNO)
-2.0
-2.0
0%
M1200 (PENTA6)
D2 node
y (ELNO) -3.0
-3.0
0%
M1200 (PENTA6)
D2 node
Z (ELNO)
-4.0
-4.0
0%
M1200 (PENTA6)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D3

T 24.0
24.0 0%
M1795 (PYRAM5)
D3 node
X (ELNO)
-2.0
-2.0
0%
M1795 (PYRAM5)
D3 node
y (ELNO) -3.0
-3.0
0%
M1795 (PYRAM5)
D3 node
Z (ELNO)
-4.0
-4.0
0%
M1795 (PYRAM5)
Point 1
X (ELGA) -2.0
-2.0
0%
Node
D4
T 29.0
29.0 0%
M1838 (TETRA4)
D4 node
X (ELNO)
-2.0
-2.0
0%
M1838 (TETRA4)
D4 node
y (ELNO) -3.0
-3.0
0%
M1838 (TETRA4)
D4 node
Z (ELNO)
-4.0

-4.0
0%
M1838 (TETRA4)
Point 1
X (ELGA) -2.0
-2.0
0%

· With a quadratic field of temperature (linear flow):

Localization Size
Reference
Aster %
difference
Net
Node or PG

Node
D1
T 35.25
35.25 0%
M400 (HEXA8)
D1 node
X (ELNO)
-10.0
-9.8
-2%
M400 (HEXA8)
D1 node
y (ELNO) -15.0 -14.7
-2%
M400 (HEXA8)
D1 node
Z (ELNO) -8.0
-8.4
5%
Node
D2
T 72.75
72.75 0%
M1200 (PENTA6)

D2 node
X (ELNO)
-20.0
-19.8
-1%
M1200 (PENTA6)
D2 node
y (ELNO) -15.0 -14.7
-2%
M1200 (PENTA6)
D2 node
Z (ELNO) -8.0
-8.4
5%
Node
D3
T 91.50
91.50 0%
M1795 (PYRAM5)
D3 node
X (ELNO)
-10.0
-9.6
-4%
M1795 (PYRAM5)
D3 node
y (ELNO) -30.0 -29.4
-2%
M1795 (PYRAM5)
D3 node
Z (ELNO) -8.0
-7.2
-10%
Node
D4
T
129.00
129.00 0%
M1838 (TETRA4)
D4 node
X (ELNO)
-20.0
-19.6

-2%
M1838 (TETRA4)
D4 node
y (ELNO) -30.0 -29.4
-2%
M1838 (TETRA4)
D4 node
Z (ELNO) -8.0
-8.4
5%

---

15 Summary of the results

Summary of the results

modeling
Flow with the nodes
Flow with the nodes with one
or with the PG with
quadratic temperature
a temperature
linear
Type
Discretization in relative Error

Relative error max %

of element
X and Y
max %
Modeling "PLANE" 2D
QUAD4 10
el/m 0%
5%

TRIA3 10
el/m 0%
1%

QUAD8 10
el/m 0%
0%

QUAD9 10
el/m 0%
0%

Modeling 2D "PLAN_DIAG"
QUAD4 10
el/m 0%
10%

TRIA3 10
el/m 0%
10%

TRIA6 10
el/m 0%
5%

QUAD9 10
el/m 0%
1%

Modeling 2D "AXIS"
QUAD4 10
el/m 0%
5%

TRIA3 10
el/m 0%
1%

QUAD8 10
el/m 0%
0%

QUAD9 10
el/m 0%
0%

Modeling 2D "AXIS_DIAG"
QUAD4 10
el/m 0%
10%

TRIA3 10
el/m 0%
10%

TRIA6 10
el/m 0%
5%

QUAD9 10
el/m 0%
1%

Modeling "3D"
HEXA8 10
el/m 0%
5%

PENTA6 10
el/m
0%
5%

PYRAM5 5
el/m
0%
10%

TETRA4 5

el/m
0%
5%

HEXA20 10
el/m
0%
0%

HEXA27 10
el/m
0%
0%

PENTA15 10
el/m
0%
0%

PYRAM13 5
el/m
0%

0%

TETRA10 5
el/m
0%
0%

Modeling "3D_DIAG"
HEXA8 10
el/m 0%
5%

PENTA6 10
el/m
0%
5%

PYRAM5 5
el/m
0%
10%

TETRA4 5
el/m
0%
5%

With a linear field of temperature (and a constant flow):
· All modelings give exact results.

With a quadratic field of temperature (and a linear flow):
· The results are exact with elements of order 2 and one modeling not DIAG. These elements having quadratic functions of form can represent the field exactly of temperature imposed. Flows are exact and would be it still with a discretization more coarse.

· The elements of order 2 with a modeling DIAG are treated like elements of order 1 for the calculation of flow. For these elements, flows are constant by element. The error is thus directly related to the size of the elements.

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Handbook of Validation
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Code_Aster ®
Version
7.1

Titrate:
SENSM06 - Sensitivity to the parameters materials in linear elasticity
Date:
02/06/03
Author (S):
NR. TARDIEU *Key*
:
V1.01.170-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.170

SENSM06 - Sensitivity to the parameters materials in isotropic linear elasticity

Summary:

One tests the sensitivity to the parameters materials in isotropic linear elasticity on a tensile test uniaxial. One compares the results obtained by operators linear MECA_STATIQUE and nonlinear STAT_NON_LINE.

1
Problem of reference

1.1 Geometry

Traction of 100 MPa

1 mm

10 mm

1.2
Properties of material

The values of the parameters materials are as follows:

E = 100000. MPa
= 0.3

1.3
Boundary conditions and loadings

A homogeneous state of stresses is sought: one imposes only one pressure of 100 MPa.

2
Reference solution

2.1
Method of calculation

The solution in displacement is given by:

U = .r
U =. Z
R
E
Z
E

For the derived fields compared to E, one thus has:

U

U

R = -
.r
Z = -
. Z
E

E2
E

E2

For the derived fields compared to, one thus has:

U

U
R

= .
Z
R
= 0

E

2.2
Sizes and results of reference

One tests for each field derived the value from his components at the point higher right, that is to say:

ur

= -
U
5
.
1 E - 8
Z =.
1 E - 8
E
E

U
U
R

= .
5th - 3
Z = 0

7.1

3 Modeling
With

3.1
Characteristics of modeling

Axisymmetric modeling on the following grid:

3.2
Characteristics of the grid

A number of nodes: 4
Numbers and types of meshs: 4 SEG2, 1 QUAD4

3.3 Functionalities
tested

Orders

DEFI_PARA_SENSI

STAT_NON_LINE SENSITIVITY

3.4
Sizes tested and results

Sizes tested
Values obtained
Analytical values
Variation (%)
U

R
1.5E-8
1.5E-8
0
E

U

Z
1.E-8
1.E-8
0
E
U

R
5.E-3
5.E-3
0

U

Z
0
0
0

4 Modeling B

4.1 Characteristics of modeling

Axisymmetric modeling on the following grid:

4.2
Characteristics of the grid

A number of nodes: 4
Numbers and types of meshs: 4 SEG2, 1 QUAD4

4.3 Functionalities
tested

Orders

DEFI_PARA_SENSI

MECA_STATIQUE SENSITIVITY

4.4
Sizes tested and results

Sizes tested
Values obtained
Analytical values
Variation (%)
U

R
1.5E-8
1.5E-8
0
E

U

Z
1.E-8
1.E-8
0
E
U

R
5.E-3
5.E-3
0

U

Z
0
0
0

5
Summary of the results

The results given by STAT_NON_LINE and MECA_STATIQUE are exactly those given by theory.

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.171

SENSD04 - Sensitivity to the loading and C.L in dyna_line_tran

Summary:

*This case test takes again the geometry and materials of the case test SENSD01 "Sensitivity to the loading and C.L.
in dyna_line_harm " [V1.01.158]. Calculation carried out is the transitory response of a linear discrete system
not deadened.*

*The functionality tested is the derivation of the fields of displacement, speed and acceleration compared to
boundary conditions and with the loadings.*

*The reference was obtained with Code_Aster version 7.1.3 per direct application of the "derived" loading on
standard calculation.*

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V1.01 booklet: Tests of validity of the orders
HT-66/03/008/A

---

1 *Problem of reference*

1.1 Geometry

U 1
U2
U3
U8
K
K
K
K
With
m
m
m
m
B
X, U
P 1
P2
P3
P8

1.2 *Properties of material*

Stiffness in translation
K = 105 N/m
Specific mass
m = 10 kg

1.3
Boundary conditions and loadings

Boundary conditions:
Points A and B (nodes 1 and 10): null displacements:
uPi = 0 m

Not P1 (node 2):
imposed displacement:
u1 = D1
D1 = 1 m

Loading (tdébut = 0 S T tfin = 104 S):

Not P4 (node 5): nodal force according to X: F
-
P4= F T

1
(T T
end
beginning)
1
F =2 NR

Not P5 (node 6): nodal force according to X: F
-
P5= F T

2
(T T
end
beginning)

2
F =0 NR

1.4 Conditions
initial

Initial displacement no one and null initial speed.
Handbook of Validation
V1.01 booklet: Tests of validity of the orders
HT-66/03/008/A

---

2 Reference solution

2.1 Method of calculation

The equilibrium equation of the standard problem can be written in the following matric form:

M *(p)* ***X&*** *(T, p) +* ***C*** *(p)* ***X&*** *(T, p) +* ***K*** *(T, p)* ***X*** *(T, p) =* ***F*** *(T, p)*
where:

- ***M***, ***C*** *and* ***K*** *are respectively the matrices of mass, damping and stiffness of model,*
- ***X*** *indicates the vector made up of N degrees of freedom of the model,*
- ***F*** *is the vector of the loadings.*

The differential equation governing the derivative compared to the parameters of sensitivity p of the vector
X
*displacement **X**, **Y** =, are obtained by directly deriving the equilibrium equation compared to*
p
p. After rearrangement of the terms, one obtains:

***M** (*
***F**,*
M
C
K
*p) **Y&** (T, p) + (*
***C** p) **Y&** (T, p) + **K** (p) **Y** (T, p)*
(T p)
(p)
=
-
***X&** (T, p)*
(p)
-
***X&** (T, p)*
(p)
-
***X** (T, p)*
p

p

p

p

One can note that the matrices (mass, damping and stiffness) of the system associated with calculation derivative are the same ones as those of the initial problem. Thus, we chose as solution
***F** (T, p)*
of reference, that obtained by direct application of the "derived" loading
on the problem
p

standard.

In our case, the derivative of the loading compared to 1
F, respectively 2
F, corresponds to one
unit force applied to node 5, respectively applied to node 6. The derivative of the loading
compared to 1
D corresponds to a unit displacement applied to node 2.

2.2
Results of reference

The parameters of sensitivity considered are: 1
F, 2
F and 1
D.
At the moment tfin:
displacements (X, y, Z) of node 5,
derived compared to 1
F of displacement and speed of node 5,
derived compared to 2
F of the displacement and acceleration of node 5,
derived compared to 1
D of the displacement of node 5.

2.3 Uncertainties

The results depend on the temporal discretization and the diagram of integration. Here, we have chosen as reference solution that obtained by the implicit scheme of Newmark (with = 0.25 and = 0.5). We estimate uncertainty on the solution lower than 0.5%.
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HT-66/03/008/A

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3 Modeling With

3.1 Characteristics of modeling

Modeling identical to that of the SENSD01A

y
Z
With
P
P
B
X
1
2
P3
P4
P5
P6
P7
P8

Characteristics of the elements:

DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity
K_T_D_L

Limiting conditions:

in all the nodes
DDL_IMPO =

(ALL = "YES" DY = 0. , DZ = 0.)
with the nodes ends

(GROUP_NO = "AB" DX = 0.)

Names of the nodes:

Not A = N1
P1 = N2
Not B = N10
P2 = N3
....

P8 = N9

Parameters of calculation:

Temporal incrementing
T = 105 S
Parameters Newmark diagram
= 0.25

= 0.5

3.2
Characteristics of the grid

A number of nodes: 10

A number of meshs and type: 9 SEG2

3.3 Functionalities
tested

The functionality tested is the derivation of the fields of displacement, speed and acceleration by report/ratio in the boundary conditions and with the loadings.

Orders

DYNA_LINE_TRAN SENSITIVITY

EXCIT

CHARGE

NEWMARK

DIFF_CENTRE

3.4 Values
tested

The tests are carried out for the moment of calculation tfin.

Displacements of node 5:

Component Reference
Aster *Difference*
(%)
DX 3.35
10-10 3.3499767946719
10-10 6.93
10-4
DY 0
0
0
DZ 0
0

0

Derived compared to 1
F of component DX of the displacement and the speed of node 5 (diagram Newmark):

Field Reference
***Aster** Difference*
(%)
Displacement 1.67
10-10 1.6749824976405
10-10 0.298
Speed 5.00
10-6 4.9999150009176
10-6 0.002

Derived compared to 2
F of component DX of the displacement and the acceleration of node 5 (Newmark diagram)

Field Reference
***Aster** Difference*
(%)
Displacement 8.75
10-16 8.7511563568538
10-16 0.013
Acceleration 1.67
10-6 1.6749649953512
10-6 0.297

Derived compared to 1
D of component DX of the displacement of node 5

Field Reference
***Aster** Difference*
(%)
Displacement 1.18
10-15 1.179939099689
10-15 0.005

Derived compared to 1
F of component DX of the displacement and the speed of node 5 (diagram centered differences)

Field Reference
Aster *Difference*
(%)
Displacement 1.67
10-10 1.6664833417849
10-10 0.211
Speed 5.00
10-6 4.9999166758329
10-6 0.002

Derived compared to 2
F of component DX of the displacement and the acceleration of node 5
(diagram centered differences)

Field Reference
Aster *Difference*
(%)
Displacement 8.75
10-16 8.329087746405
10-16 4.81
Acceleration 1.67
10-6 1.6664666836292
10-6 0.212

4

Summary of the results

The precision of the results is coherent with the method of resolution used and the method of direct derivation “exact”.

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Code_Aster ®
Version
7.1

Titrate:
SENSD05 - Sensitivity to materials in transitory dynamics isotropic 3D Dates:
07/10/03
Author (S):
Key ***H. ANDRIAMBOLOLONA***
:
V1.01.172-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.172

SENSD05 - Sensitivity to materials in dynamics

isotropic transient 3D

Summary

This case test takes again the geometry and the materials of test SENSD02 but calculation carried out here is the answer transient of the system.

The functionality tested is the derivation of the fields of displacement, speed and acceleration compared to properties materials modulus Young and Poisson's ratio.

The reference is calculated by finished differences.

1
Problem of reference

1.1 Geometry

OPPOSE

CENTER
BORD_GAU
3. m

I

y

10. m

1 m < X < 11 m
1.5 m < Y < 1.5 m
X
0 m < Z < 1 m
Z

1.2 Properties of material

E = 105 Pa

= 0.3

= 2400 kg/m3

Viscous damping, matrix of damping: K + M, = 0.002 S and = 0.3 s1

1.3 Boundary conditions and loadings

Boundary conditions:
Line "BORD_GAU" is blocked according to X, y and Z.
The node "I" is blocked according to X, y and Z.

Loading (tdébut = 0 S T tfin = 104 S):

On the node "OPPOSES":

nodal force according to X: F
-
X= F T

1
(T T
end
beginning)
1
F =100 NR,

nodal force according to y: F
-
Y= F T

2
(T T
end
beginning)
2
F =30 NR,

nodal force according to Z: F
-
Z= F T

F =10 NR,
3
(T T
end
beginning)
3

1.4 Conditions initial

Initial displacement no one and null initial speed.
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V1.01 booklet: Tests of validity of the orders
HT-66/03/008/A

Code_Aster ®

2
Reference solution

2.1
Method of calculation

The sensitivities of the fields displacement, speed and acceleration with the data materials are calculated by finished differences. These calculations by finished differences are carried out inside even case test by Code_Aster. The diagram of finished differences used is as follows (diagram of order 1 not centered):

F (,
X)
y
F (x+,)
y - F (,
X)
y

X

The field of solution displacement of the standard problem (i.e nonderived) is subjected to a test of not regression. Tests of nonregression are also carried out on the sensitivities.

2.2
Sizes and results of reference

The parameters of sensitivity are the Young modulus E and the Poisson's ratio.

The values of reference are calculated at the moment tfin.

By finished differences:
derived compared to E from displacement following y to the node OPPOSES,
derived compared to displacement following y to the node OPPOSES,

By nonregression:
displacement following Z of the node OPPOSES
derived compared to E speed following y to the node OPPOSES,
derived compared to acceleration according to X with the node OPPOSES,

2.3 Uncertainties

The results depend on the temporal discretization and the diagram of integration. Here, we have chosen as reference solution that obtained by the implicit scheme of Newmark (with = 0.25 and = 0.5). We estimate uncertainty on the solution lower than 0.5%.

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling in voluminal element.

BORD_GAU

F

I

y

X
Z

Characteristic of the elements: 3D

Boundary conditions: line BORD_GAU and node I are blocked according to X, y and Z.

Parameters of calculation:

Temporal incrementing
T = 105 S
Parameters Newmark diagram
= 0.25

= 0.5

3.2
Characteristics of the grid

A number of nodes: 330
Numbers and type of mesh: 200 HEXA8

3.3 Functionalities tested

The functionality tested is the derivation of the fields of displacement, speed and acceleration by report/ratio with the properties materials (Young modulus and Poisson's ratio).

Orders

MEMO_NOM_SENSI NOM_UN

NOM_ZERO

NAME
NOM_SD

PARA_SENSI

NOM_COMPOSE

DYNA_LINE_TRAN SENSITIVITY

EXCIT
VECT_ASSE

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

The values of reference are calculated at the moment tfin.

By finished differences:

Derived compared to E from displacement in y, node OPPOSES:

Reference
Aster *Difference*
(%)
-9.0051091831840 10-20 -9.0051103022894
10-20 1.24
10-5

Derived compared to displacement in y, node OPPOSES:

Reference
Aster *Difference*
(%)
-9.2846474265708 10-15 -9.2625025608931
10-15 0.239

By nonregression:

Displacement in Z with the node OPPOSES:

Reference
Aster *Difference*
(%)
1.93 10-9 1.9343489167908
10-9 0.225

Derived compared to E speed in y, node OPPOSES:

Reference
Aster *Difference*

(%)
-4.37 10-15 -4.3730681471811
10-15 0.07

Derived compared to acceleration in X, node OPPOSES:

Reference
***Aster** Difference*
(%)
7.65 10-6 7.6556719982727
10-6 0.074

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4
Summary of the results

The precision of the results is coherent with the method of resolution used and the method of direct derivation "exact".

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of the orders
Document: V1.01.173

SENSD06 - Sensitivity to materials in dynamics
isotropic transient 2D

Summary:

This case test takes again the geometry and the materials of test SENSD03 [V1.01.163] but calculation carried out here is
transitory response of the system.

The functionality tested is the derivation of the fields of displacement, speed and acceleration compared to
properties materials modulus Young and Poisson's ratio. A simultaneous calculation of the sensitivities by report/ratio
with the loading is also tested.

One also tests the derivation of the stress fields using operator CALC_ELEM.

The reference is calculated by finished differences.

1
Problem of reference

1.1 Geometry

OPPOSE

3. m
BORD_GAU

CENTER

ORIGIN

y

10. m

1 m < X < 11 m
1.5 m < Y < 1.5 m
X

Z

1.2
Properties of material

E = 36.000 MPa

= 0.2

= 2400 kg/m3

1.3
Boundary conditions and loadings

Modeling 2D (x0y plan) in plane constraint.

Boundary conditions:
Surface "BORD_GAU" is blocked according to X.
The line "ORIGIN" is blocked according to X and Y.

Loading (tdébut = 0 S T tfin = 104 S):
On the line "OPPOSES":

nodal force according to X: F
-
X= F T

1
(T T
end
beginning)
1
F =10 NR

nodal force according to y: F
-
Y= F T

2
(T T
end
beginning)
2
F =3 NR

1.4 Conditions
initial

Initial displacement no one and null initial speed.
Handbook of Validation
V1.01 booklet: Tests of validity of the orders
HT-66/03/008/A

2
Reference solution

2.1
Method of calculation

The sensitivities of the fields displacement, speed and acceleration with the data materials are calculated by finished differences. These calculations by finished differences are carried out inside even case test by Code_Aster. The diagram of finished differences used is as follows (diagram of order 1 not centered):

F (,
X)
y
F (x+,)
y - F (,
X)
y

X

The field of solution displacement of the standard problem (i.e nonderived) is subjected to a test of not regression. Tests of nonregression are also carried out on the sensitivities.

2.2
Sizes and results of reference

The values of reference are calculated at the moment tfin.

By finished differences:
there derived compared to E of displacements following group from nodes OPPOSES,
derived compared to E from constraints xx with the group from nodes OPPOSES M14 mesh,
derived compared to displacements following group from nodes there OPPOSES,
derived compared to constraints xx with the group from nodes OPPOSES M14 mesh,
derived compared to 1
There F of displacements following group of nodes OPPOSES,
derived compared to 1
F of constraints xx with the group of nodes OPPOSES M14 mesh,
derived compared to 2
There F of displacements following group of nodes OPPOSES,
derived compared to 2
F of constraints xx with the group of nodes OPPOSES M14 mesh.

By nonregression:
displacements according to X of the group of nodes OPPOSES
there derived compared to E speeds following group from nodes OPPOSES,
derived compared to accelerations according to X from the group from nodes OPPOSES,
derived compared to 1
F of displacements according to X of the group of nodes OPPOSES,
derived compared to 2
There F of displacements following group of nodes OPPOSES,
derived compared to 1
F of constraints xx with the group of nodes OPPOSES M14 mesh,
derived compared to 2
F of the constraints yy to the group of nodes OPPOSES M14 mesh.

2.3 Uncertainties

The results depend on the temporal discretization and the diagram of integration. Here, we have chosen as reference solution that obtained by the implicit scheme of Newmark (with = 0.25 and = 0.5). We estimate uncertainty on the solution lower than 0.5%.

3 Modeling With

3.1 Characteristics of modeling

Modeling in plane constraints on the grid following 2D:

Surface BORD_GAU becomes a line, the lines ORIGIN and OPPOSES become points.

3.2 Characteristics of the grid

A number of nodes: 55
Numbers and types of meshs: 28 SEG2, 80 TRIA3

Parameters of calculation:

Temporal incrementing
T = 10-5 S
Parameters Newmark diagram
= 0.25

= 0.5

3.3 Functionalities tested

The functionality tested is the derivation of the fields of displacement, speed and acceleration by report/ratio with the properties materials (Young modulus and Poisson's ratio). A simultaneous calculation of
sensitivities compared to the loading is also tested.
One also tests the derivation of the stress fields using operator CALC_ELEM.

Orders

MEMO_NOM_SENSI NOM_UN

NOM_ZERO

NAME
NOM_SD

PARA_SENSI

NOM_COMPOSE

DYNA_LINE_TRAN SENSITIVITY

EXCIT
CHARGE

CALC_ELEM SENSITIVITY

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

The values of reference are calculated at the moment tfin.

By finished differences:

Derived compared to E from displacement following y, group of nodes OPPOSES:

Reference	***Aster***	*Difference* ***(%)***
-1.8694452655942 10-21	*-1.8702782343648 10-21*	*0.045*

Derived compared to E from constraints xx with the group from nodes OPPOSES M14 mesh:

Reference	***Aster***	*Difference* ***(%)***
5.3289199061525 10-10	*5.3317808348049 10-10*	*0.054*

Derived compared to displacement following y, group of nodes OPPOSES:

Reference	***Aster***	*Difference* ***(%)***
-5.3083783409877 10-11	*-5.3069502892459 10-11*	*0.027*

Derived compared to constraints xx with the group from nodes OPPOSES M14 mesh:

Reference	***Aster***	*Difference* ***(%)***

1.09323624960921 01 1.09313331077441
01 0.009

Derived compared to 1
F of displacement following y, group of nodes OPPOSES:
Reference
***Aster** Difference*
(%)
-4.9326303397235 10-12 -4.9326303396751
10-12 9.82
10-10

Derived compared to 1
F of constraints xx with the group of nodes OPPOSES M14 mesh:
Reference
***Aster** Difference*
(%)
3.2954061238655 3.2954061238708 1.60
10-10

Derived compared to 2
F of displacement following y, group of nodes OPPOSES:
Reference
***Aster** Difference*
(%)
3.4334537389989 10-11 3.4334537389978
10-11 3.26
10-11

Derived compared to 2
F of constraints xx with the group of nodes OPPOSES M14 mesh:
Reference
***Aster** Difference*
(%)
3.6294380946345 10-1 3.6294380947267
10-1 2.54
10-9

By nonregression:

Displacement following X, group of nodes OPPOSES:
Reference
***Aster** Difference*
(%)

3.70 10-10 3.7000067178680
10-10 1.82
10-4

Derived compared to E speed following y, group of nodes OPPOSES:
Reference
***Aster** Difference*
(%)
-6.11 10-17 -6.1127945905412
10-17 0.046

Derived compared to acceleration according to X, group of nodes OPPOSES:
Reference
***Aster** Difference*
(%)
3.35 10-2 3.3506762414860
10-2 0.02

Derived compared to 1
F of displacement following X, group of nodes OPPOSES:
Reference
***Aster** Difference*
(%)
3.85 10-11 3.8479856280582
10-11 0.052

Derived compared to 2

F of displacement following y, group of nodes OPPOSES:
Reference
Aster *Difference*
(%)
3.43 10-11 3.43345373899978
10-11 0.101

Derived compared to 1
F of constraints xx with the group of nodes OPPOSES M14 mesh:
Reference
Aster *Difference*
(%)
3.29 3.2954061238708
0.164

Derived compared to 2
F of the constraints yy to the group of nodes OPPOSES M14 mesh:
Reference
Aster *Difference*
(%)
3.46 3.4618790581068
0.054

4
Summary of the results

The precision of the results is coherent with the method of resolution used and the method of direct derivation "exact".

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.178

SENSM08 - Sensitivity to the parameters material in elastoplasticity (linear isotropic work hardening)

Summary

One tests the calculation of sensitivity to the parameters material, in the case of the elastoplasticity of Von-settings with
linear isotropic work hardening in 2D plane deformations. The sensitivity is calculated by direct differentiation
discrete equations. The reference comes from an analytical solution (simple compactness).

1
Problem of reference

1.1 Geometry

Y

D

C

DY = - 0.2 T

1.

With
X

B

5.

1.2
Properties of material

E = 100.000 MPa

= 0.3

AND = 2000 MPa

y = 200 MPa

1.3
Boundary conditions and loadings

Sides AC and data base are blocked according to X.
Side AB is blocked according to Y.
*A displacement towards AB of standard 0.2 * T is imposed on the side CD (the moment T belongs to [0,1])*

2
Reference solution

2.1
Method of calculation

The reference solution comes from an analytical solution:

If yy < K (1+) /E,
- 2
E
- 2k 1
(+)
p =
YY

3rd + 2R 1
(+)
1
XX = -
[(RP + K) + Ep/2]
1 - 2

=
- (RP + K)
YY
XX

With:
p: cumulated plastic deformation
R = E AND/(E - AND)
K = y

That is to say:
2
2
2
p

1
(
2 + 3
) (kE - 6kE E + K 1
(- 2) E - 2nd E)
T
T
T YY
=

2
2
E

E 3
(E - 1
(- 2) E)
T

p

4 1
(+) (E
+ K 1
(+))
YY
=

2
E

3
(E - 1
(- 2) E)
T
T

p
- 1
(
2 +)
=

K
3rd + 2R 1
(+)

XX =
E

K
3rd + 2R 1
(+)

- 2
YY =
E

K
3rd + 2R 1
(+)

2.2
Sizes and results of reference

All the sizes are uniform on all the field. The point of calculation will thus not be clarified.

Plastic deformation cumulated at the moment T = 1.0:
p (1.0) = 0.129313

Sensitivity of the plastic deformation cumulated to the Young modulus E to the moment t=0.5:
dp/dE (0.5) = 2.83475 E-8
Sensitivity of the plastic deformation cumulated to the Young modulus E to the moment t=1.0:
dp/dE (1.0) = 3.99649 E-8

Sensitivity of the plastic deformation cumulated to the module AND the moment t=0.5:
dp/dET (0.5) = 5.65769 E-7
Sensitivity of the plastic deformation cumulated to the module AND the moment t=1.0:
dp/dET (1.0) = 1.14664 E-6

Sensitivity of the constraint according to xx to the t=1.0 and elastic limit K to the moments t=0.5:
D xx /dk (0.5) = D xx /dk (1.0) = 0.32754
Sensitivity of the constraint according to yy to the t=1.0 and elastic limit K to the moments t=0.5:
D yy /dk (0.5) = D yy /dk (1.0) = 0.65508
Sensitivity of the plastic deformation cumulated to the t=1.0 and elastic limit K to the moments t=0.5:
dp/dk (0.5) = dp/dk (1.0) = 8.51604 E-6

3 Modeling With

3.1 Characteristics of modeling

Modeling in plane deformations on a grid 2D consisted an element QUAD4

3.2 Characteristics of the grid

A number of nodes: 4
Numbers and types of meshs: 1 QUAD4, 2 SEG2, 1POI1

3.3 Functionalities tested

Orders

DEFI_PARA_SENSI

STAT_NON_LINE COMP_INCR
RELATION
VMIS_ISOT_LINE
SENSITIVITY

TEST_RESU SENSITIVITY

3.4 Sizes tested and results

Size tested	Theory	Code_Aster	Difference (%)
V1 with T = 1.0	0.129313	0.1293128	1.28 E-4
Sensitivity of V1 to E to T = 0.5	2.83475 E-8	2.834746 E-8	1.24 E-4
Sensitivity of V1 to E to T = 1.0	3.99649 E-8	3.9964897 E-8	6.3 E-6
Sensitivity of V1 to AND to T = 0.5	5.65769 E-7	5.6576897 E-7	5.87 E-6
Sensitivity of V1 to AND to T = 1.0	1.14664 E-6	1.1466406 E-6	5.2 E-5
Sensitivity of V1 to K to T = 0.5	8.51604 E-6	8.516043 E-6	3.27 E-5
Sensitivity of V1 to K to T = 1.0	8.51604 E-6	8.516043 E-6	3.27 E-5

Sensitivity of SIXX to K to T = 0.5
0.32754
0.3275401
3.27 E-5
Sensitivity of SIXX to K to T = 1.0
0.32754
0.3275401
3.27 E-5
Sensitivity of SIYY to K to T = 0.5
-0.65508
-0.6550802
3.27 E-5
Sensitivity of SIYY to K to T = 1.0
-0.65508
-0.6550802
3.27 E-5

4
Summary of the results

The numerical results of sensitivity are in very good agreement with those of the theory.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
V1.01.179 document

SENSM09 - Infinite elastoplastic cylinder under pressure: sensitivity to the parameters material

Summary:

One tests the calculation of sensitivity to the parameters material, in the case of the elastoplasticity of Von Mises with
linear isotropic work hardening in axisymmetric 2D.

The sensitivity is calculated by direct differentiation of the discrete equations.

The reference comes from a calculation from derived by finished differences.

Titrate:

SENSM09 - Infinite elastoplastic cylinder under pressure
Date
:

20/02/04
Author (S):
P. of BONNIERES

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1
Problem of reference

1.1 Geometry

Z
3
9 - 27
With
D
p
I J
· · K
1
L
H
E
R
20
20

1.2
Material properties

E = 210.000 MPa
= 0.3
T
E = 2000 MPa

y = 50 MPa

1.3 Boundary conditions and loadings

On HE: uz = 0
On AD: uz uniform
100
Pressure p (T) distributed uniformly on AH: p (T) =
T
60
(p in MPa, T in seconds)

---

2 Reference solution

2.1 Method of calculation

The solution comes from finished differences (approximation of derived with order 1) carried out with Aster.

2.2
Sizes and results of reference

2
2 3
The mesh 75, noted M75, corresponds to rectangle IJKL (side IJ has as a length
+
). All
5
135
the sizes are taken at the moment T = 60. The moment of calculation will thus not be specified.

Sensitivity of ur displacement to the point K compared to the Young modulus E:

ur = -, 228851 E -8
E

Sensitivity of uz displacement to the point K compared to the Young modulus E:

uz =, 4746 E -12
E

Sensitivity of the constraint rr to item 1 of M75 compared to the Young modulus E:

rr = 7,4146 E -7
E

Sensitivity of the constraint to item 1 of M75 compared to the Young modulus E:

= 08096
,
1
E - 6
E

Sensitivity of the constraint zz to item 5 of M75 compared to the module T
E:

zz = 3384
,
1
E - 4
AND

Sensitivity of the cumulated plastic deformation p to item 5 of M75 compared to the module T

E:

p = - 78363
,
1
E - 5
AND

Sensitivity of the cumulated plastic deformation p to item 1 of M75 compared to the elastic limit
y:
p = - 54865
,
4
E - 4
y

Sensitivity of the cumulated plastic deformation p to item 5 of M75 compared to the elastic limit
y:
p = - 50133
,
4
E - 4
y

---

3 Modeling With

3.1 Characteristics of modeling

Z
With
I J
B
C D
L
K
1
H G
F E
20 meshs
R
45 meshs
20 20

Loading: pressure p (T) distributed on AH (p (T) defined in [§1.3]).

Boundary conditions:
uz = 0 for the group of nodes NOEHGFE (side HE)

U
U
Z = Z (D) for each node located on side AD

3.2 Characteristics of the grid

A number of nodes: 381
A number of meshs and types: 94 elements QUAD8

3.3 Functionalities tested

Orders

DEFI_PARA_SENSI

STAT_NON_LINE
COMP_INCR RELATION
VMIS_ISOT_LINE
SENSITIVITY
TEST_RESU SENSITIVITY

3.4
Sizes tested and results

Size tested
Reference
Code_Aster
Difference (%)
Sensitivity of Ux to E to the point K
2,28851 E-8
2,28845 E-8
-0,002
Sensitivity of Uy to E to the point K
4,746 E-12
4,7425 E-12
-0,074
Sensitivity of SIXX to E to item 1 of M75
7,4146 E-7
7,41465 E-7
6,72 E-4
Sensitivity of SIZZ to E to item 1 of M75
1,08096 E-6
1,0809601 E-6
9,27 E-6
Sensitivity of SIYY to AND item 5 of M75
1,3384 E-4
1,33844 E-4
0,003
Sensitivity of V1 to AND item 5 of M75
1,78363 E-5
1,7836315 E-5
8,51 E-5
Sensitivity of V1 to y to item 1 of M75
4,54865 E-4

4,548652 E-4
4,57 E-5
Sensitivity of V1 to y to item 5 of M75
4,50133 E-4
4,5013315 E-4
3,35 E-5

---

4 *Summary of the results*

The numerical results of sensitivity are in concord with the reference consisted calculations by finished differences.

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Author (S):
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Code_Aster ®
Version
7.2

Titrate:
SENSM10 - Elastoplastic elbow under pressure

Date
:

26/04/04
Author (S):
P. of BONNIERES

Key: V1.01.181-A
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Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
V1.01.181 document

SENSM10 - Elastoplastic elbow under pressure: sensitivity compared to the loading and to material

Summary:

One tests the calculation of sensitivity to the parameters loading and material, in the case of the elastoplasticity of Von
Settings with linear isotropic work hardening in 3D.

The sensitivity is calculated by direct differentiation of the discrete equations.

The reference comes from a calculation from derived by finished differences.

---

1 Problem of reference

1.1 Geometry

The study relates to a piping including/understanding two right pipes and an elbow [Figure 1.1-a].

The geometrical data of the problem are as follows:

- *length LG of the two right pipes is 3 m,*
- *the Rc ray of the elbow is 0.6 m,*
- *the angle of the elbow is 90 degrees,*
- *the thickness of the right pipes and the elbow is 0.02 m,*
-

and the ray external Re of the right pipes and the elbow is of 0.2 Mr.

LG

D
B
section D
section B
RC
C
O
section C
Z
Y
E
L
Z
G
X
Re
X
With
section A

Appear 1.1-a
Note:

The geometry of the problem has a symmetry compared to the plan (A, X, Y).

1.2
Material properties

E = 210.000 MPa
= 0.3
T
E = 2000 MPa
y = 200 MPa
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Code_Aster ®
Version

1.3
Boundary conditions and loadings

On the level of section a: embedding.
On the level of section b: displacement imposed D (T) directed according to the axis Y

D (T)
0,1
0
0,4 0,6
1
T (S)

Internal pressure: p (T) = T with = 5
,
2 MPa s1

2
Reference solution

2.1
Method of calculation

The solution comes from finished differences (approximation of derived with order 1) carried out with *Aster*.

2.2
Sizes and results of reference

The position of the mesh 45, noted M45, is as follows (see [§3.1]):

· 5th mesh starting from the segment *d2*, while turning towards [*p* 1,
I
p 1
E],
· 3rd mesh starting from section A towards Y positive.

The number of the quoted points is the number of the point of corresponding Gauss of M45.

2 3
2
The N3235 node, whose co-ordinates are -

, ,

, belongs to M45.
10 5 10

Sensitivity of *ux* displacement to the N3235 node by report/ratio (defined in [§1.3]) to *T* = 0,6 S:

ux = - 56007
,
1
E - 3

Sensitivity of the constraint *zz* to item 27 of M45 compared to to *T* = 0,6 S:

zz = 36732
,
2

Sensitivity of the constraint *yy* to item 3 of M45 compared to to *T* = 0,6 S:

yy = - 0447
,
1
E +1

Sensitivity of the constraint *xz* to item 19 of M45 compared to to *T* = 0,6 S:

xz = 37787
,
3

Sensitivity of displacement *U y* to the N3235 node compared to to *T* = 1 S:

U y = - 71676
,
2
E - 3

Sensitivity of constraint *xx* to item 1 of M45 compared to to *T* = 1 S:

xx = 9896
,
9

Sensitivity of the constraint *yy* to item 3 of M45 compared to to *T* = 1 S:

yy =, 12685

Sensitivity of the constraint *xy* to item 27 of M45 compared to to *T* = 1 S:

xy = 51774
,
4
-

Sensitivity of the cumulated plastic deformation *p* to item 27 of M45 compared to to *T* = 1 S:

p = 36402

,
5
E - 4

Sensitivity of the constraint *zz* to item 7 of M45 compared to *E* to *T* = 0,6 S:

zz = 56151
,
6
E - 5
E

Sensitivity of the cumulated plastic deformation *p* to item 1 of M45 compared to *E* to *T* = 0,6 S:

p = 07624
,
1
E - 8
E

Sensitivity of constraint *xx* to item 25 of M45 compared to *E* to *T* = 1 S:

xx = 54847
,
2
E - 5
E

Sensitivity of the constraint *xz* to item 7 of M45 compared to *E* to *T* = 1 S:

xz = 5494
,
3
E - 6
E

Sensitivity of the constraint *yz* to item 19 of M45 compared to *E* to *T* = 1 S:

yz = - 00755
,
2
E - 5
E

Sensitivity of *uz* displacement to the N3235 node compared to *T*
E with *T* = 1 S:

uz = 53184
,
4
E - 8
AND

Sensitivity of the constraint *zz* to item 27 of M45 compared to *T*
E with *T* = 1 S:

zz = -, 128275 *E* - 2
AND
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Sensitivity of the constraint *yy* to item 25 of M45 compared to *there* to *T* = 1 S:

yy = - 52017
,
8
E -1
y

Sensitivity of the cumulated plastic deformation *p* to item 9 of M45 compared to *there* to *T* = 1 S:

p = -, 141329 *E* -5
y

---

3 Modeling With

3.1 Characteristics of modeling

The right pipes and the elbow are modelled by quadratic isoparametric solid elements.
Piping presents a symmetry plane Z=0. Only one half volume is netted.

Y
X
With
d2 A
With D A
e2
i2
i1
1

e1
d2
L
With
2
With
i1
P
L
With
i2
P
L
i1
2
With
i1
1
e2
e1
P
L
e1
1
D
P
1
e1
Z

3.2
Characteristics of the grid

4240 meshs HEXA20, 5913 nodes

3.3 Functionalities
tested

Orders

DEFI_PARA_SENSI

STAT_NON_LINE COMP_INCR
RELATION
VMIS_ISOT_LINE
SENSITIVITY

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

Size tested
Localization *T* (*S*)
Reference
Code_Aster
Difference (%)
in M45
Sensitivity of Ux to
N3235

0,6 1,56007 E-3
1,560071 E-3
3,93 E-5
Sensitivity of SIXX to
point 27
0,6
2,36732
2,36731
3,37 E-4
Sensitivity of SIYY to
point 3
0,6 1,0447 E+1
1,04468 E+1
-0,002
Sensitivity of SIXZ to
point 19
0,6
3,37787
3,377868
6,18 E-5
Sensitivity of Uy to
N3235
1
2,71676 E-3
2,71675 E-3
3,36 E-4
Sensitivity of SIXX to
point 1
1
9,9896
9,98963
3,52 E-4
Sensitivity of SIYY to
point 3
1
1,2685
1,2689
0,033
Sensitivity of SIXY to
point 27
1
-4,51774
-4,51758

-0,004
Sensitivity of V1 to
point 27
1
5,36402 E-4
5,36399 E-4
5,71 E-4
Sensitivity of SIZZ to E
point 7
0,6
6,56151 E-5
6,55853 E-5
-0,045
Sensitivity of V1 to E
point 1
0,6
1,07624 E-8
1,076702 E-8
0,043
Sensitivity of SIXX to E
point 25
1
2,54847 E-5
2,55017 E-5
0,067
Sensitivity of SIXZ to E
point 7
1
3,5494 E-6
3,5606 E-6
0,315
Sensitivity of SIYZ to E
point 19
1
2,00755 E-5
2,00823 E-5
0,034
Sensitivity of Uz to AND
N3235
1
4,53184 E-8
4,53152 E-8
-0,007

Sensitivity of SIZZ to AND
point 27
1
1,28275 E-2
1,282695 E-2
-0,004
Sensitivity of SIYY to y
point 25
1
8,52017 E-1
8,52442 E-1
0,050
Sensitivity of V1 to y
point 9
1
1,41329 E-5
1,41175 E-5
-0,109

4
Summary of the results

The numerical results of sensitivity are in concord with the reference consisted calculations by finished differences.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
V1.01.182 document

SENSM11 - Elastoplastic axisymmetric structure in inflection: sensitivity compared to the loading and with material

Summary:

One tests the calculation of sensitivity to the parameters loading and material, in the case of the elastoplasticity of
Von Mises with linear isotropic work hardening in axisymmetric 2D.

The sensitivity is calculated by direct differentiation of the discrete equations.

The reference comes from a calculation from derived by finished differences.

Version
7.2

Titrate:
SENSM11 - Elastoplastic axisymmetric structure in inflection
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P. of BONNIERES

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1
Problem of reference

1.1 Geometry

Z
1
With
G
B
1
H
C
O
R
3

1.2
Material properties

E = 210.000 MPa
= 0,3
T
E = 2000 MPa
y = 200 MPa

1.3
Boundary conditions and loadings

Side OA is blocked according to R.
The point O is blocked according to Z.
A specific force directed according to OZ towards Z < 0 is applied to the point B. Its intensity depends time T and is worth:

F (T) = T with T in seconds and = 1,6667
1
-
NS

2
Reference solution

2.1
Method of calculation

The solution comes from finished differences (approximation of derived with order 1) carried out with Aster.

2.2
Sizes and results of reference

The M1 mesh corresponds to square AGHO on side 1 Misters.

All the sizes are taken at the moment T = 60s. The moment of calculation will thus not be specified.

Sensitivity of ur displacement to the point G compared to the force F:

ur =, 422826 E -5
F

Sensitivity of the constraint rr to item 4 of M1 compared to the force F:

rr =, 1
- 28653
F

Sensitivity of the cumulated plastic deformation p to item 3 of M1 compared to the force F:

p = 69781
,
1
E - 3
F

Sensitivity of uz displacement to point A compared to the Young modulus E:

uz = 17304
,
3
E - 8
E

Sensitivity of the constraint rz to item 3 of M1 compared to the module T
E:

rz =, 80665 E - 4
AND

Sensitivity of the cumulated plastic deformation p to item 1 of M1 compared to the elastic limit
y:
p = - 9766
,
4
E - 4
y

---

3 Modeling With

3.1 Characteristics of modeling

Z
With
G
B
1
O
H
C
R
3

Loading: specific force F (T) to the bottom with the point B (defined in [§1.3])
Boundary conditions:
ur = 0 for the node N4 (not A)
ur = uz = 0 for the node N1 (not O)

3.2

Characteristics of the grid

A number of nodes: 8
A number of meshs and types: 3 elements QUAD4

3.3 Functionalities
tested

Orders

DEFI_PARA_SENSI

STAT_NON_LINE COMP_INCR
RELATION
VMIS_ISOT_LINE
SENSITIVITY

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

Size tested
Reference
Code_Aster
Difference (%)
Sensitivity of Ux to F to the point G
4,22826 E-5
4,2282602 E-5
4,89 E-6
Sensitivity of SIXX to F to item 4 of M1 -1,28653
-1,2865305
4,09 E-5
Sensitivity of V1 to F to item 3 of M1
1,69781 E-3
1,6978105 E-3
2,94 E-5
Sensitivity of Uy to E to point A
3,17304 E-8

3,173036 E-8
-1,16 E-4
Sensitivity of SIXY to AND item 3 of M1
8,0665 E-4
8,066447 E-4
-6,6 E-4
Sensitivity of V1 to y to item 1 of M1
-4,9766 E-4
-4,9765995 E-4
-1,06 E-5

4
Summary of the results

The numerical results of sensitivity are in concord with the reference consisted calculations by finished differences.

Author (S):
Key S. CAMBIER

Organization (S): EDF-R & D /AMA

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Document: V1.01.184

SENSD07 - Sensitivity in nonlinear dynamics 3D (VON-MISES ISOT)

Summary

This case test takes again the geometry of test SENSD02 but calculation carried out here is the transitory answer not linear of the system.

The functionality tested is the derivation of the fields of displacement and speed compared to the properties materials (Young modulus, Poisson's ratio, slope of the traction diagram, elastic limit), and with loading (nodal force). Two DYNA_NON_LINE are connected to also test the functionality of recovery with sensitivity.

The reference solution of the sensitivities is calculated by finished differences, then one tests with a loading such as the mode is linear, and one compares with the results of DYNA_LINE_TRAN.

---

1 Problem of reference

1.1 Geometry

OPPOSE

CENTER
BORD_GAU
3. m

I

y

10. m

1 m < X < 11 m
1.5 m < Y < 1.5 m
X

0 m < Z < 1 m
Z

1.2
Properties of material

E = 105 Pa

= 0.3

AND = 2000 MPa

y = 200 MPa

= 2400 kg/m3

The model integrates modal damping (amor_réduit = 0.07) and damping proportional (K + M, = 0. S and = 0.3 s1).

1.3
Boundary conditions and loadings

Boundary conditions:
Line “BORD_GAU” is blocked according to X, y and Z.
The node “I” is blocked according to X, y and Z.

Loading (tdébut = 0 S T tfin = 104 S):
On the node “OPPOSES”:

nodal force according to X F
-
X= F T

1
(T T
end
beginning)
1
*F =100*coef_char,*
:

nodal force according to y F
-
Y= F T

2
(T T
end
beginning)
2
*F =30*coef_char,*
:

nodal force according to Z F
-
Z= F T

*F =10*coef_char.*
3
(T T
end
beginning)
3
:

With coef_char =107 for the first calculation (into nonlinear) and coef_char=1 for the second calculation (in
linear).

1.4 Conditions
initial

Initial displacement no one and null initial speed.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

Code_Aster ®
Version
8.1

Titrate:
SENSD07 - Sensitivity in nonlinear dynamics 3D

Date:
25/11/05
Author (S):
Key ***S. CAMBIER***
:

2
Reference solution

2.1
Method of calculation

The sensitivities of the fields displacement, speed and acceleration with the data materials are calculated by finished differences. These calculations by finished differences are carried out inside even case test by Code_Aster. The diagram of finished differences used is as follows (diagram of order 1 not centered):

F (,
X)
y
F (x+,)
y - F (,
X)
y

X

The field of solution displacement of the standard problem (i.e nonderived) is subjected to a test of not regression. Tests of nonregression are also carried out on the sensitivities.

2.2
Sizes and results of reference

The values of reference are calculated at the moment tfin.

By finished differences:
derived compared to E speed according to X, y and Z with the node OPPOSES,
derived compared to speed according to X, y and Z with the node OPPOSES,
derived compared to AND speed according to X, y and Z with the node OPPOSES,
derived compared to there speed according to X, y and Z with the node OPPOSES,
derived compared to 1
F speed according to X, y and Z with the node OPPOSES,

Note:

*In the command file, it is enough to replace nom_cham=' VITE' by nom_cham=' DEPL'
or nom_cham=' ACCE' to test (values of reference calculated automatically by
finished differences) the derivative compared to these fields.*

*By nonregression:
displacement following X of the node OPPOSES
derived compared to E from displacement according to X to the node OPPOSES,
derived compared to displacement following y to the node OPPOSES,
derived compared to AND speed according to Z to the node OPPOSES,
derived compared to speed according to X to the node OPPOSES there,
derived compared to AND from acceleration following y to the node OPPOSES,
derived compared to from acceleration according to Z to the node OPPOSES there,*

*By comparison with DYNA_LINE_TRAN:
displacement following X of the node OPPOSES
derived compared to E speed according to X with the node OPPOSES,
derived compared to speed following y to the node OPPOSES,
derived compared to 1
F speed following y to the node OPPOSES,
derived compared to 1
F speed according to Z with the node OPPOSES,*

2.3 Uncertainties

*Results depending amongst other things on the convergence of calculations (what can disturb the values of reference calculated by difference-finished); uncertainty on the solution can be estimated order from 0.5% for the values tested significant (not too small).
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A*

Code_Aster ®
*Version
8.1*

*Titrate:
SENSD07 - Sensitivity in nonlinear dynamics 3D*

*Date:
25/11/05
Author (S):
Key* ***S. CAMBIER***

3 Modeling With

3.1 Characteristics of modeling

Modeling in voluminal element.

BORD_GAU

F

I

y

X

Z

Characteristic of the elements: 3D

Boundary conditions: line BORD_GAU and node I are blocked according to X, y and Z.

3.2

Characteristics of the grid

A number of nodes: 330
Numbers and type of mesh: 200 HEXA8

3.3 Functionalities tested

The functionality tested is the derivation of the fields of displacement and speed compared to properties materials (Young modulus, Poisson's ratio, slope of the traction diagram, limiting of elasticity), and with the loading (nodal force). Two DYNA_NON_LINE are connected to test also functionality of recovery with sensitivity.

Orders

MEMO_NOM_SENSI NOM_UN

NOM_ZERO

NAME
NOM_SD

PARA_SENSI

DYNA_NON_LINE
COMP_INCR RELATION VMIS_ISOT_LINE

SENSITIVITY

EXCIT
CHARGE

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

The values of reference are calculated at the moment tfin.

The results are obtained on the machine Compaq clayastr.

References obtained by finished differences:

derived compared to E speed to the node OPPOSES,
Reference
Aster *v 8.01.16* ***Difference***

Dx
-1.1166186341777D-08 1.1163137969561D-08
0.027
%
Dy
1.3767938854149D-08 -1.3768385542789D-08
-0.003
dz
1.4266008217134D-08 1.4266220205172D-08
-0.001

derived compared to speed with the node OPPOSES,

Reference
Aster *v 8.01.16* ***Difference***

dx
-5.3322155999948D-03 5.3308516119917D-03
0.026
%
Dy
-6.8047395954361D-03 -6.8049909411153D-03
-0.004
%
dz
7.1532137250567D-03 7.1529269784399D-03
-0.004
%

derived compared to AND speed to the node OPPOSES,
Reference
Aster *v 8.01.16* ***Difference***

dx
-7.9808160080574D-08 -7.9791920495776D-08
-0.020
%
Dy
-2.5306690076832D-08 -2.5282262727618D-08
-0.097
%
dz
-5.9742433222709D-09 -5.9807380106367D-09
0.109
%

derived compared to speed to the node OPPOSES there,
Reference
Aster *v 8.01.16* ***Difference***

dx
-1.5106706996448D-06 -1.5118362142106D-06
0.077
%
Dy
-4.7919002099661D-07 -4.7932548945879D-07
0.028

%
dz
-1.1976908353972D-07 -1.1987342764877D-07
0.087
%

derived compared to 1
F speed to the node OPPOSES,
Reference
Aster** v 8.01.16 **Difference

dx
5.7737287084819D-06 5.7737284500162D-06
-4.48E-06
%
Dy
-7.5037860369775D-13
-2.7661560722007D-14
7.23E-13
dz
2.0658944777097D-12 2.3753534498295D-12
14.979
%

References obtained by nonregression:

displacement following X of the node OPPOSES
Reference
***Aster** Difference*
1.9342000000000D-01 1.9342038655185D-01
2.00E-04
%

derived compared to E from displacement according to X to the node OPPOSES,
Reference
***Aster** Difference*
-2.4739000000000D-13 -2.4738842664910D-13
-6.36E-04
%

derived compared to displacement following y to the node OPPOSES,
Reference
Aster *Difference*
-1.3969000000000D-07 -1.3969162792960D-07
0.001
%

derived compared to AND speed according to Z to the node OPPOSES,
Reference
Aster *Difference*
-5.9807000000000D-09 -5.9807380106367D-09
6.36E-04
%

derived compared to speed according to X to the node OPPOSES there,
Reference
Aster *Difference*
-1.5118000000000D-06 -1.5118362142106D-06
0.002
%

derived compared to AND from acceleration following y to the node OPPOSES,
Reference
Aster *Difference*
-1.0214000000000D-03 -1.0214309235913D-03
0.003
%

derived compared to from acceleration according to Z to the node OPPOSES there,
Reference
Aster *Difference*
-1.7587000000000D-03 -1.7586721905067D-03
-0.002
%

References by DYNA_LINE_TRAN:

Derived compared to E speed in y, node OPPOSES:

Reference
Aster *Difference*
1.9342000000000D-08 1.9342020834004D-08
1.08E-04
%

Derived compared to E speed in y, node OPPOSES:

Reference
Aster *Difference*
-1.0577000000000D-14 -1.0577116503182D-14
0.001
%

Derived compared to E speed in y, node OPPOSES:

Reference
Aster *Difference*
-4.4996000000000D-10 -4.4996345033970D-10
7.67E-04
%

Derived compared to acceleration in X, node OPPOSES:

Reference
Aster *Difference*
-9.9810000000000D-13 -9.8309867263082D-13
-1.503
%

Derived compared to acceleration in X, node OPPOSES:

Reference

Aster *Difference*
2.3704000000000D-12 2.3593190530811D-12
-0.467
%

4
Summary of the results

Precision evaluated by comparison of the results of the method of resolution by direct derivation "exact" with those obtained by finished differences and those obtained by another operator Code_Aster is completely satisfactory.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.185

ZZZZ185 - Validation of the order
MODI_MAILLAGE associated with SYMMETRY and with
order PROJ_CHAMP associated with DISTANCE_MAX

Summary:

The objective of this case test is to validate order MODI_MAILLAGE with the key word SYMMETRY and
order PROJ_CHAMP with key word DISTANCE_MAX.

.

order MODI_MAILLAGE, with the key word SYMMETRY makes it possible to take the symmetrical one of one
grid 2D or 3D,

.

order PROJ_CHAMP with key word DISTANCE_MAX makes it possible not to project the field on the nodes which do not answer the 2 following criteria:
- the nodes are not in an element of the 1st grid,
- the nodes are beyond DISTANCE_MAX.

The case test consists in realizing:

.

a thermal study on 1/8ème of structure,

.

the construction of the thermal field on 1/4 of structure by projection of the results obtained on 1/8ème of structure, with the taking into account of a symmetry plane,

.

a thermal study on 1/4 of structure,

.

the comparison of the field of temperature obtained by projection and a study on 1/4 of structure.

1
Problem of reference

1.1 Geometry

The structure is obtained by rotation around axis Z, of the section represented with [Figure 1.1-a].

Z
m
0,20
X
0,05m
R1=5,00m
R2=5,05m
R3=5,30m
R4=5,40m

Appear 1.1-a: Cut structure

1.2
Properties of material

The study is carried out in linear thermics, only the thermal characteristics are necessary to the definition of materials.

Isotropic thermal conductivity: LAMBDA = 15.0 W/m.k
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/04/005/A

1.3
Boundary conditions and loadings

The study is carried out in linear thermics, the conditions on the imposed temperatures are represented with [Figure 1.3-a], the conditions of flow and heat exchange are indicated to [Figure 1.3-b].

Y
Temp 1
Temp 2
X
Temp 1
Temp 2

Appear 1.3-a: Sight of top, with the conditions in imposed temperature

1
3
H2, Tf2
h1, TF1
h3, Tf3
2

Appear 1.3-b: Cross-section, with the conditions of flow and heat exchange
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/04/005/A

Conditions of flow:
1 = 10.0 W/m ²
2 =
0.0 W/m ²
3 = 30.0 W/m ²

Conditions of exchange by convection:
h1 = 350.0 W/m ² .k
TF1 = 300.0 °C
H2 = 400.0 W/m ² .k
tf2 = 275.0 °C
h3 = 600.0 W/m ² .k
tf3 = 310.0 °C

Conditions of imposed temperature:
Temp1 = 250.0 °C
Temp2 = 160.0 °C

1.4 Conditions initial

Without object.

---

2 Reference solution

2.1 Method of calculation

For this case test, 2 studies are carried out.

- *The first study is carried out on 1/8ème structure. Calculation is a thermal analysis linear, with the boundary conditions described with [§1.2].*
- *The second study is carried out on 1/4 of structure. Calculation is a thermal analysis linear, with the boundary conditions described with [§1.2].*

Z
Y
X

Appear 2.1-a: Grid of 1/8ème of structure

2.2 Sizes and results of reference

The result of reference is the field of temperature.
The result of the study on 1/8ème of structure and its grid are safeguarded in a file with format "MED". The projected fields will be then compared with those obtained by the study carried out on 1/4 of structure.

[Figure 2.2-a] the field of temperature gives obtained on 1/8ème of structure.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/04/005/A

Appear 2.2-a: Field of temperature calculated on 1/8ème of the structure

2.3 Uncertainties on the solution

No significance in this case.
The goal of the case test is to check that the symmetry of the grid and that projections of the field of temperature are correctly made.

2.4 References bibliographical

Without use.

Code_Aster ®
Version
7.2

Titrate:
ZZZZ185 - Validation MODI_MAILLAGE/PROJ_CHAMP

Date:
01/01/04

3 Modeling
With

3.1
Characteristics of modeling

The goal of this modeling is to obtain the solution with the thermal problem starting from calculation carried out
on 1/8ème of the structure.
The case test proceeds the following way:

·
reading of the grid, 1/8ème of structure, starting from the file with the format "MED", order LIRE_MAILLAGE.
·
reading of the field of temperature starting from the file with format "MED", order LIRE_CHAMP.
·
creation of a result starting from the field previously read, order CREA_RESU.
·
creation of a model starting from the grid previously read, order AFFE_MODELE.

·
creation of a model for the groups of meshs which belong to the symmetry plane,
order AFFE_MODELE (cf notices n°1).

·
reading of the grid, 1/8ème of structure, starting from the file with the format "MED" and modification of
grid by symmetry compared to the plan (sym) defined by:
AXE_1 = (1.0, 1.0, 0.0), AXE_2 = (0.0, 0.0, -1.0), NOT = (0.0, 0.0, 0.0)
orders LIRE_MAILLAGE and MODI_MAILLAGE.
·
reading of the field of temperature starting from the file with format "MED", order LIRE_CHAMP.
·
creation of a result starting from the field previously read, order CREA_RESU.

·

creation of a model starting from the symmetrical grid, orders AFFE_MODELE.

·

reading of the grid accounting for 1/4 of the structure, orders LIRE_MAILLAGE.

·

creation of a model starting from the grid previously read, order AFFE_MODELE.

·

projection of the 3 results created starting from the solution calculated on 1/8ème of structure, order PROJ_CHAMP with key word DISTANCE_MAX.

·

extraction of the fields of temperature of the 3 results resulting from projection, orders CREA_CHAMP.

·

creation of a null field on the model built on 1/4 of the structure, orders CREA_CHAMP (cf notices n°2).

·

combination of all the fields, orders COMB_CHAM_NO.

·

creation of a result starting from the combination of the fields, CREA_RESU.

Notice n°1:

In this case test, nodes of the grid, [Figure 3.2-a], belong to the symmetry plane (sym). For these nodes, the projection of the field of temperature will thus be entered 2 times. To avoid once cumulating the field of temperature of too, a solution is to create one model containing only these nodes and to carry out projection on the complete grid. This projected field will be then withdrawn using order COMB_CHAM_NO.

Notice n°2:

The projection of the fields using order PROJ_CHAMP and the key word DISTANCE_MAX makes it possible not to create a field on the nodes which are not contained in one of the elements of the initial grid and which are at a distance higher than DISTANCE_MAX of the element nearest. When one combines fields using order COMB_CHAM_NO, it is the first field with the nodes which is taken as reference. If the field is incomplete, as in our case, the combination does not go to give the anticipated result. The solution is thus to create a null field on all the model and to make use of it like reference field.

3.2
Characteristics of the grid

The projection of the field of temperature calculated on 1/8ème of structure (grid of [Figure 1.1-a]) is projected on the model built starting from the grid of the 1/4 of structure [Figure 3.2-a]).

Z

Y
sym
Z
sym
X
X

Appear 3.2-a: Grid of the 1/4 of the structure

3.3 Functionalities
tested

Orders

LIRE_MAILLAGE
FORMAT= " MED "

IMPR_RESU
FORMAT= " MED "

LIRE_CHAMP
FORMAT= " MED "

CREA_RESU
OPERATION= " AFFE " TYPE_RESU= " EVOL_THER "
CREA_CHAMP
OPERATION= " EXTR " TYPE_CHAM= " NOEU_TEMP_R "
MODI_MAILLAGE
SYMMETRY
NOT, AXE_1, AXE_2
PROJ_CHAMP
METHODE= " ELEM "
DISTANCE_MAX
COMB_CHAM_NO COMB_R

3.4
Sizes tested and results

The test is carried out on the field of temperature.
Result obtained by projection and combination on 1/4 of structure is extracted the field from temperature TEMP1. Result calculated on 1/4 of structure is extracted the 2nd field from temperature TEMP2. These 2 fields are withdrawn using order COMB_CHAM_NO, and the test is carried out on the maximum and minimal value of the resulting field. In all points of the structure, one must have TEMP1 = TEMP2, the field resulting from order COMB_CHAM_NO must thus be null in all

points.

Values tested
Reference
Code_Aster
Precision
Max 0.0
2.694E-05
1.0E-4
Min 0.0
-1.808E-05
1.0E-4

[Figure 3.4-a] the chart of the differences between the two fields of temperature obtained gives at the time
this case test.

Appear 3.4-a: Chart of the differences in temperature

---

4 Summary of the results

This case test makes it possible to validate:

.

order MODI_MAILLAGE associated with the key word SYMMETRY,
.
order PROJ_CHAMP associated with key word DISTANCE_MAX.

The validation is done on all the field of temperature and not only on some points.

When the 2 orders are associated, it should be held account owing to the fact that the fields supported by nodes which belong to the symmetry plane can be entered 2 times.

During the combination of the fields using the order COMB_CHAM_NO, it is the structure of first CHAM_NO which is used as structure of reference. If the structure is incomplete, it is thus necessary to create
a CHAM_NO of reference.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.188

SENSD08 - Sensitivity of modes suitable for parameter material

Summary:

This case test corresponds to a modal calculation of a beam with supported supported rectangular section. One calculates
the derivative of the Eigen frequencies and the clean deformations compared to the Young modulus.

The functionality tested is the derivation of the Eigen frequencies and the clean deformations. One also tests
the derivative of the clean deformations following a modification of the standard of the modes.

The results of reference are obtained in an analytical way.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/04/005/A

Code_Aster ®
Version
7.3

Titrate:
SENSD08 - Sensitivity of the modes suitable for the parameter material
Date:
14/10/04
Author (S):
Key ***H. ANDRIAMBOLOLONA***
:
V1.01.188-A Page:
2/8

1
Problem of reference

1.1 Geometry

L

B

Z

y
H

X

L: 0.4 m
b: 0.02 m
H: 0.01 m

1.2
Properties of material

E = 2.1 1011 Pa

= 0.3

= 7800 kg/m3

Viscous damping, matrix of damping: K + M, with = 10-4 S and = 10-4 s-1

1.3
Boundary conditions and loadings

Displacements of the nodes located on the left edge of co-ordinates X = 0 m, Z = 0.005 m are blocked according to X, y and Z.
Displacements of the nodes located on the flat rim of co-ordinates X = 0.4 m, Z = 0.005 m are

blocked according to X, y and Z.

1.4 Conditions initial

No initial condition is applied to the structure.

---

2 Reference solution

2.1 Method of calculation

In the case of a supported supported beam, the Eigen frequency of the mode of inflection number I express yourself in the following way [bib1]:

I
2
I.E.(internal excitation)
F =

I
2L2
S

With:
L: length of the beam

E: Young modulus

I: quadratic moment of inertia compared to the bending axis

: density

S: section of the beam

The clean deformation of mode I is given by the following relation:
ix
y = sin

I

L
One can thus obtain in an analytical way the derivative of the Eigen frequency and clean deformation compared to a given parameter.

2.2 Sizes and results of reference

The values of reference are obtained analytically.

3
bh
For our case: I =
and: S = bh
12
The derivative of the Eigen frequency compared to the Young modulus E, is thus given by the relation following:

F

I
2
H2
I =

E

4L2 12th

And the clean deformation does not depend on the Young modulus.

yi = 0
E

2.3 Uncertainties

The reference solution is obtained analytically.

2.4 Reference bibliographical

[1] Formulated for natural frequency and shape mode. Robert D. Blevins Ph.D. Krieger.

---

3 Modeling With

3.1 Characteristics of modeling

One considers in this modeling modal calculation by simultaneous iterations, with and without catch in count matrix of damping. One calculates then the derivative of the clean modes by report/ratio with the Young modulus of material constituting the beam.

The beam was modelled in voluminal finite elements.

Boundary conditions: the central nodes (Z = h/2) of the faces left and right-hand side are blocked according to
X, y and Z.

Parameters of calculation:
Modal calculation carried out by the operator: MODE_ITER_SIMULT
Standardization of the clean deformations by: NORM_MODE

3.2 Characteristic of the grid

Numbers and type of meshs: 10 elements of the type HEXA20.

3.3 Functionalities tested

The functionalities tested are the Eigen frequencies resulting from a modal calculation by the method simultaneous iterations, the derivation of the Eigen frequencies and deformations clean by report/ratio with the Young modulus.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_SIMULT SENSITIVITY

NORM_MODE SENSITIVITY

TEST_RESU SENSITIVITY

3.4 Sizes tested and results

The values of reference are calculated for the first and the second mode of the system.

3.4.1 Without taking into account of the matrix of damping (real modes)

Eigen frequencies:

Number of the mode
Reference
Aster *Difference*
(%)
1
147.05 Hz
147.31 Hz
0.17
2
588.21 Hz
592.35 Hz
0.70

Derived from the Eigen frequencies compared to E:

Number of the mode
Reference
Aster *Difference*
(%)
1 3.50
10-10 Hz/Pa
3.51 1010 Hz/Pa
0.17
2 1.40
10-9 Hz/Pa
1.41 109 Hz/Pa
0.70
Handbook of Validation
V1.01 booklet: Tests of validity of orders
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Code_Aster ®
Version
7.3

Titrate:
SENSD08 - Sensitivity of the modes suitable for the parameter material
Date:

Derived from the modal deformation of the central node (N6) compared to E:

Number of the mode
Mode normalizes
Reference
Aster
1 (*)
0
2.01
10-24
2 (*)
0
-9.34
10-24
1
MASS_GENE
0 3.60
10-24
2
MASS_GENE
0 -1.67
10-23

(*): absolute value of the largest component not multiplier of Lagrange equalizes to 1.

3.4.2 Taking into account of the matrix of damping (complex modes)

Eigen frequencies:

Number of the mode
Reference
Aster *Difference*
(%)
1
147.05 Hz

147.31 Hz
0.17
2
588.21 Hz
592.35 Hz
0.70

Derived from the Eigen frequencies compared to E:

Number of the mode
Reference
Aster *Difference*
(%)
1 3.50
10-10 Hz/Pa
3.51 1010 Hz/Pa
0.17
2 1.40
10-9 Hz/Pa
1.41 109 Hz/Pa
0.70

Derived from the modal deformation of the central node (N6) compared to E:

Number of the mode
Mode normalizes
Reference
Aster
1 (*)
0
8.49
1024 - I 5.70 10-27
2 (*)
0
-4.90
1023 + I 5.43 10-25
1
MASS_GENE
0 2.50
1025 I 1.68 10-28
2
MASS_GENE
0 -7.19
1025 + I 7.97 10-27

(*): modulate larger component not multiplier of Lagrange equalizes to 1.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/04/005/A

---

4 Modeling B

4.1 Characteristics of modeling

One considers in this modeling a modal calculation by opposite iteration, with and without catch in count matrix of damping. One calculates then the derivative of the clean modes by report/ratio with the Young modulus of material constituting the beam.

The beam was modelled in voluminal finite elements.

Boundary conditions: the central nodes (Z = h/2) of the faces left and right-hand side are blocked according to
X, y and Z.

Parameters of calculation:
Modal calculation carried out by the operator: MODE_ITER_INV
Standardization of the clean deformations by: NORM_MODE

4.2 Characteristics of the grid

Numbers and type of meshs: 10 elements of the type HEXA20.

4.3 Functionalities tested

The functionalities tested are the Eigen frequencies resulting from a modal calculation by the method iterations opposite, the derivation of the Eigen frequencies and deformations clean compared to Young modulus.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_INV SENSITIVITY

NORM_MODE SENSITIVITY

TEST_RESU SENSITIVITY

4.4 Sizes tested and results

The values of reference are calculated for the first and the second mode of the system.

4.4.1 Without taking into account of the matrix of damping (real modes)

Eigen frequencies:

Number of the mode	***Reference***	***Aster***	*Difference* ***(%)***
1	*147.05 Hz*	*147.31 Hz*	*0.17*
2	*588.21 Hz*	*592.35 Hz*	*0.70*

Derived from the Eigen frequencies compared to E:

Number of the mode
Reference
Aster *Difference*
(%)
1 3.50
10-10 Hz/Pa
3.51 1010 Hz/Pa
0.17
2 1.40
10-9 Hz/Pa
1.41 109 Hz/Pa
0.70

Derived from the modal deformation of the central node (N6) compared to E:

Number of the mode
Mode normalizes
Reference
Aster
1 (*) 0 -2.26
10-16
2 (*) 0 -5.66
10-15
1
MASS_GENE

0 -4.05
10-16
2
MASS_GENE
0 -1.01
10-14

(*): absolute value of the largest component not multiplier of Lagrange equalizes to 1.

4.4.2 Taking into account of the matrix of damping (complex modes)

Eigen frequencies:

Number of the mode
Reference
Aster *Difference*
(%)
1
147.05 Hz
147.31 Hz
0.17
2
588.21 Hz
592.35 Hz
0.70

Derived from the Eigen frequencies compared to E:

Number of the mode
Reference
Aster *Difference*
(%)
1 3.50
10-10 Hz/Pa
3.51 1010 Hz/Pa
0.17
2 1.40
10-9 Hz/Pa
1.41 109 Hz/Pa
0.70

Derived from the modal deformation of the central node (N6) compared to E:

Number of the mode

Mode normalizes
Reference
Aster
1 (*) 0
3.20
1015 - I 6.76 10-16
2 (*) 0
-2.38
1014 - I 9.65 10-15
1
MASS_GENE
0 9.42
1017 I 1.99 10-17
2
MASS_GENE
0 -3.50
1016 I 1.42 10-16

(*): modulate larger component not multiplier of Lagrange equalizes to 1.

5
Summary of the results

The precision relative of derived from each Eigen frequency compared to the Young modulus is lower than 1% of the theoretical solution. The precision on the derivative of the clean deformation is

lower than 10-14 in absolute value.
The precision of the results depends obviously on the discretization in finite elements. Here, us modelled the beam in 10 parabolic elements. This discretization is reasonable and precision obtained on the first Eigen frequencies is acceptable.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/04/005/A

Code_Aster ®
Version
8.1

Titrate:
ZZZZ189 circumferential Orientation by a loop Python
Date:
22/07/05
Author (S):
NR. TARDIEU *Key*
:
V1.01.189-A Page:
1/4

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.189

ZZZZ189 circumferential Orientation by one

buckle Python

Summary:

In the case of the modeling of a hemisphere or a dome, it is delicate to direct circonférentiellement elements in AFFE_CARA_ELEM [U4.42.01]. One proposes a Python function which allows simply to carry out this action.
One treats the case of a concrete hemisphere with reinforcements under pressure in linear elasticity. One seeks with
to direct the reinforcements circonférentiellement.

1
Problem of reference

1.1 Geometry

Z
Z
C
C
y

B
B
y
With
With
X
X

Ray
R = 10. m
Thickness
T = 0.04

Co-ordinates of the points:

With
B
C
X 10.
0.
0.
y 0.
10.
0.
Z 0.
0.
10.

1.2
Material properties

The hemisphere made up of concrete is reinforced by grids. As the objective is only of to test orders, one gives the same properties to the concrete and the grids.

E = 200000 Pa, = 0.3

1.3
Boundary conditions and loadings

On a quarter of the hemisphere:

Not C

no displacement in Z
Side AC
symmetry compared to the xz plan
Side BC
symmetry compared to the yz plan
Side AB
free

Internal pressure: P=10. Pa

1.4 Problems of orientation

It is wanted that the grids of reinforcement are directed circonférentiellement. However, seen the form hemispherical considered, one cannot impose this orientation by AFFE_CARA_ELEM in the state current of the code. One thus proposes a Python function allowing it.

The principle is as follows:

- *the axis of the hemisphere is Z*
- *for each mesh, one calculates the vector indicating the ciconférentielle direction by V=Z^N where NR is the normal with the mesh. One notes V= [Vx, Vy, Vz] and one defines his projection on plan (XOY) by W= [Vx, Vy, 0]*
- *one calculates the values of ANGL_REP to be assigned to the current mesh by =arctan (Vy/Vx) and*

=arctan (Vz/norm (W))

Function called LIST_CARA_CIRCONF buckles on all the meshs roasts, calculates and and creates key words:

_F (SECTION=20.0,
MAILLE=Nom_Maille_Courante,
EXCENTREMENT=0.0,
ANGL_REP= (,)),
GRILLE_NCOU=1,
COEF_RIGI_DRZ=1.E-10),

and it adds them in a list. One provides then this list to AFFE_CARA_ELEM. They are thus obtained orders:

LIST_GRI=LIST_CARA_CIRCONF (GROUP_MA=' GRILLE',
AXE= (0. , 0. , 1.),
MODELE=MODEL,
GRILLE=_F (SECTION=20., EXCENTREMENT=0.,));

CARA_COQ=AFFE_CARA_ELEM (MODELE=MODEL,
COEF_RIGI_DRZ=0.,),
GRILLE=LIST_GRI,

);

Let us note finally that, formally, LIST_CARA_CIRCONF obeys the following catalogue:

LIST_CARA_CIRCONF
(
GROUP_MA
*=SIMP (statut=' o', typ=grma, max=' ** '),*

CENTER =SIMP (statut=' o', typ=' R', max=3, min=3),
MODEL
=SIMP (statut=' o', typ=modele_sdaster
),
ROAST
=FACT (statut=' f', max=1,
SECTION =SIMP (statut=' o', typ=' R'),
OFFSETTING
=SIMP (statut=' f', typ=' R'),
COEF_RIGI_DRZ
=SIMP (statut=' f', typ=' R'),
GRILLE_NCOU
=SIMP (statut=' f', typ=' I'),

),

);

***2 Modeling
With***

***2.1
Characteristics of modeling***

***1373 elements of hull DKT
1373 elements of grid GRILLE_MEMBRANE***

Modeling of a quarter of the hemisphere in TRIA3.

***2.2
Characteristics of the grid***

***A number of nodes: 734
A number of meshs and types: 2746 TRIA3***

***2.3 Functionalities
tested***

Test of functionality Python within a command file.

***3
Results of modeling A***

***3.1 Values
tested***

One tests values of not-regression calculated with the V7.03.30 version.

***Identification
Aster
Node 30
0
displacement DX
Node 30
3.13928853337581E-05
displacement DY
Node 30
1.53564292393 44E-05
displacement DZ***

Node 700
4.4873398127688E-06
displacement DX
Node 700
3.3210448836551E-05
displacement DY
Node 700
1.5155123546576E-05
displacement DZ

4
Summary of the results

This test presents a advanced use of the Python language within Code_Aster.
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.205

ZZZZ205 Calculation of the kinetic energy of one rectangular plate

Summary:

This case test is intended to validate the calculation of the kinetic energy for modelings 2D solid masses.

Only one modeling is carried out:

Modeling A made up of meshs QUAD4 and TRIA3.

1

Problem of reference

1.1 Geometry

Y
0.35
X
0.25
0.3
0.45

1.2
Properties of material

· Acier
E = 2x1011 MPa
- = 0.3
= 7800 kg/m3

1.3
Boundary conditions

1
Calculation of the kinetic energy starting from speed E = V T MV:
C
2
· One imposes a uniform speed:
with t=1s: according to X of 1.5 m/s
with t=2s: according to X of 1.5 m/s and following Y of 2.5 m/s

1.4 Conditions
initial

None.

8.1

Titrate:
ZZZZ205 Calculation of the kinetic energy of a rectangular plate
Date:
02/11/05
Author (S):
X. DESROCHES, F. LEBOUVIER Key
:
V1.01.205-A Page:
3/4

2
Reference solution

2.1
Method of calculation

The analytical solution is presented below:

Calculation of the kinetic energy starting from speed

1
E = V T MV
C
2

2.2
Sizes and results of reference

Sizes Values
Unit
Mass
2.0475x103 kg
E (T = 1s)
C
2.3034375x103 W
E (T = 2s)
C
8.70187 x103 W

Handbook of Validation
V1.01 booklet: Tests of validity of orders

HT-66/05/005/A

---

3 Modeling With

3.1 Characteristics of modeling

3.2 Characteristics of the grid

A number of meshs: 541 (320 TRIA3, 221 QUAD4)
A number of nodes: 423

3.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE AFFE
PHENOMENON
"MECHANICAL"
MODELING
"D_PLAN"
POST_ELEM MASSE_TOT

ENER_CIN

3.4
Sizes tested and results

Identification
Size Reference Aster
% Difference
Mass
TOTAL 2.0475x103 2.0475x103 -2.33
x10-13
Kinetic energy
TOTAL
2.30344 x103 2.30344
x103 -1.09
x10-4
(t=1)
Kinetic energy
TOTAL
8.70187 x103 8.70187
x103 5.75
x10-5
(t=2)

4
Summary of the results

This test makes it possible to validate the calculation of the kinetic energy for modeling D_PLAN.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.207

SENSD09 - Sensitivity of clean modes of one beam POU_D_E compared to the parameters material

Summary

This case test validates the derivation of element POU_D_E compared to the parameters material (Young modulus and Poisson's ratio). One calculates the clean modes, like their derivative compared to E and, of one beam with supported circular section "supported" in inflection and "embedded embedded" in torsion.

The results of reference are obtained in an analytical way.

1
Problem of reference

1.1 Geometry

L

R

Z

y

X

L: 0.4 m
R: 0.01 m

1.2
Properties of material

E = 2.1 1011 Pa

= 0.3

= 7800 kg/m3

Viscous damping, matrix of damping: K + M, with = 10-6 S and = 10-6 s-1

1.3
Boundary conditions and loadings

Displacements following y and rotations around Z are blocked.
Displacements according to X and Z, as well as rotation around the axis of the beam (axis X) of the nodes
located at the ends of the beam are blocked.

1.4 Conditions
initial

No initial condition is applied to the structure.

2
Reference solution

2.1
Method of calculation

At the same time the modes of inflection and the modes of torsion are considered.

2.1.1 Mode of inflection

In the case of a supported supported beam, the Eigen frequency of the mode of inflection number I express yourself in the following way [bib1]:

I
2
I.E.(internal excitation)
F =

I
2L2
S

With:
L: length
beam

of

E: modulate
Young
I
: moment of

quadratiqu

inertia
by

E

with

report/ratio

inflection

of

center

:
voluminal

mass
S:
beam

of

section

In the case of a beam with circular section of ray R, one obtains:

I
2 R E
F =

I
4L2

The clean deformation of the mode of inflection number I is given by the following relation:

I X

Z = sin

I

L

2.1.2 Mode of torsion

The Eigen frequency of the mode of torsion number I, an embedded fixed beam (in torsion), express yourself in the following way [bib1]:

I
CG
F =

I

2L
I
p

E
With: G
: modulate
cisailleme

of

NT (21+)
C
:
torsion

of

constant

I
: moment of

quadratiqu

inertia
by

E
report/ratio

with

torsion

of

center
p

In the case of a beam with circular section of ray R, one obtains:

F = I

E

I
2L 2 (1+)

The clean deformation of the mode of torsion number I is given by the following relation:

I X

= sin

I

L

One can thus obtain in an analytical way the derivative of the Eigen frequency and clean deformation compared to a given parameter.

2.2
Sizes and results of reference

With the geometrical characteristics and mechanics chosen, the first two modes of the beam are modes of inflection and the third clean mode corresponds to the first mode of torsion.

The derivative of the Eigen frequency of inflection are given by the following relations:

F

F
F
I
I
=
and
I = 0
E

2nd

The derivative of the Eigen frequency of torsion are given by the following relations:

F

F
F
F
I
I
=
and
I = -
I

E

2nd

(
2 1+)

The clean deformations depend neither on the Young modulus, nor of the Poisson's ratio.

Z

Z

I = 0
I = 0 and I = 0
I = 0

E
E

2.3 Uncertainties

The reference solution is obtained analytically.

2.4 Reference bibliographical

[1] Formulated for natural frequency and shape mode. Robert D. Blevins Ph.D. Krieger (1984).

---

3 Modeling With

3.1 Characteristics of modeling

One considers in this modeling modal calculation by opposite iteration. One calculates then them derived from the clean modes compared to the Young modulus and the Poisson's ratio material constituting the beam.

3.2
Characteristic of the grid

Numbers and type of meshs: 10 elements of the type POU_D_E.

3.3 Functionalities
tested

The functionalities tested are derivations of real clean modes resulting from a modal calculation by method of iteration opposite, compared to the Young modulus and the Poisson's ratio.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_INV SENSITIVITY

TEST_RESU SENSITIVITY

3.4
Sizes tested and results

The values of reference are calculated for the first three modes of the system.

Eigen frequencies:
Number of the mode
Reference
Aster *Difference*
(%)
1
509.4034 Hz
509.4073 Hz
7.59 10-4
2
2037.614 Hz
2037.833 Hz

0.011
3
4022.404 Hz
4038.965 Hz
0.412

Derived from the Eigen frequencies compared to E:
Number of the mode
Reference
***Aster** Difference*
(%)
1 1.21286
10-9
1.21287 109 Hz/Pa
7.59 10-4
Hz/Pa
2 4.85146
10-9
4.85198 109 Hz/Pa
0.011
Hz/Pa
3 9.57715
10-9
9.61658 109 Hz/Pa
0.412
Hz/Pa

Derived from the Eigen frequencies compared to:
Number of the mode
Reference
***Aster** Difference*
(%)
1
0.0 Hz
-2.71 1040 Hz
-
2
0.0 Hz
-1.24 1024 Hz
-
3 -1.5471
103 Hz

-1.5534 103 Hz
0.412

Derived from the modal deformation of the central node (GROUP_NO = MEDIUM) compared to E:
Number of the mode
Degree of freedom
Reference
Aster
1 DZ
0
6.069
10-21
3 DRX
0
-5.561
10-22

Derived from the modal deformation of the central node (GROUP_NO = MEDIUM) compared to:
Number of the mode
Degree of freedom
Reference
Aster
1 DZ
0

-1.405
10-33
3 DRX
0
8.983
10-11

4 Modeling B

4.1 Characteristics of modeling

One considers in this modeling a modal calculation by simultaneous iterations, with catch in count matrix of damping. One calculates then the derivative of the clean modes by report/ratio with the Young modulus and the Poisson's ratio of material constituting the beam.

4.2 Characteristics of the grid

Numbers and type of meshs: 10 elements of the type POU_D_E.

4.3 Functionalities tested

The functionalities tested are derivations of complex clean modes resulting from a modal calculation by the method of simultaneous iterations, compared to the Young modulus and the Poisson's ratio.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_SIMULT SENSITIVITY

TEST_RESU SENSITIVITY

4.4 Sizes tested and results

The values of reference are calculated for the first three modes of the beam.

Eigen frequencies:

Number of the mode	***Reference***	***Aster***	*Difference* ***(%)***
1	*509.4034 Hz*	*509.4066 Hz*	*6.31 10-4*
2	*2037.614 Hz*	*2037.792 Hz*	*0.009*
3	*4022.404 Hz*	*4038.640 Hz*	*0.404*

Derived from the Eigen frequencies compared to E:

Number of the mode
Reference
Aster *Difference*
(%)
1 1.21286
10-9
1.21287 109 Hz/Pa
7.59 10-4
Hz/Pa
2 4.85146
10-9
4.85198 109 Hz/Pa
0.011
Hz/Pa
3 9.57715
10-9
9.61658 10-9 Hz/Pa
0.412
Hz/Pa

Derived from the Eigen frequencies compared to:
Number of the mode
Reference
Aster *Difference*
(%)
1
0.0 Hz
-3.22 1036 Hz
-
2
0.0 Hz
-3.77 1031 Hz
-
3 -1.5471
103 Hz
-1.5534 103 Hz
0.412

Derived from the modal deformation of the central node (GROUP_NO = MEDIUM) compared to E:

Number of the mode	***Degree of freedom***	***Reference***	***Aster***
1	*DZ*	*0 + 0 I*	*6.07 1021 - I 9.71 1024*
3	*DRX*	*0 + 0 I*	*-5.57 1022 + I 7.09 1024*

Derived from the modal deformation of the central node (GROUP_NO = MEDIUM) compared to:

Number of the mode	***Degree of freedom***	***Reference***	***Aster***
1	*DZ*	*0 + 0 I*	*-5.80 1031 - I 9.48 1032*
3	*DRX*	*0 + 0 I*	*9.00 1011 - I 1.14 1012*

5 Summary of the results

Precision relative of derived from each Eigen frequency compared to the Young modulus or to Poisson's ratio is lower than 0.5% of the theoretical solution. Precision on the derivative of clean deformation is lower than 10-10 in absolute value.
The precision of the results depends obviously on the discretization in finite elements. Here, us modelled the beam in 10 elements POU_D_E. This discretization is reasonable and the precision obtained on the first Eigen frequencies is acceptable.

Handbook of Validation
V1.01 booklet: Tests of validity of orders
Document: V1.01.214

SENSD10 - Sensitivity of clean modes of one plate simply supported compared to parameters material

Summary

This case test validates the derivation of the elements plates planes isotropic (DKT, DSQ, Q4G, COQUE_3D) by report/ratio
with the parameters material (Young modulus and Poisson's ratio). One calculates the Eigen frequencies, thus
that their derivative compared to E and, of a rectangular plate simply pressed on its edges.

The results of reference are obtained in an analytical way.

---

1 Problem of reference

1.1 Geometry

B

X
has
y
Z

H

Width:
a: 0.2 m
Length:
b: 0.3 m
Thickness:
H: 0.001 m

1.2 Properties of material

Young modulus:

E = 2.1 1011 Pa
Poisson's ratio:
= 0.3
Density:
= 7800 kg/m3

1.3
Boundary conditions and loadings

Displacements according to X, y and Z on the edges of the plate are blocked.

1.4 Conditions
initial

No initial condition is applied to the structure.

2
Reference solution

2.1
Method of calculation

An isotropic homogeneous plate is considered and one calculates his first clean modes of inflection.

In the case of a plate simply pressed on its edges, the Eigen frequency of the mode of inflection number ij is expressed in the following way [bib1]:

=
H
fij
[2 2 2 2
B I + has
]
E
J

2 2
2a B
12(
2
1 -)

With:
I: belly of vibration numbers according to dimension has

J: belly of vibration numbers according to the Directorate B

E: Young modulus

: Poisson's ratio

H: thickness of the plate

: density

In the case where, the a/b report/ratio is equal to 2/3, the order of arrangement of the first Eigen frequencies
of inflection is as follows:
f11, f12, f21, f13, f22, f23,…

2.2
Sizes and results of reference

The derivative of the Eigen frequency of inflection are given by the following relations:

F

F

F
F
ij
ij
=
and:
ij =
ij

E

2nd
2

1-

2.3 Uncertainties

The reference solution is obtained analytically.

2.4 Reference bibliographical

[1]
Formulated for natural frequency and shape mode. Robert D. Blevins Ph.D. Krieger (1984).

---

3 Modeling With

3.1 Characteristics of modeling

One considers in this modeling a modal calculation of the plate modelled by elements DKT.
One calculates then the derivative of the clean modes compared to the Young modulus and compared to Poisson's ratio of material constituting the plate.

3.2 Characteristic of the grid

Numbers and type of meshs: 192 elements of the type TRIA3.

3.3 Functionalities tested

The functionalities tested are derivations of real clean modes of plate (DKT) resulting from one modal calculation by the method of simultaneous iterations, compared to the Young modulus and the coefficient of Poisson.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_SIMULT SENSITIVITY

TEST_RESU SENSITIVITY

3.4

Sizes tested and results

The values of reference are calculated for the first three modes of the plate.

Eigen frequencies:
Number of the mode
Reference
Aster *Difference*
(%)
1
89.0659 Hz
88.7199 Hz
0.388
2
171.280 Hz
170.004 Hz
0.745
3
274.049 Hz
272.288 Hz
0.643

Derived from the Eigen frequencies compared to E:
Number of the mode
Reference
Aster *Difference*
(%)
1 2.1206
10-10 Hz/Pa
2.1124 1010 Hz/Pa
0.388
2 4.0781
10-10 Hz/Pa
4.0477 1010 Hz/Pa
0.745
3 6.5250
10-10 Hz/Pa
6.4830 1010 Hz/Pa
0.643

Derived from the Eigen frequencies compared to:
Number of the mode

Reference
Aster *Difference*
(%)
1
29.3624 Hz
29.1626 Hz
0.680
2
56.4661 Hz
55.7189 Hz
1.323
3
90.3458 Hz
89.0907 Hz
1.389

---

4 Modeling B

4.1 Characteristics of modeling

One considers a modal calculation of the plate modelled by elements DSQ. One calculates then them derived from the clean modes compared to the Young modulus and the Poisson's ratio *material constituting the plate.*

4.2
Characteristics of the grid

Numbers and type of meshs: 96 elements of the type QUAD4.

4.3 Functionalities
tested

The functionalities tested are derivations of real clean modes of plate (DSQ) resulting from one modal calculation by the method of simultaneous iterations, compared to the Young modulus and the coefficient
of Poisson.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_SIMULT SENSITIVITY

TEST_RESU SENSITIVITY

4.4
Sizes tested and results

The values of reference are calculated for the first three modes of the beam.

Eigen frequencies:
Number of the mode
Reference
Aster *Difference*
(%)
1
89.0659 Hz
88.4294 Hz
0.715

2
171.280 Hz
168.774 Hz
1.463
3
274.049 Hz
271.592 Hz
0.897

Derived from the Eigen frequencies compared to E:
Number of the mode
Reference
***Aster** Difference*
(%)
1 2.1206
10-10 Hz/Pa
2.1055 1010 Hz/Pa
0.715
2 4.0781
10-10 Hz/Pa
4.0184 1010 Hz/Pa
1.463
3 6.5250
10-10 Hz/Pa
6.4665 1010 Hz/Pa
0.897

Derived from the Eigen frequencies compared to:
Number of the mode
Reference
***Aster** Difference*
(%)
1
29.3624 Hz
29.0709 Hz
0.993
2
56.4661 Hz
55.3148 Hz
2.039
3
90.3458 Hz

89.2520 Hz
1.211
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

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5 Modeling C

5.1 Characteristics of modeling

One considers a modal calculation of the plate modelled by elements Q4G. One calculates then them derived from the clean modes compared to the Young modulus and the Poisson's ratio material constituting the plate.

5.2 Characteristic of the grid

Numbers and type of meshs: 96 elements of the type QUAD4.

5.3 Functionalities tested

The functionalities tested are derivations of real clean modes of plate (Q4G) resulting from one modal calculation by the method of simultaneous iterations, compared to the Young modulus and the coefficient *of Poisson.*

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_SIMULT SENSITIVITY

TEST_RESU SENSITIVITY

5.4
Sizes tested and results

The values of reference are calculated for the first three modes of the plate.

Eigen frequencies:

Number of the mode	Reference	Aster	Difference (%)
1	89.0659 Hz	88.7167 Hz	0.392
2	171.280 Hz	169.663 Hz	0.944
3	274.049 Hz	277.358 Hz	1.208

Derived from the Eigen frequencies compared to E:

Number of the mode
Reference
Aster *Difference*

(%)
1 2.1206
10-10 Hz/Pa
2.1123 1010 Hz/Pa
0.392
2 4.0781
10-10 Hz/Pa
4.0396 1010 Hz/Pa
0.944
3 6.5250
10-10 Hz/Pa
6.6038 1010 Hz/Pa
1.208

Derived from the Eigen frequencies compared to:
Number of the mode
Reference
***Aster** Difference*
(%)
1
29.3624 Hz
29.1611 Hz
0.686
2
56.4661 Hz
55.5716 Hz
1.584
3
90.3458 Hz
91.0203 Hz
0.747
Handbook of Validation
V1.01 booklet: Tests of validity of orders
HT-66/05/005/A

***Code_Aster** ®*
Version
8.2

Titrate:
SENSD10 - Sensitivity of clean modes of a plate

Date:

6 Modeling D

6.1 Characteristics of modeling

One considers a modal calculation of the plate modelled by elements COQUE_3D. They are calculated derived from the first clean mode compared to the Young modulus and the coefficient from Poisson of material constituting the plate. For this modeling, we introduced one viscous damping proportional in the mechanical characteristics of constituent material the plate (AMOR_ALPHA = 10-6 S, AMOR_BETA = 10-6 s-1).

6.2 Characteristic of the grid

Numbers and type of meshs: 24 elements of the type QUAD9.

6.3 Functionalities tested

The functionalities tested are derivations of clean mode complexes hull (COQUE_3D) resulting from a modal calculation by the method of simultaneous iterations, compared to the Young modulus and with Poisson's ratio.

Orders

DEFI_PARA_SENSI VALE

MODE_ITER_SIMULT SENSITIVITY

TEST_RESU SENSITIVITY

6.4
Sizes tested and results

The values of reference are calculated for the first mode of the plate.

Eigen frequency:
Number of the mode
Reference
***Aster** Difference*
(%)
1
89.0659 Hz
88.33472 Hz
0.807

Derived from the first Eigen frequency compared to E:
Number of the mode
Reference
***Aster** Difference*
(%)
1 2.1206
10-10 Hz/Pa
2.1035 1010 Hz/Pa
0.807

Derived from the first Eigen frequency compared to:
Number of the mode
Reference
***Aster** Difference*
(%)
1
29.3624 Hz
30.3057 Hz
3.213

7 *Summary of the results*

The relative precision on the derivative of each Eigen frequency compared to the Young modulus is lower than 2% of the theoretical solution for various modelings of the plate. For derivation compared to the Poisson's ratio, the precision is lower than 4% of the solution theoretical.
The precision of the results depends obviously on the discretization in finite elements and on assumptions of plane constraint, small deformation and small displacement.
Here, we chose a discretization corresponding to 8 finite elements by wavelength of vibration. This discretization is certainly rather coarse, but it makes it possible nevertheless to obtain one solution acceptable for the derivative of the first three Eigen frequencies of the plate.

Organization (S): EDF-R & D /SINETICS

Handbook of Validation
V1.04 booklet: -
Document: V1.04.101

FETI001 Validation of the basic architecture of one calculation FETI

Summary:

This case-test validates the not-regression of the basic commands of a calculation FETI in linear mechanics:
manual partitioning and sequential calculation multidomaine without rigid mode of body and Dirichlet or
loading being based on late meshs or nodes. It is a question of making sure that insertions of
order DEFI_PART_OPS and key word SOLVEUR+METHODE=' FETI' in MECA_STATIQUE remains
operational.
One checks the algorithmic one thus (factorization symbolic system with the iterative resolution) and the management of
structures of encapsulated data (NUME_DDL, CHAM_NO, MATR_ASSE…) specific to FETI.
For that one studies a calculation in linear elasticity on a plate 2D not aligned with the principal axes,
subjected to a constant and not blocked pressure. The inversion of the local matrices of rigidity

remains possible
fact of the addition of ad hoc mesh-point. The initial field division in four parts is
completely given in order to generate homogeneous under-fields sharing a node of junction of
multiplicity 4.

1
Problem of reference

The geometry on which one will affect materials and loadings does not correspond to any
real case. It is here only about one functional, numerical validation and of data-processing not-
regression
of a basic calculation FETI in linear mechanics: manual partitioning and calculation multidomaine
sequential without rigid mode of body and Dirichlet or loading being pressed on meshs or
late nodes.

1.1 Geometry

E

D

F

With

Y
B

P

P'
C

O
X

Appear 1.1-a: Geometry and loading

Mesh-point
The structural features are: AC=CD=ED=AE=5mm, AB=BC, AF=FD=FE=FC.

1.2
Material properties

The characteristics materials are homogeneous in all the geometry: E=180000 Mpa and =0.3.

1.3
Boundary conditions and loadings

Imposed normal constant pressure:

P=1000 Mpa on [A, B]
P'=2000 Mpa on [B, C]

Particular blockings of the substructures by addition of elementary matrices of rigidity to

mesh-point.

2
Reference solutions

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution. Calculations FETI are validated by comparison with the results of the multifrontale.

2.2
Uncertainty on the solutions

Convergence of the grid and parameter of control of the test of stop of FETI (RESI_RELA).

---

3 Modeling With

3.1 Characteristics of modeling

N9
N15
SD2:
FETI2
N1
N8
N11
N14
N16
SD3:
FETI3
N2
N3
N10
N7
N12
SD1:
N17
FETI1
N18
N4
N5
N13

SD4:
FETI4
N19
N6

Appear 3.1-a: Division of the square in four pennies fields

Mesh-point corresponding to finite elements DISCRETE

(modeling 2D SAY T)

Co-ordinates of some points:
N1= {5.5, 5}, N2= {7,3}, N3= {3.5, 3.5}, N4= {5,1.5}, N5= {1.5, 2}, N6= {3,0}, N7= {0,4}, N8= {2,5.5}, N9= {4,7}…
The interface with direction FETI of the term thus relates to DDLs of the nodes: N1, N3, N4, N5, N8, N16 and
N17. These nodes are all multiplicity 2, except N3, of multiplicity 4.
The grid is composed of 24 TRIA3 and 4 SEG2 associated with usual modeling 2D_PLAN with MECHANICAL phenomenon (GROUP_MA=STRU). One there assistant 8 discrete finite elements (modeling
2D_DIS_T, GROUP_MA=RES) which will be able to contribute to the local matrices of rigidity to each under-fields and to make them invertible even if the substructures are not blocked. Via

AFFE_CARA_ELEM one thus adds elementary matrices of rigidity of the type:

E 0

0 E

Calculation FETI is sequential, it is pressed on the preconditionnor lumpé with scaling by nodal multiplicity and on a total reorthogonalisation of the directions of descent via a GSM. For to obtain a relative residue lower than 10-10, 18 iterations are necessary. The local solvor is multifrontale with its default settings.

3.2 Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

3.3 Functionalities tested

Orders

DEFI/AFFE_MATERIAU ELAS

AFFE_CHAR_MECA PRESS_REP

MECHANICAL AFFE_MODELE D_PLAN

MECHANICS
2D_DIS_PLAN

AFFE_CARA_ELEM DISCRET_2D

DEFI_PART_OPS

4
Results of modeling A

4.1 Values
tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of
grid. The relative tolerance is thus severe: 1.10- 8%.

Values
Ux
Uy
tested
multi
FETI Variation
multi
FETI Variation
frontal

relative
frontal
relative
(in %)
(in %)
N1
4.063 10-3 4.063
10-3 1.2
10-12 3.512
10-3 3.512 10-3 1.
10-13
N2
1.958 10-3 1.958
10-3 9.
10-13 6.472
10-4 6.472 10-4 -9
10-13
N3
6.573 10-3 6.573
10-3 3
10-13 5.724
10-3 5.724 10-3 -1
10-13
N4
7.446 10-3 7.446
10-3 -4
10-14 2.484
10-3 2.484 10-3 6.
10-13
N5
1.579 10-2 1.579
10-2 2.0
10-12 1.175
10-2 1.175 10-2 1.4
10-12
N6
6.094 10-3 6.094
10-3 5
10-14 4.458
10-3 4.458 10-3 0
N7
3.443 10-3 3.443
10-3 -3

10-14 2.326
10-3 2.326 10-3 -1.2
10-12
N8
2.732 10-3 2.732
10-3 5
10-13 5.815
10-3 5.815 10-3 5
10-13
N9
8.751 10-3 8.751
10-3 3
10-13 1.716
10-3 1.716 10-3 -2
10-13
N10
4.411 10-3 4.411
10-3 0 2.983
10-3 2.983 10-3 -2.
10-13
N11
2.928 10-3 2.928
10-3 9
10-13 3.626
10-3 3.626 10-3 -1.1
10-12
N12
5.0848 10-3 5.0848
10-3 8.
10-13 6.947
10-3 6.947 10-3 6.
10-14
N13
9.773 10-3 9.773
10-3 4.
10-13 4.893
10-3 4.893 10-3 6.
10-13
N14
2.630 10-3 2.630
10-3 4.
10-13 1.539
10-3 1.539 10-3 -1.1.

10-12
N15
1.710 10-3 1.710
10-3 -2.5
10-12 2.179
10-3 2.179 10-3 -1.6.
10-12
N16
4.150 10-3 4.150
10-3 2.
10-13 5.393
10-3 5.393 10-3 -6.
10-14
N17
7.013 10-3 7.013
10-3 -5.
10-13 4.056
10-3 4.056 10-3 -1.3
10-12
N18
7.099 10-3 7.099
10-3 -5.
10-13 4.313
10-3 4.313 10-3 7.
10-13
N19
9.521 10-3 9.521
10-3 2.
10-13 7.817
10-3 7.817 10-3 8.
10-14

5
Summary of the results

One checks the good adequacy of the results, the variations are close to the precision machine.

8.1

Titrate:
FETI002 - Validation of the basic architecture of a calculation FETI
Date:
02/11/05
Author (S):
***O. BOITEAU** Key*
:
V1.04.102-A Page:
1/6

Organization (S): EDF-R & D /SINETICS

Handbook of Validation
V1.04 booklet: -
Document: V1.04.102

FETI002 Validation of the basic architecture of one calculation FETI with rigid modes

Summary:

This case-test validates the not-regression of the basic commands of a calculation FETI in linear mechanics:
manual partitioning and sequential calculation multidomaine with rigid modes of body and without Dirichlet or

loading being based on late meshs or nodes. It is a question of making sure that insertions of order DEFI_PART_OPS and key word SOLVEUR+METHODE=' FETI' in MECA_STATIQUE remains operational within this framework.

One checks the algorithmic one thus (factorization symbolic system with the iterative resolution) and the management of structures of encapsulated data (NUME_DDL, CHAM_NO, MATR_ASSE…) specific to FETI when some under-fields are floating.

For that one studies a calculation in linear elasticity on a plate 2D not aligned with the principal axes, subjected to a constant and not blocked pressure. The inversion of the local matrices of rigidity remains possible fact of the addition of ad hoc mesh-points. The initial field division in four parts is completely given in order to generate homogeneous under-fields sharing a node of junction of multiplicity 4 and to control their possible rigid modes.

1
Problem of reference

One is based here on the geometry of case-test FETI001. It does not correspond to any real case. It does not act here that of a functional, numerical validation and of data-processing not-regression of a calculation FETI basic in linear mechanics: manual partitioning and sequential calculation multidomaine with rigid modes of body and without Dirichlet or loading being based on meshs or nodes late.

To make floating of the under-fields initially blocked with FETI001, it is enough to associate elementary matrices of null rigidity at the mesh-point correspondents.

1.1 Geometry

E

D

F

With

Y
B

P

P'
C

O
X

Appear 1.1-a: Geometry and loading

Mesh-point activates (nonfloating under-field)
Mesh-points inactive (floating under-field)

The structural features are: AC=CD=ED=AE=5mmAB=BC, AF=FD=FE=FC.

1.2

Material properties

The characteristics materials are homogeneous in all the geometry: E = 180000 Mpa and = 0.3.

1.3
Boundary conditions and loadings

*Imposed normal constant pressure: **

P = 1000 Mpa on [A, B]
P' = 2000 Mpa on [B, C]

Particular blockings of the substructures by addition of elementary matrices of rigidity to mesh-points.

2
Reference solutions

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution. Calculations FETI are validated by comparison with the results of the multifrontale.

2.2
Uncertainty on the solutions

3 Modeling
With

3.1
Characteristics of modeling

N9

N15
SD2

floating:

FETI2

N1

N8
N11

N14

N16

N2

N3

N10
N7

N12

N17
SD1

blocked:

FETI1

N18

N4

N5

N13

SD3

SD4
blocked:

floating:
FETI3

FETI4

N19

N6

Appear 3.1-a: Division of the square in 4 pennies fields

Mesh-point corresponding to finite elements DISCRETE credits

(modeling 2D SAY T, GROUP MA=' POIACR')

Mesh-point corresponding to finite elements DISCRETE inactive

(modeling 2D SAY T, GROUP MA=' POISCR')

Co-ordinates of some points:
N1= {5.5, 5}, N2= {7,3}, N3= {3.5, 3.5}, N4= {5,1.5}, N5= {1.5, 2}, N6= {3,0}, N7= {0,4}, N8= {2,5.5}, N9= {4,7}…

The interface with direction FETI of the term thus relates to DDLs of the nodes: N1, N3, N4, N5, N8, N16 and
N17. These nodes are all multiplicity 2, except N3, of multiplicity 4.

The grid is composed of 24 TRIA3 and 4 SEG2 associated with usual modeling 2D_PLAN with MECHANICAL phenomenon (GROUP_MA=' STRU'). One there assistant 8 discrete finite elements (modeling
2D_DIS_T, GROUP_MA=' POIACR' and "POISCR") which will be able to contribute to the matrices of rigidity
local with each under-field.
Thus the n°1 under-fields and n°3 become blocked and their invertible local matrices of rigidity via AFFE_CARA_ELEM on the GROUP_MA=' POIACR' which adds elementary matrices of rigidity
type:
E 0

.
0 E

Contrary to the n°2 under-fields and n°4 which remains floating because the AFFE_CARA_ELEM on
GROUP_MA=' POISCR' adds null elementary matrices of rigidity. Calculation FETI comprises thus 6 rigid modes.

Calculation FETI is sequential, it is pressed on the preconditionnor lumpé with scaling by nodal multiplicity, a total reorthogonalisation of the directions of descent via a GSM and one seek automatic rigid modes by relative test on the value of the pivots. To obtain one relative residue lower than 10-10, 12 iterations are necessary. The local solvor is the multifrontale with
its default settings.

3.2
Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

3.3 Functionalities
tested

Orders

DEFI/AFFE_MATERIAU ELAS

AFFE_CHAR_MECA PRESS_REP

MECHANICAL AFFE_MODELE D_PLAN

MECHANICS
2D_DIS_PLAN

AFFE_CARA_ELEM DISCRET_2D

DEFI_PART_OPS

MECA_STATIQUE SOLVEUR
METHODE=' FETI'

Handbook of Validation
V1.04 booklet: -
HT-66/05/005/A

4
Results of modeling A

4.1 Values

tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of
grid. The relative tolerance is thus severe: 1.10- 8%.

Values
Ux
Uy
tested
Multi
FETI Variation
Multi
FETI Variation
frontal
relative
frontal
relative
(in %)
(in %)
N1
1.235 10-2 1.235
10-2 1.
10-13 2.379
10-2 2.379 10-2 1.7
10-12
N2
5.765 10-3 5.765
10-3 3.
10-13 4.487
10-3 4.487 10-3 -1
10-14
N3
1.504 10-2 1.504
10-2 2.7
10-12 2.915
10-3 2.915 10-3 -2.4
10-12
N4
2.683 10-2 2.683
10-2 -6
10-13 2.709

10-2 2.709 10-2 2
10-13
N5
3.494 10-2 3.494
10-2 1.0
10-12 2.320
10-2 2.320 10-2 -2.6
10-12
N6
5.918 10-2 5.918
10-2 2
10-13 3.058
10-2 3.058 10-2 -9
10-13
N7
5.480 10-3 5.4809
10-3 -7
10-13 2.582
10-3 2.582 10-3 1.1
10-12
N8
5.489 10-3 5.489
10-3 1.2
10-12 1.982
10-2 1.982 10-2 -4.
10-13
N9
6.718 10-3 6.718
10-3 6.
10-13 2.430
10-2 2.430 10-2 -1.5
10-12
N10
1.284 10-2 1.284
10-2 1.0
10-12 2.342
10-2 2.342 10-2 -2.3
10-12
N11
9.127 10-3 9.127
10-3 -3.
10-13 2.531
10-2 2.531 10-2 -1.0

10-12
N12
9.921 10-3 9.921
10-3 0 1.854
10-2 1.854 10-2 -1.2
10-12
N13
3.387 10-2 3.387
10-2 -4.
10-13 3.000
10-2 3.000 10-2 -1.
10-13
N14
8.438 10-3 8.438
10-3 8.
10-14 1.040
10-2 1.040 10-2 -4.1
10-12
N15
8.850 10-3 8.850
10-3 -7.
10-13 2.446
10-2 2.446 10-2 -5
10-13
N16
9.156 10-3 9.156
10-3 -1.
10-13 2.320
10-2 2.320 10-2 -2.9
10-12
N17
2.196 10-2 2.196
10-2 1.4
10-12 2.817
10-2 2.817 10-2 5.
10-13
N18
1.364 10-2 1.364
10-2 1.9
10-12 7.520
10-3 7.520 10-3 -7.
10-13
N19

4.943 10-2 4.943
10-2 -5.
10-13 2.825
10-2 2.825 10-2 5.
10-13

5
Summary of the results

One checks the good adequacy of the results, the variations are close to the precision machine.

V1.04 booklet: -
Document: V1.04.103

FETI003 Validation of a calculation FETI with Dirichlet simple

Summary:

This case-test validates the not-regression of a calculation FETI in linear mechanics: manual partitioning or
automatic (MONGREL partitionneurs and SCOTCH TAPE) and calculation multidomaine sequential with Dirichlet simple,
homogeneous or not, divided between under-fields or not. It is a question of making sure that insertions of
orders DEFI_PART_OPS/FETI and of key word SOLVEUR+METHODE=' FETI' in MECA_STATIQUE
remain operational within this framework.
One thus checks the validity of automatic partitionings and that of the structures of data FETI and of the algorithmic associated one which manages the conditions of simple Dirichlet.
For that one studies a calculation in linear elasticity on a plate 2D not aligned with the principal axes, subjected to a pressure constant and blocked in 3 nodes and on a mesh 1D.

---

1 *Problem of reference*

One is based here on the geometry of case-test FETI001 (without mesh-point). It does not correspond to any real case. It is here only about one functional, numerical validation and of data-processing not-regression of a calculation FETI in linear mechanics: manual partitioning or automatic (partitionneurs MONGRELS and SCOTCH TAPE) and calculation multidomaine sequential with Dirichlet simple, homogeneous or not, divided between under-fields or not.

1.1 Geometry

P' ***E***

I

D

H

G

F

With

J

B

Uy=-1
C

Y

P'

O
X

Appear 1.1-a: Geometry and loading

Boundary conditions of the simple Dirichlet type (DDL_IMPO)

The structural features are: AC=CD=ED=AE=5, AB=BC, AJ=JB, AF=FD=FE=FC, AG=GF=FH=HD, EI=3 ID.

1.2
Material properties

The characteristics materials are homogeneous on all the geometry: E=180000 Mpa and =0.3.

1.3
Boundary conditions and loadings

Imposed normal constant pressure:
P'=2000 Mpa on [B, C].

Simple Dirichlet:
***Uy=-1** on [A, J],*
*At the point G and H: **Ux=2** and **Uy=-3**,*
*At item I: **Ux=0**.*

2
Reference solutions

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution. Calculations FETI are validated by comparison with the results of the multifrontale.

2.2
Uncertainty on the solutions

Convergence of the grid and parameter of control of the test of stop of FETI (RESI_RELA).

---

3 Modeling
With

3.1
Characteristics of modeling

N9
N15
SD2
floating:
FETI2
N1
N8
N11
N14
N16
N2
N3
N10
N7
N12
N17
SD1
blocked:
FETI1
N18
N4
N5
N13
SD3

SD4
blocked:
floating:
FETI3
FETI4
N19
N6
Appear 3.1-a: Division of square in four under-field

Co-ordinates of some points:
N1= {5.5, 5}, N2= {7,3}, N3= {3.5, 3.5}, N4= {5,1.5}, N5= {1.5, 2}, N6= {3,0}, N7= {0,4}, N8= {2,5.5}, N9= {4,7}…

The interface with direction FETI of the term thus relates to DDLs of the nodes: N1, N3, N4, N5, N8, N16 and
N17. These nodes are all multiplicity 2, except N3, of multiplicity 4.
The grid is composed of 24 TRIA3 and 4 SEG2 associated with usual modeling 2D_PLAN with MECHANICAL phenomenon (GROUP_MA=' STRU').
The nodes blocked by conditions of simple Dirichlet are: N7 and N18 (FACE_IMPO on M25),
N12 and N10 (DDL_IMPO on DIRI13) and N14 (DDL_IMPO on DIRI1). The LIGREL of load of the second
must thus be cut out because it relates to two under-fields.
Calculation FETI is sequential, it is pressed on the preconditionnor lumpé with scaling by
nodal multiplicity, a total reorthogonalisation of the directions of descent via a GSM and one
seek automatic rigid modes by relative test on the value of the pivots. To obtain one
relative residue lower than 10-12, 12 iterations are necessary. The local solvor is the multifrontale with its default settings.

3.2
Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

3.3 Functionalities
tested

Orders

DEFI/AFFE_MATERIAU ELAS

AFFE_CHAR_MECA PRESS_REP

FACE_IMPO

DDL_IMPO

MECHANICAL AFFE_MODELE D_PLAN

DEFI_PART_OPS

MECA_STATIQUE SOLVEUR
METHODE=' FETI'

4

Results of modeling A

4.1 Values
tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of
grid. The relative tolerance is thus severe: 1.10- 10%.

Values
Ux
Uy
tested
Multi
FETI Variation
Multi
FETI Variation
frontal
relative
frontal
relative
(in %)
(in %)
N1
0.764 0.764
8.
10-13 -2.451 -2.451 6.
10-13
N2
1.823 1.823
-5.
10-13 -2.055 -2.055 8.
10-14
N3
2.010 2.010
3.
10-13 -3.229 -3.229 -5.
10-13
N4
1.864 1.864
1.1
10-12 -3.142 -3.142 7.
10-13

N5
1.283 1.283
2.
10-13 -2.533 -2.533 -8.
10-13
N6
1.328 1.328
8.
10-13 -2.775 -2.775 1.6.
10-12
N7
2.063 2.063
-1.3
10-12 -1.
-1.
0.
N8
1.866 1.866
-1.8
10-12 -3.126 -3.126 -2.
10-13
N9
1.028 1.028
3.9
10-12 -2.604 -2.604 1.2
10-12
N10
2.
2. 0. -3. -3. 0.
N11
1.426 1.426
3.2
10-12 -2.824 -2.824 1.3
10-12
N12
2.
2. 0. -3. -3. 0.
N13
1.632 1.632
8.
10-13 -2.923 -2.923 1.
10-13
N14

0. 0. 0.
-2.315
-2.315
-7.
10-13
N15
1.168 1.168
-2.
10-13 -2.494 -2.494 7.
10-13
N16
1.879 1.879 0. -3.126
-3.126
-4.
10-14
N17
1.927 1.927
-9.
10-13 -3.123 -3.123 20.
10-12
N18
1.531 1.531
-1.6
10-12 -1.
-1. 1.
10-14
N19
1.451 1.451
-1.1
10-12 -2.644 -2.644 9.
10-13

5 Modeling B

5.1 Characteristics of modeling

It is same modeling as with A, by replacing manual partitioning by an automatic being pressed on the MONGREL tool.

5.2 Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

5.3 Functionalities tested

Orders

DEFI/AFFE_MATERIAU
ELAS

AFFE_CHAR_MECA PRESS_REP

MECHANICAL AFFE_MODELE D_PLAN

FACE_IMPO

DDL_IMPO

DEFI_PART_FETI METHODE=' KMETIS'

MECA_STATIQUE SOLVEUR
METHODE=' FETI'

6
Results of modeling B

6.1 Values
tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of
grid. The relative tolerance is thus severe: 1.10- 10%.

Values
Ux
Uy
tested
Multi
FETI
Variation
Multi
FETI
Variation
frontal
+ MONGREL
relative
frontal
+ MONGREL
relative
(in %)
(in %)
N1
0.764 0.764
-7.

10-13 -2.451 -2.451 6.
10-13
N2
1.823 1.823
7.
10-13 -2.055 -2.055 1.
10-13
N3
2.010 2.010
3.
10-13 -3.229 -3.229 -5.
10-13
N4
1.864 1.864
1.1
10-12 -3.142 -3.142 7.
10-13
N5
1.283 1.283
2.
10-13 -2.533 -2.533 -8.
10-13
N6
1.328 1.328
8.
10-13 -2.775 -2.775 1.8
10-12
N7
2.063 2.063
-1.2
10-12 -1.
-1.
0.
N8
1.866 1.866
-1.7
10-12 -3.126 -3.126 -2.
10-13
N9
1.028 1.028
4.2
10-12 -2.604 -2.604 1.3
10-12

N10
2.
2. 0. -3. -3. 0.
N11
1.426 1.426
3.3
10-12 -2.824 -2.824 1.3
10-12
N12
2.
2. 0. -3. -3. 0.
N13
1.632 1.632
8.
10-13 -2.923 -2.923 1.
10-13
N14
0. 0. 0.
-2.315
-2.315
-7.
10-13
N15
1.168 1.168
-2.
10-13 -2.494 -2.494 7.
10-13
N16
1.879 1.879 0. -3.126
-3.126
-4.
10-14
N17
1.927 1.927
-9.
10-13 -3.123 -3.123 20.
10-12
N18
1.531 1.531
-1.6
10-12 -1.
-1. 1.
10-14

N19
1.451 1.451
-1.1
10-12 -2.644 -2.644 9.
10-13

---

7 Modeling C

7.1 Characteristics of modeling

It is same modeling as with A, by replacing manual partitioning by an automatic being pressed on the tool SCOTCH TAPE.

7.2 Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

7.3 Functionalities tested

Orders

DEFI/AFFE_MATERIAU ELAS

AFFE_CHAR_MECA PRESS_REP

DDL_IMPO

FACE_IMPO

MECHANICAL AFFE_MODELE D_PLAN

DEFI_PART_FETI METHODE=' SCOTCH'

MECA_STATIQUE SOLVEUR
METHODE=' FETI'

8
Results of modeling C

8.1 Values
tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of
grid. The relative tolerance is thus severe: 1.10- 10%.

Values
Ux
Uy
tested
Multi

FETI
Variation
Multi
FETI
Variation
frontal
+ MONGREL
relative
frontal
+ MONGREL
relative
(in %)
(in %)
N1
0.764 0.764
-7.
10-13 -2.451 -2.451 6.
10-13
N2
1.823 1.823
7.
10-13 -2.055 -2.055 1.
10-13
N3
2.010 2.010
3.
10-13 -3.229 -3.229 -5.
10-13
N4
1.864 1.864
1.1
10-12 -3.142 -3.142 7.
10-13
N5
1.283 1.283
2.
10-13 -2.533 -2.533 -8.
10-13
N6
1.328 1.328
8.
10-13 -2.775 -2.775 1.8
10-12

N7
2.063 2.063
-1.2
10-12 -1.
-1.
0.
N8
1.866 1.866
-1.7
10-12 -3.126 -3.126 -2.
10-13
N9
1.028 1.028
4.2
10-12 -2.604 -2.604 1.3
10-12
N10
2.
2. 0. -3. -3. 0.
N11
1.426 1.426
3.3
10-12 -2.824 -2.824 1.3
10-12
N12
2.
2. 0. -3. -3. 0.
N13
1.632 1.632
8.
10-13 -2.923 -2.923 1.
10-13
N14
0. 0. 0.
-2.315
-2.315
-7.
10-13
N15
1.168 1.168
-2.
10-13 -2.494 -2.494 7.
10-13

N16
1.879 1.879 0. -3.126
-3.126
-4.
10-14
N17
1.927 1.927
-9.
10-13 -3.123 -3.123 20.
10-12
N18
1.531 1.531
-1.6
10-12 -1.
-1. 1.
10-14
N19
1.451 1.451
-1.1
10-12 -2.644 -2.644 9.
10-13

9
Summary of the results

One checks the good adequacy of the results, the variations are close to the precision machine.

Organization (S): EDF-R & D /SINETICS

Handbook of Validation
V1.04 booklet: -
Document: V1.04.104

FETI004 Validation of a calculation FETI with Dirichlet generalized

Summary:

This case-test validates the not-regression of a calculation FETI in linear mechanics: manual partitioning and calculation
multidomaine sequential with Dirichlet simple and generalized, homogeneous or not, divided between under
fields or not. It is a question of making sure that insertions of orders DEFI_PART_OPS and the key word
SOLVEUR+METHODE=' FETI' in MECA_STATIQUE remain operational within this framework.
One thus checks the validity of the structures of data FETI and algorithmic associated as for the catch in count condition of generalized Dirichlet.
For that one studies a calculation in linear elasticity on a plate 2D, not aligned with the principal axes, subjected to a constant pressure, whose 3 nodes are blocked and 2 are linearly dependent.
Handbook of Validation
V1.04 booklet: -
HT-66/05/005/A

1
Problem of reference

One is based here on the geometry of case-test FETI001 (without mesh-point). It does not correspond to any
real case. It is here only about one functional, numerical validation and of data-processing not-regression
of a basic calculation FETI in linear mechanics: manual partitioning and calculation multidomaine
sequential with Dirichlet simple homogeneous and divided between under-fields and generalized Dirichlet
inhomogenous clean with a under-field.

1.1 Geometry

P' ***E***

J

D

H

G

I

With

B

C

Y
P'

X

O

Appear 1.1-a: Geometry and loading

Boundary conditions of the simple Dirichlet type (DDL_IMPO).

Boundary conditions of generalized the Dirichlet type (LIAISON_DDL).
The structural features are
: AC=CD=ED=AE=5mm, AB=BC, AF=FD=FE=FC,
AG=GF=FH=HD, EJ=JF=FI=IC.

1.2
Material properties

The characteristics materials are homogeneous in all the geometry: E=180000 Mpa and =0.3.

1.3
Boundary conditions and loadings

Imposed normal constant pressure:
P'=2000 Mpa on [B, C]

Simple Dirichlet:
At the points G, H and I: ***Ux=0*** *and* ***Uy=0***

Generalized Dirichlet:
Between the points E and J: 3rd
U **-** *5 11*
U *= 7*
X
y
Handbook of Validation
V1.04 booklet: -
HT-66/05/005/A

2

Reference solutions

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution. Calculations FETI are validated by comparison with the results of the multifrontale.

2.2
Uncertainty on the solutions

Convergence of the grid and parameter of control of the test of stop of FETI (RESI_RELA).

---

3 Modeling With

3.1 Characteristics of modeling

N9
N15
SD2
floating:
FETI2
N1
N8
N11
N14
N16
N2
N3
N10
N7
N12
N17
SD1
floating:
FETI1
N18
N4
N5
N13
SD4

SD3
floating:
floating:
FETI4
N19
FETI3
N6
Appear 3.1-a: Division of square in four under-field

Co-ordinates of some points:
N1= {5.5, 5}, N2= {7,3}, N3= {3.5, 3.5}, N4= {5,1.5}, N5= {1.5, 2}, N6= {3,0}, N7= {0,4}, N8= {2,5.5}, N9= {4,7}…

The interface with direction FETI of the term thus relates to DDLs of the nodes: N1, N3, N4, N5, N8, N16 and
N17. These nodes are all multiplicity 2, except N3, of multiplicity 4.
The grid is composed of 24 TRIA3 and 4 SEG2 associated with usual modeling 2D_PLAN with MECHANICAL phenomenon (GROUP_MA=' STRU').
The nodes blocked by conditions of simple Dirichlet are: N10, N12 and N13 (DDL_IMPO). Their LIGREL of load must thus be cut out because it relates to three under-fields. Those blocked by one condition of Dirichlet generalized are: N9 and N11.
Calculation FETI is sequential, it is pressed on the preconditionnor lumpé with scaling by nodal multiplicity, a total reorthogonalisation of the directions of descent via a GSM and one seek automatic rigid modes by relative test on the value of the pivots. To obtain one relative residue lower than 10-12, 13 iterations are necessary. The local solvor is the multifrontale with its default settings.

3.2
Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

3.3 Functionalities
tested

Orders

DEFI/AFFE_MATERIAU ELAS

AFFE_CHAR_MECA PRESS_REP

DDL_IMPO

LIAISON_DDL

MECHANICAL AFFE_MODELE D_PLAN

DEFI_PART_OPS

MECA_STATIQUE SOLVEUR
METHODE=' FETI'

4
Results of modeling A

4.1 Values
tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of
grid. The relative tolerance is thus severe: 1.10- 10%.

Values
Ux
Uy
tested
Multi
FETI Variation
Multi
FETI Variation
frontal
relative
frontal
relative
(in %)
(in %)
N1
-0.234 0.234
-2.1.
10-12
-0.162 -0.162 3.7
10-12

N2
1.61 10-3 1.61
10-3 -2.4
10-12 2.53
10-2 2.53
10-2 -1.1
10-11
N3
9.90 10-2 9.90
10-2 1.0
10-12 -7.69
10-3 -7.69
10-3 1.0
10-11
N4
-6.04 10-3 -6.04
10-3 1.0
10-11 1.88
10-2 1.88
10-2 5.
10-14
N5
8.19 10-3 8.19
10-3 -7.8
10-12 -4.93
10-2 -4.93
10-2 4.
10-13
N6
5.82 10-2 5.82
10-2 -1.2
10-12 -6.30
10-3 -6.30
10-3 1.9
10-12
N7
3.01 10-2 3.01
10-2 9.
10-13 -1.73
10-1 -1.73
10-1 8.
10-13
N8

-2.52 10-1 -2.52
10-1 -2.
10-13 2.79
10-1 2.79
10-1 1.8
10-12
N9
1.51 1.51
2.
10-13 -7.52
10-2 -7.52
10-2 4.3
10-12
N10
0. 0. 0
0.
0.
0
N11
-0.493 -0.493
-2.7
10-13 -0.102 -0.102 1.8
10-12
N12
0. 0. 0
0.
0.
0
N13
0. 0. 0
0.
0.
0
N14
-4.98 10-2 -4.98
10-2 -3.0
10-12 1.90
10-2 1.90
10-2 -1.4
10-11
N15
2.15 10-1 2.15
10-1 -8

10-13 -4.44
10-1 -4.44
10-1 2.
10-13
N16
2.66 10-1 2.66
10-1 -1.4
10-12 3.81
10-2 3.81
10-2 -2.1
10-12
N17
-2.36 10-2 -2.36
10-2 -1
10-13 1.72
10-2 1.72
10-2 -1.2
10-12
N18
2.66 10-2 2.66
10-2 -9
10-13 -8.58
10-2 -8.58
10-2 -2.
10-13
N19
3.16 10-2 3.16
10-2 -7
10-13 -2.64
10-2 -2.64
10-2 5.
10-13

5
Summary of the results

One checks the good adequacy of the results, the variations are close to the precision machine.

Version
8.2

Titrate:
FETI005 - Validation of a calculation FETI with simple Dirichlet with the interface
Date:
02/11/05
Author (S):
***O. BOITEAU** Key*
:
V1.04.105-A Page:
1/6

Organization (S): EDF-R & D /SINETICS

Handbook of Validation
V1.04 booklet: -
Document: V1.04.105

FETI005 Validation of a calculation FETI with Dirichlet simple with the interface

Summary:

This case-test validates the not-regression of a calculation FETI in linear mechanics: manual partitioning and calculation

multidomaine sequential with simple Dirichlet with the interface. It is a question of making sure that insertions of
orders DEFI_PART_OPS and of key word SOLVEUR+METHODE=' FETI' in MECA_STATIQUE remain
operational within this framework.
One thus checks the validity of the structures of data FETI and algorithmic associated as for the catch in
count conditions of Dirichlet on nodes of the interface.
For that one studies a calculation in linear elasticity on a plate 2D, not aligned with the principal axes,
subjected to a pressure constant and blocked in 4 nodes (including one on the interface) and 2 meshs 1D (including one
concerning the interface).

1
Problem of reference

One is based here on the geometry of case-test FETI001 (without mesh-point). It does not correspond to any
real case. It is here only about one functional, numerical validation and of data-processing not-regression
of a calculation FETI in linear mechanics: manual partitioning and sequential calculation multidomaine
with Dirichlet simple with the interface

1.1 Geometry

E

I

D

H

G

F

With

B

U
C

y= -1

P'

Y
X

O

Appear 1.1-a: Geometry and loading

Boundary conditions of the simple Dirichlet type (DDL_IMPO)
The structural features are:
AC=CD=ED=AE=5mm, AB=BC, AF=FD=FE=FC, AG=GF=FH=HD, EI=3 ID.

1.2
Material properties

The characteristics materials are homogeneous on all the geometry: E=180000 Mpa and =0.3.

1.3
Boundary conditions and loadings

Imposed normal constant pressure:
P'=2000 Mpa on [B, C]

Simple Dirichlet:
Uy=-1 on [A, B],
At the point G, F and H: Ux=2 and Uy=-3,
At item I: Ux=0.

2
Reference solutions

2.1
Method of calculation used for the reference solutions

On such a case of figure, it is not possible to exhume an analytical solution. Calculations FETI are validated by comparison with the results of the multifrontale.

2.2
Uncertainty on the solutions

Convergence of the grid and parameter of control of the test of stop of FETI (RESI_RELA).

3 Modeling
With

3.1
Characteristics of modeling
N9
N15
SD2
floating:
FETI2
N1
N8
N11
N14
N16
N2
N3

N10
N7
N12
N17
SD1
blocked:
FETI1
N18
N4
N5
N13
SD3
SD4
blocked:
blocked:
FETI3
N19
FETI4
N6
Appear 3.1-a: Division of square in four under-field

Co-ordinates of some points:
N1= {5.5, 5}, N2= {7,3}, N3= {3.5, 3.5}, N4= {5,1.5}, N5= {1.5, 2}, N6= {3,0}, N7= {0,4}, N8= {2,5.5}, N9= {4,7}…

The interface with direction FETI of the term thus relates to DDLs of the nodes: N1, N3, N4, N5, N8, N16 and
N17. These nodes are all multiplicity 2, except N3, of multiplicity 4.
The grid is composed of 24 TRIA3 and 4 SEG2 associated with usual modeling 2D_PLAN with MECHANICAL phenomenon (GROUP_MA=' STRU').
The nodes blocked by conditions of simple Dirichlet are: N7, N18 and N5 (FACE_IMPO on M25 and M26), N12, N3 and N10 (DDL_IMPO on DIRI13) and N14 (DDL_IMPO on DIRI1). LIGRELs of
charge of the two first must thus be cut out because they relate to several under-fields.
Calculation FETI is sequential, it is pressed on the preconditionnor lumpé with scaling by nodal multiplicity, a total reorthogonalisation of the directions of descent via a GSM and one seek automatic rigid modes by relative test on the value of the pivots. To obtain one relative residue lower than 10-12, 10 iterations are necessary. The local solvor is the multifrontale with
its default settings.
Handbook of Validation
V1.04 booklet: -
HT-66/05/005/A

3.2
Characteristics of the grid

19 points, 24 TRIA3, 4 SEG3.

3.3 Functionalities
tested

Orders

DEFI/AFFE_MATERIAU ELAS

AFFE_CHAR_MECA PRESS_REP

FACE_IMPO

DDL_IMPO

MECHANICAL AFFE_MODELE D_PLAN

DEFI_PART_OPS

MECA_STATIQUE SOLVEUR
METHODE=' FETI'

4
Results of modeling A

4.1 Values
tested

One tests the data-processing not-regression of the values of the field of displacement compared to results resulting from a calculation with multifrontale (METHODE=' MULT_FRONT'), and this, in any point of grid. The relative tolerance is thus severe: 1.10- 8%.

Values
Ux
Uy
tested
Multi
FETI Variation

Multi
FETI Variation
frontal
relative
frontal
relative
(in %)
(in %)
N1
0.819 0.819
2.
10-13 -2.446 -2.446 1.5
10-12
N2
1.751 1.751
-2.0
10-12 -2.273 -2.273 3.
10-13
N3
2. 2. 0.
-3.
-3.
0.
N4
1.501 1.501
1.4
10-12 -3.158 -3.158 8.
10-13
N5
1.194 1.194
1.
10-13 -1. -1.
0.
N6
0.301 0.301
-1.2
10-12 -2.160 -2.160 5.
10-13
N7
2.032 2.032
2.3
10-12 -1.
-1.

0.
N8
1.835 1.835
-1.1
10-12 -3.071 -3.071 -8.
10-14
N9
1.059 1.059
-1.1
10-12 -2.499 -2.499 -2.2
10-12
N10
2. 2. 0.
-3.
-3.
0.
N11
1.445 1.445
-2.0
10-12 -2.693 -2.693 -1.1
10-12
N12
2. 2. 0.
-3.
-3.
0.
N13
1.296 1.296
2.0
10-12 -2.453 -2.453 1.2
10-12
N14
0. 0. 0.
-2.406
-2.406
-1.2
10-12
N15
1.208 1.208
-2.
10-13 -2.426 -2.426 -4.
10-13
N16

1.855 1.855
-4.
10-13 -3.008 -3.008 1.0
10-12
N17
1.785 1.785
-3.
10-14 -2.957 -2.957 -1.1
10-12
N18
1.191 1.191
2.
10-13 -1. -1.
0.
N19
0.796 0.796
6.
10-13 -1.633 -1.633 -8.
10-13

5
Summary of the results

One checks the good adequacy of the results, the variations are close to the precision machine.

V1.10 booklet: Benchmarks
V1.10.102 document
YYYY102 - Eigen frequency of a paddle of ventilator

Summary:
This case test of calculation of Eigen frequencies results from an industrial problem. It makes it possible to be ensured of not regression of the calculation algorithm of clean modes. The values of reference result from a calculation carried out on the grid with code PERMAS.
In the preceding versions, this case test was named SDLV100.

Code_Aster ®
Version
4.0
Titrate:
YYYY102 Eigen frequency of a paddle of ventilator
Date:
05/01/98
Author (S):
J.P. LEFEBVRE
Key: V1.10.102-A
Page:
2/6

1 Problem of reference

1.1 Geometry

B
With
A'
C
G
K
blocked part
D
EB
= 742.5 mm
E
F
EC.
= 151.5 mm
ED
= 56 mm
AA'
= 10 mm
AK
= 208 mm
BEA
= 67.5°

1.2 Material properties

E = 210.000 Mpa
= 0.3
= 7.8 106 kg/mm3

1.3

Boundary conditions and loadings
Embedding of the end of the higher veil in the hub (shaded zone).
Handbook of Validation
V1.10 booklet: Benchmarks
HI-75/97/002 - Ind A

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution is that obtained on the same grid with code PERMAS (Version 3.12) on CRAY XMP.

2.2 Results of reference

Mode	**Frequency**
1	0.31401786
2	0.77987974
3	2.5495422
4	2.7474513
5	3.7961008
6	6.6220969
7	10.122032
8	

12.562072
9
18.980812
10
21.922584

2.3
Uncertainty on the solution

Numerical solution.

---

3 Modeling
With

3.1
Characteristics of modeling

Algorithm of eigenvalues: simultaneous iterations on a subspace.
57 nodes blocked on the elements hexaedric with 20 nodes (6 elements of the end with exception of the nodes located at the interface with the remainder of the structure).

3.2
Characteristics of the grid

A number of nodes: 841
A number of meshs and types: 96 HEXA20, 15 PENTA15.

3.3 Functionalities
tested

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]

AFFE_MATERIAU
ALL
[U4.23.01]
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
CALC_MATR_ELEM
“MASS_MECA”
“RIGI_MECA”
[U4.41.01]
NUME_DDL
MATR_RIGI
[U4.42.01]
ASSE_MATRICE
[U4.42.02]
MODE_ITER_SIMULT
[U4.52.01]

4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference

(number of mode)
1
0.3140
0.3140
0
2
0.7799
0.7799
0
3
2.5495
2.5496
0
4
2.7475
2.7475
0
5
3.7961
3.7961
0
6
6.6221
6.6221
0
7
10.122
10.122
0
8
12.562
12.562
0
9
18.980
18.981
0
10
21.923
21.854
0.3

4.2 Parameters of execution

Version: 3.06
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
16 MW
Time CPU To use:
20 seconds

4.3
Time CPU to use of the last obsvervation

Values tested in conformity with the reference solution.

Order	**Time To use**
BEGINNING	1.0022
PRE_IDEAS	0.4370
LIRE_MAILLAGE	0.7115
AFFE_MODELE	0.0981
DEFI_MATERIAU	0.4856
AFFE_MATERIAU	0.0553
AFFE_CHAR_MECA	0.6626
CALC_MATR_ELEM	0.5441
CALC_MATR_ELEM	0.2601
NUME_DDL	0.2123
ASSE_MATRICE	0.4764
ASSE_MATRICE	0.4495
MODE_ITER_SIMULT	9.3649
IMPR_RESU	2.9920
TEST_RESU	0.1095

END
0.0583
Total time:
19.6095

4.4
History of the performances

Code	Version	Date	Memory	To use total CPU	System
PERMAS	3.12	23/01/91	?	27.61 S	Unicos 5.1
ASTER	1.03	0.7799	16 MW	21.29 S	Unicos 5.1
ASTER	2.0.8	2.5496	16 MW	26.12 S	Unicos 6.0
ASTER	2.2.18	2.7475	16 MW	19.41 S	Unicos 6.1
ASTER	3.6.0	3.7961	16 MW	19.89 S	Unicos 8.0

Handbook of Validation

Code_Aster ®
Version
4.0
Titrate:
YYYY102 Eigen frequency of a paddle of ventilator
Date:
05/01/98
Author (S):
J.P. LEFEBVRE
Key: V1.10.102-A
Page:
6/6

5
Summaries of the results

One notes few modifications in the values of time CPU with the various versions of code.

A more consequent grid would be certainly more significant to measure the performances of the associated operator.

Code_Aster ®
Version
4.0
Titrate:
Prismatic YYYY104 Test-tube fissured in 3D
Date:
05/01/98
Author (S):
J.P. LEFEBVRE
Key: V1.10.104-A
Page:
1/16
Organization (S): EDF/IMA/MMN

Handbook of Validation
V1.10 booklet: Benchmarks
V1.10.104 document
YYYY104 - Prismatic test-tube fissured in 3D
Summary:

This case test of elastic design results from an industrial problem. It makes it possible to compare the performances of
various solveurs established in Code_Aster, as well as the two methods of treatment of the conditions with
limits of the Dirichlet type.
The values of reference result from a calculation carried out on the grid with code PERMAS.
The test comprises 11 modelings on the same problem of reference: modeling 3D of a quarter
of prismatic test-tube fissured in 4784 pentahedrons with 15 nodes and 598 hexahedrons with 20 nodes, are 16565
nodes.
In the preceding versions, this case test was named SSLV103.
Handbook of Validation
V1.10 booklet: Benchmarks
HI-75/97/002 - Ind A

1
Problem of reference
1.1 Geometry
fissure
1/4 of circle
U = 0
in the xy plan
Z
U = - 1 mm
15 mm
X
7,5 mm
With
B
X
C

y
D
E
Z
F
72,5 mm
G
H
U = 0
y
I
120 mm
J
in the xz plan
K
support
225 mm
725 mm
Dimension in X:
A: 127.5
D: 105.00
G: 60.00
J: 15.00
(mm)
B: 123.75
E: 90.00
H: 45.00
K: 0.00

C: 120.00
F: 75.00
I: 30.00

1.2
Material properties

E = 210.000 Mpa
= 0.3

1.3
Boundary conditions and loadings

Uz = 0
in the plan:
Z = 0
Ux = 0

on the segment:
X = 0
Y = 225 mm
Uy = 0
in the plan:
Y = 0
out of the crack
Ux = -1 mm
on the segment:
X = 120 mm
Y = 725 mm

---

2 Modeling of reference

2.1 Modeling common to all the tests

With
NO13943 G NO15862
B NO13944 H NO15863
C NO15854 I NO15868
D NO15855 J NO15869
E NO15858 K NO15866
F NO15860

2.1.1 Grid

A number of nodes: 16565
A number of meshs and types: 598 HEXA20, 4784 PENTA15.

2.1.2 Boundary conditions

in all the nodes of the Y=0 plan except crack DDL_IMPO:

(GROUP_NO: Supy DY: 0.)
in all the nodes of the segment X=0mm Y=225mm
(GROUP_NO: Support DX: 0.)
in all the nodes of the Z=0 plan
(GROUP_NO: Supz DZ: 0.)
in all the nodes of the segment X=120mm Y=725mm
(GROUP_NO: Charge DX: -1.)

2.2
Functionalities tested common to all modelings

Orders
Keys
AFFE_MODELE
[U4.22.01]
DEFI_MATERIAU
[U4.23.01]
AFFE_MATERIAU
[U4.23.02]

3
Reference solution

3.1
3.1 Method of calculation used for the reference solution

The reference solution is that obtained on the same grid with code PERMAS (Version 3.12) on CRAY XMP.

3.2
3.2 Result of reference: values tested

Identification
Reference

Aster
% difference
WITH DX
0.65855E03
0.65855E03
0
WITH DY
0.64428E01
0.64428E01
0
WITH DZ
0.63926E02
0.63926E02
0
B DX
0.86832E03
0.86831E03
0
B DY
0.61357E01
0.61357E01
0
B DZ
0.62244E02
0.62244E02
0
C DX
0.11315E02
0.11315E02
0
C DY
0.58735E01
0.58735E01
0
C DZ
0.60645E02
0.60645E02
0
D DX
0.23537E02
0.23537E02
0
D DY

0.43551E01
0.43551E01
0
D DZ
0.45381E02
0.45381E02
0
E DX
0.31725E02
0.31725E02
0
E DY
0.28244E01
0.28244E01
0
E DZ
0.29278E02
0.29278E02
0
F DX
0.36759E02
0.36759E02
0
F DY
0.12585E01
0.12585E01
0
F DZ
0.12193E02
0.12193E02
0
G DX
0.38304E02
0.38304E02
0
G DY
0.31279E02
0.31278E02
0
G DZ
0.48316E03
0.48320E03
0

H DX
0.35835E02
0.35835E02
0
H DY
0.18953E01
0.18953E01
0
H DZ
0.21508E02
0.21508E02
0
I DX
0.29512E02
0.29512E02
0
I DY
0.34851E01
0.34851E01
0
J DZ
0.37679E02
0.37679E02
0
J DX
0.17340E02
0.17340E02
0
J DY
0.50995E01
0.50995E01
0
J DZ
0.49749E02
0.49749E02
0
K DX
0.00000E+00
0.30011E14
0
K DY
0.67226E01
0.67226E01

0
K DZ
0.58204E02
0.58204E02
0
C SIXX
0.35204E+01
0.35546E+01
0.97
C SIXY
0.18101E+01
0.17856E+01
1.35
C SIYY
0.53914E+02
0.53884E+02
0.06
C SIXZ
0.71500E+00
0.69591E+00
2.67
C SIYZ
0.10373E+01
0.10348E+01
+0.24
C SIZZ
0.10672E+01
0.11319E+01
+6.06

---

4 Modeling
With
4.1
Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
MECA_STATIQUE
SOLVEUR
METHOD
“LDLT”
[U4.31.01]
RENUM
“WITHOUT”
CALC_ELEM
[U4.61.02]

4.2
Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
50 MW
Time CPU To use:
474 seconds

4.3
Time CPU to use by order at the time of the last observation

Orders
Time CPU to use
BEGINNING
1.00
LIRE_MAILLAGE
18.65
AFFE_MODELE
0.24
DEFI_MATERIAU
0.45
AFFE_MATERIAU

0.01
AFFE_CHAR_MECA
10.06
MECA_STATIQUE
435.84
CALC_ELEM
5.33
TEST_RESU
0.26
TEST_RESU
0.07
END
0.06
TOTAL_JOB
473.87

4.4
History of the performances

Code
Version
Machine/System
Date
Time CPU to use total
PERMAS
3.12
YMP 264/Unicos 5.1
23/01/91
1036
PERMAS
4.0
YMP 264/Unicos 6.0
02/07/91
1032
Code_Aster
1.03
YMP 264/Unicos 5.1
16/01/91
1069
Code_Aster
2.0.02
YMP 264/Unicos 6.0
24/07/91
1096
Code_Aster

2.00.08
YMP 264/Unicos 6.0
23/09/91
1063
Code_Aster
2.02.18
YMP 264/Unicos 6.1
09/06/92
1071
Code_Aster
2.05.24
YMP 264/Unicos 7.0
27/09/93
944
Code_Aster
3.05.24
C98/Unicos 8.0
27/11/95
474
Handbook of Validation
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HI-75/97/002 - Ind A

---

5 Modeling B

5.1 Functionalities tested by modeling

Orders		Keys
AFFE_CHAR_CINE	MECA_IMPO	[U4.25.01]
NUME_DDL		[U4.42.01]
CALC_MATR_ELEM		[U4.41.01]
ASSE_MATRICE		[U4.42.02]
AFFE_CHAM_NO		[U4.26.01]
CALC_CHAR_CINE		[U4.41.03]
FACT_LDLT		[U4.51.01]
RESO_LDLT		[U4.51.02]
CALC_CHAM_ELEM		[U4.61.02]

5.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z

Obstruction memory:
45 MW
Time CPU To use:
457 seconds

5.3

Time CPU to use by order at the time of the last observation

Orders	Time CPU to use
BEGINNING	1.00
LIRE_MAILLAGE	18.66
AFFE_MODELE	0.24
DEFI_MATERIAU	0.45
AFFE_MATERIAU	0.01
AFFE_CHAR_CINE	0.33
CALC_MATR_ELEM	8.91
NUME_DDL	2.08
ASSE_MATRICE	36.15
AFFE_CHAM_NO	1.42
CALC_CHAR_CINE	0.01
FACT_LDLT	378.34
RESO_LDLT	1.02
CALC_CHAM_ELEM	5.31
TEST_RESU	0.26
TEST_RESU	0.08
END	0.04
TOTAL_JOB	

---

6 Modeling C

6.1 Functionalities tested by modeling

Orders		**Keys**	
AFFE_CHAR_MECA	DDL_IMPO		[U4.25.01]
MECA_STATIQUE	SOLVEUR	METHOD "LDLT"	[U4.31.01]
		RENUM "RCMK"	
CALC_ELEM			[U4.61.02]

6.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
50 MW

Time CPU To use:
588 seconds

6.3
Time CPU to use by order at the time of the last observation

Orders	**Time CPU to use**
BEGINNING	1.00
LIRE_MAILLAGE	18.66
AFFE_MODELE	0.24
DEFI_MATERIAU	0.45
AFFE_MATERIAU	0.01
AFFE_CHAR_MECA	10.08
MECA_STATIQUE	549.10
CALC_ELEM	5.34
TEST_RESU	0.25
TEST_RESU	0.07
END	0.06
TOTAL_JOB	587.17

---

7 Modeling
D

7.1
Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.01]
NUME_DDL
RENUM
“RCMK”
[U4.42.01]
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]
AFFE_CHAM_NO
[U4.26.01]
CALC_CHAR_CINE
[U4.41.03]
FACT_LDLT
[U4.51.01]
RESO_LDLT
[U4.51.02]
CALC_CHAM_ELEM
[U4.61.02]

7.2
Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
45 MW
Time CPU To use:
472 seconds

7.3
Time CPU to use by order at the time of the last observation

Orders

Time CPU to use
BEGINNING
1.00
LIRE_MAILLAGE
18.66
AFFE_MODELE
0.24
DEFI_MATERIAU
0.45
AFFE_MATERIAU
0.01
AFFE_CHAR_CINE
0.33
CALC_MATR_ELEM
8.89
NUME_DDL
6.41
ASSE_MATRICE
35.48
AFFE_CHAM_NO
1.41
CALC_CHAR_CINE
0.01
FACT_LDLT
390.18
RESO_LDLT
1.00
CALC_CHAM_ELEM
5.35
TEST_RESU
0.08
TEST_RESU
0.04
END
0.07
TOTAL_JOB
471.70
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Code_Aster ®
Version

8 Modeling E

8.1 Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]
CALC_VECT_ELEM
[U4.41.02]
ASSE_VECTEUR
[U4.42.03]
FACT_GRAD
[U4.51.03]
RESO_GRAD
[U4.51.04]
CALC_CHAM_ELEM
[U4.61.02]

8.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z

Obstruction memory:
45 MW
Time CPU To use:
163 seconds

8.3
Time CPU to use by order at the time of the last observation

Orders	Time CPU to use
BEGINNING	1.00
LIRE_MAILLAGE	18.66
AFFE_MODELE	0.24
DEFI_MATERIAU	0.45
AFFE_MATERIAU	0.01
AFFE_CHAR_MECA	10.06
CALC_MATR_ELEM	9.41
NUME_DDL	9.16
ASSE_MATRICE	15.04
CALC_VECT_ELEM	0.57
ASSE_VECTEUR	0.08
FACT_GRAD	5.30
RESO_GRAD	85.02
CALC_CHAM_ELEM	5.30
TEST_RESU	0.08
TEST_RESU	0.04
END	0.07
TOTAL_JOB	

---

9 Modeling F

9.1 Functionalities tested by modeling

Orders
Keys

AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]
AFFE_CHAM_NO
[U4.26.01]
CALC_CHAR_CINE
[U4.41.03]
FACT_GRAD
[U4.51.03]
RESO_GRAD
CHAM_CINE
[U4.51.04]

9.2
Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
45 MW
Time CPU To use:
152 seconds

9.3
Time CPU to use by order at the time of the last observation

Orders	**Time CPU to use**
BEGINNING	0.83
LIRE_MAILLAGE	18.07
AFFE_MODELE	0.21
DEFI_MATERIAU	0.21
AFFE_MATERIAU	0.01
AFFE_CHAR_CINE	0.32
CALC_MATR_ELEM	12.77
NUME_DDL	8.85
ASSE_MATRICE	16.54
AFFE_CHAM_NO	0.61
CALC_CHAR_CINE	0.01
FACT_GRAD	5.30
RESO_GRAD	73.86
CALC_CHAM_ELEM	

12.03
TEST_RESU
0.07
TEST_RESU
0.03
END
0.05
TOTAL_JOB
151.28

---

10 Modeling
G
10.1 Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
"MORSE"
[U4.42.01]
RENUM
"RCMK"
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]

CALC_VECT_ELEM
[U4.41.02]
ASSE_VECTEUR
[U4.42.03]
FACT_GRAD
[U4.51.03]
RESO_GRAD
CHAM_NO
[U4.51.04]
CALC_CHAM_ELEM
[U4.61.02]

10.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
45 MW
Time CPU To use:
150 seconds

10.3 Time CPU to use by order at the time of the last observation

Orders
Time CPU to use
BEGINNING
1.00
LIRE_MAILLAGE
18.64
AFFE_MODELE
0.24
DEFI_MATERIAU
0.45
AFFE_MATERIAU
0.01
AFFE_CHAR_MECA
10.04
CALC_MATR_ELEM
9.38
NUME_DDL
13.53
ASSE_MATRICE
14.99
CALC_VECT_ELEM
0.57

ASSE_VECTEUR
0.08
FACT_GRAD
5.35
RESO_GRAD
67.89
CALC_CHAM_ELEM
5.33
TEST_RESU
0.08
TEST_RESU
0.04
END
0.07
TOTAL_JOB
149.76
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V1.10 booklet: Benchmarks
HI-75/97/002 - Ind A

Code_Aster ®
Version
4.0
Titrate:
YYYY104 prismatic Test-tube fissured in 3D
Date:
05/01/98
Author (S):
J.P. LEFEBVRE
Key: V1.10.104-A
Page:
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11 Modeling
H

11.1 Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
“MORSE”

[U4.42.01]
RENUM
“RCMK”
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]
AFFE_CHAM_NO
[U4.26.01]
CALC_CHAR_CINE
[U4.41.03]
FACT_GRAD
[U4.51.03]
RESO_GRAD
CHAM_CINE
[U4.51.04]
CALC_CHAM_ELEM
[U4.61.02]

11.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
45 MW
Time CPU To use:
150 seconds

11.3 Time CPU to use by order at the time of the last observation

Orders
Time CPU to use
BEGINNING
1.00
LIRE_MAILLAGE
18.67
AFFE_MODELE
0.24
DEFI_MATERIAU
0.45
AFFE_MATERIAU
0.01
AFFE_CHAR_CINE
0.33
CALC_MATR_ELEM

8.90
NUME_DDL
12.71
ASSE_MATRICE
16.60
AFFE_CHAM_NO
1.42
CALC_CHAR_CINE
0.01
FACT_GRAD
5.32
RESO_GRAD
76.21
CALC_CHAM_ELEM
5.31
TEST_RESU
0.08
TEST_RESU
0.04
END
0.06
TOTAL_JOB
149.47

---

12 Modeling
I
12.1 Functionalities tested by modeling
Orders

Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“MANDELEVIUM”
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]
CALC_VECT_ELEM
[U4.41.02]
ASSE_VECTEUR
[U4.42.03]
FACT_LDLT
[U4.51.01]
RESO_LDLT
[U4.51.02]
CALC_CHAM_ELEM
[U4.61.02]

12.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
45 MW
Time CPU To use:
223 seconds

12.3 Time CPU to use by order at the time of the last observation

Orders
Time CPU to use
BEGINNING
1.00
LIRE_MAILLAGE
18.65
AFFE_MODELE
0.24
DEFI_MATERIAU

0.45
AFFE_MATERIAU
0.01
AFFE_CHAR_MECA
10.07
CALC_MATR_ELEM
9.41
NUME_DDL
31.30
ASSE_MATRICE
15.08
CALC_VECT_ELEM
0.57
ASSE_VECTEUR
0.08
FACT_LDLT
128.21
RESO_LDLT
0.51
CALC_CHAM_ELEM
5.33
TEST_RESU
0.08
TEST_RESU
0.04
END
0.07
TOTAL_JOB
223.18

---

13 Modeling

J

13.1 Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
"MORSE"
[U4.42.01]
RENUM
"MANDELEVIUM"
CALC_MATR_ELEM
[U4.41.01]
ASSE_MATRICE
[U4.42.02]
AFFE_CHAM_NO
[U4.26.01]
CALC_CHAR_CINE
[U4.41.03]
FACT_LDLT
[U4.51.01]
RESO_LDLT
CHAM_CINE
[U4.51.02]
CALC_CHAM_ELEM
[U4.61.02]

13.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
45 MW
Time CPU To use:
206 seconds

13.3 Time CPU to use by order at the time of the last observation

Orders
Time CPU to use

BEGINNING
1.00
LIRE_MAILLAGE
18.66
AFFE_MODELE
0.24
DEFI_MATERIAU
0.45
AFFE_MATERIAU
0.01
AFFE_CHAR_CINE
0.33
CALC_MATR_ELEM
8.90
NUME_DDL
30.81
ASSE_MATRICE
16.73
AFFE_CHAM_NO
1.42
CALC_CHAR_CINE
0.01
FACT_LDLT
119.12
RESO_LDLT
0.47
CALC_CHAM_ELEM
5.31
TEST_RESU
0.08
TEST_RESU
0.04
END
0.06
TOTAL_JOB
205.75

Titrate:
Prismatic YYYY104 Test-tube fissured in 3D
Date:
05/01/98
Author (S):
J.P. LEFEBVRE
Key: V1.10.104-A
Page:
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14 Modeling
K

14.1 Functionalities tested by modeling

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
MECA_STATIQUE
SOLVEUR
METHOD
“GCPC”
[U4.31.01]
RENUM
“WITHOUT”
PRE_COND
“LDLT_INC”
JAGG_DIAG
“SCAN”
CALC_ELEM
[U4.61.02]

14.2 Parameters of executions of the last observation

Version: 3.5.24
Machine: CRAY C98
System:
UNICOS 8.0 Mode Z
Obstruction memory:
50 MW
Time CPU To use:
170 seconds

14.3 Time CPU to use by order at the time of the last observation

Orders
Time CPU to use
BEGINNING

1.00
LIRE_MAILLAGE
18.67
AFFE_MODELE
0.24
DEFI_MATERIAU
0.45
AFFE_MATERIAU
0.01
AFFE_CHAR_MECA
10.07
MECA_STATIQUE
131.55
CALC_ELEM
5.32
TEST_RESU
0.25
TEST_RESU
0.07
END
0.06
TOTAL_JOB
169.60

---

15 Summary of the results

15.1 Classification per time growing for the last observation

Code_Aster
3.05.24
C98/Unicos 8.0
27/11/95

Key	**Solvor**	**Time To use 3.05.24**
H	AFFE_CHAR_CINE GCPC RENUM "RCMK"	149.47
G	AFFE_CHAR_MECA GCPC RENUM "RCMK"	149.76
F	AFFE_CHAR_CINE GCPC without RENUM	151.28
E	AFFE_CHAR_MECA GCPC without RENUM	162.57
K	AFFE_CHAR_MECA GCPC - SCAN without RENUM	169.60
J	AFFE_CHAR_CINE MULT_FRONT	205.75
I	AFFE_CHAR_MECA MULT_FRONT	

223.18
B
AFFE_CHAR_CINE LDLT without RENUM
456.21
D
AFFE_CHAR_CINE LDLT RENUM “RCMK”
471.70
With
AFFE_CHAR_MECA LDLT without RENUM
473.87
C
AFFE_CHAR_MECA LDLT RENUM “RCMK”
587.17

15.2 Comparison enters the two last observations

Key
Solvor
Time To use
Time To use
2.05.24
3.05.24
With
AFFE_CHAR_MECA LDLT without RENUM
943.97
473.87
B
AFFE_CHAR_CINE LDLT without RENUM
892.13
456.21
C
AFFE_CHAR_MECA LDLT RENUM “RCMK”
1006.80
587.17
D
AFFE_CHAR_CINE LDLT RENUM “RCMK”
959.50
471.70
E
AFFE_CHAR_MECA GCPC without RENUM
290.16
162.57
F
AFFE_CHAR_CINE GCPC without RENUM
257.25

151.28
G
AFFE_CHAR_MECA GCPC RENUM “RCMK”
327.09
149.76
H
AFFE_CHAR_CINE GCPC RENUM “RCMK”
279.09
149.47
I
AFFE_CHAR_MECA MULT_FRONT
490.49
223.18
J
AFFE_CHAR_CINE MULT_FRONT

205.75
K
AFFE_CHAR_MECA GCPC - SCAN without RENUM

169.60

Author (S):
X. DESROCHES, J.R. LÉVESQUE

Organization (S): EDF/IMA/MMN

Handbook of Validation
V1.10 booklet: Benchmarks
V1.10.108 document

YYYY108 - Test-tube CTJ25

Summary:

This test has two objectives:
· to ensure itself of nonthe regression of the various methods of resolution of the linear problem of elasticity
with various solveurs or methods of treatments of the boundary conditions kinematics
(dualisation or elimination),
· to ensure a follow-up of the performances for a 3D problem of about 10000 ddl.
The test comprises 14 modelings on the same problem of reference: modeling 3D of a quarter
of test-tube CTJ25 in 630 hexahedrons for a loading of imposed displacement. Only method of
resolution is different with each modeling.
In the preceding versions this test was named SSLV101.
Handbook of Validation
V1.10 booklet: Benchmarks
HI-75/97/002 - Ind A

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1 Problem of reference

1.1 Geometry

Of
D
E'
F'
X
F
It
Y
B 5 '
C
X
Z
B5
B0'

B4
X
B3
B2
X
A'
B 0
B1
With
The geometry represents only one quarter of test-tube CTJ25
symmetry planes: (X B0 y) and (X B0 Z)
Thickness: DD' = 12.5 mm
Face1: (A, B0, B1, B2, B3, B4, B5, C, D, E)
Face2: (A, B0, B0', A')
Co-ordinates of the points (mm):
min
max
B0
F'
B5'
X
-20.
42.5
0.
30.
30.
y
0.
30.
0.
20.25
3.5
Z
0.
12.5
0.
12.5
12.5

1.2
Material properties

E = 2.027027 1011 Pa
= 0.3

1.3

Boundary conditions and loadings
All nodes of the face1:
W = 0.
All nodes of the face2:
v = 0.
All nodes of line FF':
U = 0.
v = 0.01 mm
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2 Modeling of reference

2.1 Modeling common to all the tests

Grid: A number of nodes: 3323 a Number of meshs: 630 HEXA20
Cutting:
Face1 (A, B1,…, B5, C, D, E)
428 nodes
Face2 (A, B0, B0', A')
198 nodes
Segment FF'
11 nodes
Name of the nodes:
Not F' = NO2958
Not B5' = NO2974
Boundary conditions:
in all the nodes of Face1 DDL_IMPO:
(GROUP_NO: Grno1 DZ: 0.)
in all the nodes of Face2

(GROUP_NO: GRno8 DY: 0.)
in all the nodes of segment FF'
(GROUP_NO: Grno7 DX: 0. DY: 0.01)

2.2
Functionalities tested common to all modelings

Orders
Keys
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]

3
Reference solution

3.1
Method of calculation used for the reference solution

The reference solution is that obtained on the same grid with code PERMAS (Version 3.12) on CRAY XMP 25/01/91.

3.2
Results of reference: values tested

Reference
Aster
% Difference
Localization
(mm)
(mm)
Not F' vF'
1. 102
1. 102
0.
W
0.
F'
1.0296 104
1.0296 104
Not B5' uB5'
4.3006 103
4.3006 103
0.
v

0.
B5'
9.2890 103
9.2890 103
W
2.9173 105
2.9173 105
0.
B5'

---

4 Modeling
With
4.1
Functionalities tested by modeling

Dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).
Solveur **LDLT** by defect **without renumerotation.**

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
MECA_STATIQUE
SOLVEUR
METHOD
“LDLT”
[U4.31.01]
RENUM
“WITHOUT”

4.2
Parameters of execution of the two last observations
Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW
4.3
Time CPU to use of the two last observations
Values tested in conformity with the reference solution.
Order
Time To use
Time To use
3.05.24
3.02.11
BEGINNING
0.9954
0.7486
LIRE_MAILLAGE
3.0474
3.4488
AFFE_MODELE
0.0761
0.0753
DEFI_MATERIAU
0.4799
0.3783
AFFE_MATERIAU
0.0115
0.0118
AFFE_CHAR_MECA
2.2759
1.9005
MECA_STATIQUE
24.9792
25.7438
TEST_RESU
0.0459
0.0474
END
0.0537
0.0451
TOTAL_JOB 3.05.24

33.0770
0.8954
33.9724
TOTAL_JOB 3.02.11
33.3957
0.9740
34.3697

4.4

History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks

PERMAS
3.12
6/02/90
47.3
without dualisation
SIVA/88
6/02/90
157.2
without dualisation
ASTER
1.00.23
6/02/90
138.7
YMP
ASTER
1.00.55
22/05/90
16 MW
139.76
YMP
ASTER
1.01.07
6/08/90
8 MW
70.27
YMP
ASTER
1.02.15

15/11/90
8 MW
69.40
YMP
ASTER
1.04.13
30/05/91
8 MW
72.2
YMP
ASTER
2.02.02
14/04/92
8 MW
76.82
YMP
ASTER
2.02.25
17/07/92
8 MW
51.29
YMP
ASTER
2.05.25
13/10/93
16 MW
57.61
YMP
ASTER
3.02.11
11/10/94
16 MW
34.37
C90 Mode Y
ASTER
3.05.24
27/11/95
16 MW
33.97
C90 Mode Z

5 Modeling B

5.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Solveur **LDLT** by defect **without renumerotation.**

Orders	**Keys**		
AFFE_CHAR_CINE	MECA_IMPO		[U4.25.05]
NUME_DDL	RENUM	"WITHOUT"	[U4.42.01]
AFFE_CHAM_NO	SIZE	"DEPL_R"	[U4.26.01]
CALC_CHAR_CINE	CHAR_CINE		[U4.41.03]
RESO_LDLT			[U4.51.02]

5.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

5.3
Time CPU to use of the two last observations
Values tested in conformity with the reference solution.

Order	**Time To use**	**Time To use**
	3.05.24	**3.02.15**
BEGINNING	0.9956	0.7619
LIRE_MAILLAGE	3.0437	3.5535
AFFE_MODELE	0.0761	0.0747
DEFI_MATERIAU	0.4792	0.3838
AFFE_MATERIAU	0.0115	0.0116
AFFE_CHAR_CINE	0.0421	0.0430
CALC_MATR_ELEM	1.5854	1.5696
NUME_DDL	0.4535	0.4522
ASSE_MATRICE	4.1539	4.1030
AFFE_CHAM_NO	0.2946	0.1848
CALC_CHAR_CINE	0.0109	0.0111
FACT_LDLT	18.2386	

18.2914
RESO_LDLT
0.0864
0.0888
TEST_RESU
0.0194
0.0197
END
0.0539
0.0430
TOTAL_JOB 3.05.24
31.0639
0.8312
31.8951
TOTAL_JOB 3.02.15
30.9464
0.2983
31.2447

5.4
History of the performances
Code
Version
Date
Memory
To use Total CPU
Remarks

PERMAS
3.12
6/02/90
47.3
without dualisation
SIVA/88
6/02/90
157.2
without dualisation
ASTER
2.02.25
17/07/92
8 MW
47.9
YMP
ASTER
2.05.25

13/10/93
16 MW
54.42
YMP
ASTER
3.02.15
07/11/94
16 MW
31.25
C90 Mode Y
ASTER
3.05.24
27/11/95
16 MW
31.90
C90 Mode Z
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6 Modeling C

6.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).
Solveur **LDLT** by defect **with renumerotation** (Reverse Kuthil Mac Kee).

Orders	**Keys**	
AFFE_CHAR_MECA	DDL_IMPO	[U4.25.01]

MECA_STATIQUE
SOLVEUR
METHOD
“LDLT”
[U4.31.01]
RENUM
“RCMK”

6.2
Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

6.3
Time CPU to use of the two last observations

Values tested in conformity with the reference solution.

Order
Time To use
Time To use
3.05.24
3.02.11
BEGINNING
0.9939
0.7484
LIRE_MAILLAGE
3.0415
3.4450
AFFE_MODELE
0.0761
0.0756
DEFI_MATERIAU
0.4794
0.3778
AFFE_MATERIAU
0.0115
0.0117
AFFE_CHAR_MECA
2.2751
1.8991
MECA_STATIQUE
24.0927
19.6053

TEST_RESU
0.0459
0.0474
END
0.0537
0.0451
TOTAL_JOB 3.05.24
32.1968
0.5955
32.7923
TOTAL_JOB 3.02.11
27.2516
0.7576
28.0092

6.4
History of the performances

Code	Version	Date	Memory	To use Total CPU	Remarks
ASTER	2.05.25	13/10/93	16 MW	45.70	YMP
ASTER	3.02.11	11/10/94	16 MW	28.00	C90
ASTER	3.05.24	27/11/95	16 MW	32.79	C90 Mode Z

7 Modeling D

7.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Solveur **LDLT** by defect **with renumerotation** (Reverse Kuthil Mac Kee).

Orders	**Keys**		
AFFE_CHAR_CINE	MECA_IMPO		[U4.25.05]
NUME_DDL	RENUM	“RCMK”	[U4.42.01]
AFFE_CHAM_NO	SIZE	“DEPL_R”	[U4.26.01]
CALC_CHAR_CINE	CHAR_CINE		[U4.41.03]
RESO_LDLT			[U4.51.02]

7.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

7.3
Time CPU to use of the two last observations
Values tested in conformity with the reference solution.

Order	**Time To use**	**Time To use**
	3.05.24	**3.02.15**
BEGINNING	0.9952	0.7592
LIRE_MAILLAGE	3.0445	3.5527
AFFE_MODELE	0.0763	0.0750
DEFI_MATERIAU	0.4810	0.3837
AFFE_MATERIAU	0.0115	0.0116
AFFE_CHAR_CINE	0.0423	0.0429
CALC_MATR_ELEM	1.5824	1.5685
NUME_DDL	1.2654	1.2577
ASSE_MATRICE	3.7553	3.7108
AFFE_CHAM_NO	0.2948	0.1845
CALC_CHAR_CINE	0.0109	0.0111
FACT_LDLT	12.0916	

12.0831
RESO_LDLT
0.0754
0.0767
TEST_RESU
0.0194
0.0197
END
0.0537
0.0427
TOTAL_JOB 3.05.24
25.3171
0.9215
26.2386
TOTAL_JOB 3.02.15
25.0749
0.2375
25.3124

7.4

History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks

ASTER
2.05.25
13/10/93
16 MW
42.82
YMP
ASTER
3.02.15
07/11/94
16 MW
25.31
C90 Mode Y
ASTER
3.05.24
27/11/95
16 MW
26.24

---

8 Modeling E

8.1 Functionalities tested by modeling

Dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).
Solvor **gradient combined** (Solveur **GCPC**) **without renumerotation**.

Orders		**Keys**	
AFFE_CHAR_MECA	DDL_IMPO		[U4.25.01]
NUME_DDL	STORAGE	"MORSE"	[U4.42.01]
	RENUM	"WITHOUT"	
RESO_GRAD	METHOD	"GCPC"	[U4.51.04]

8.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98

System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW
8.3
Time CPU to use of the two last observations
Values tested in conformity with the reference solution.

Order	**Time To use**	**Time To use**
	3.05.24	**3.02.15**
BEGINNING	0.9567	0.7181
LIRE_MAILLAGE	3.0336	3.5353
AFFE_MODELE	0.0561	0.0547
DEFI_MATERIAU	0.4658	0.3724
AFFE_MATERIAU	0.0075	0.0075
AFFE_CHAR_MECA	2.2138	1.8889
CALC_MATR_ELEM	1.7262	1.7065
NUME_DDL	1.4979	1.4652
ASSE_MATRICE	2.7750	2.7599
CALC_VECT_ELEM	0.1904	0.1939
ASSE_VECTEUR	0.0287	0.0284

FACT_GRAD
1.3066
1.3093
RESO_GRAD
5.4980
5.3648
TEST_RESU
0.0158
0.0159
END
0.0465
0.0434
TOTAL_JOB 3.05.24
21.2454
0.8778
22.1232
TOTAL_JOB 3.02.15
20.6797
0.1453
20.8250

8.4
History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks
ASTER
2.08.03
14/11/94
16 MW
19.88
C90 Mode Y
ASTER
3.02.15
07/11/94
16 MW
20.82
C90 Mode Y
ASTER
3.05.24
27/11/95

---

9 Modeling F

9.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Solvor **gradient combined** (Solveur **GCPC**) **without renumerotation.**

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“WITHOUT”
AFFE_CHAM_NO
SIZE
“DEPL_R”
[U4.26.01]
CALC_CHAR_CINE
CHAR_CINE
[U4.41.03]

RESO_GRAD
METHOD
"GCPC"
[U4.51.04]

9.2

Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

9.3

Time CPU to use of the two last observations

Values tested in conformity with the reference solution.

Order	**Time To use**	**Time To use**
	3.05.24	**3.02.15**
BEGINNING	0.9583	0.7197
LIRE_MAILLAGE	3.0326	3.5394
AFFE_MODELE	0.0561	0.0549
DEFI_MATERIAU	0.4655	0.3730
AFFE_MATERIAU	0.0075	0.0075
AFFE_CHAR_CINE	0.0374	0.0382
CALC_MATR_ELEM	1.5646	1.5510
NUME_DDL	1.4038	1.3754

ASSE_MATRICE
3.1365
3.1324
AFFE_CHAM_NO
0.2908
0.1802
CALC_CHAR_CINE
0.0070
0.0072
FACT_GRAD
1.2990
1.3031
RESO_GRAD
5.1014
5.1417
TEST_RESU
0.0154
0.0154
END
0.0451
0.0418
TOTAL_JOB 3.05.24
18.8650
0.3580
19.2231
TOTAL_JOB 3.02.15
18.7115
0.1380
18.8495

9.4

History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks
ASTER
2.05.25
13/10/93
16 MW
31.5553
YMP

ASTER
3.02.15
07/11/94
16 MW
18.85
C90 Mode Y
ASTER
3.05.24
27/11/95
16 MW
19.22
C90 Mode Z
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10 Modeling
G

10.1 Functionalities tested by modeling

Dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).
Solvor **gradient combined** (Solveur **GCPC**) **with renumerotation** (Reverse Kuthil Mac Kee)

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“RCMK”
RESO_GRAD
METHOD
“GCPC”
[U4.51.04]

10.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

10.3 Time CPU to use of the two last observations

Values tested in conformity with the reference solution.
Order
Time To use
Time To use

3.05.24
3.02.15
BEGINNING
0.9965
0.7764
LIRE_MAILLAGE
3.0426
3.3226
AFFE_MODELE
0.0760
0.0758
DEFI_MATERIAU
0.4791
0.3788
AFFE_MATERIAU
0.0115
0.0117
AFFE_CHAR_MECA
2.2744
2.3866
CALC_MATR_ELEM
1.7402
1.7182
NUME_DDL
2.4128
2.4004
ASSE_MATRICE
2.8799
2.8937
CALC_VECT_ELEM
0.2107
0.2154
ASSE_VECTEUR
0.0326
0.0328
FACT_GRAD
1.2709
1.2873
RESO_GRAD
4.5478
4.5395
TEST_RESU
0.0198

0.0202
END
0.0548
0.0448
TOTAL_JOB 3.05.24
21.5823
0.7205
22.3028
TOTAL_JOB 3.02.15
21.5589
1.0165
22.5754

10.4 History of the performances

Code	**Version**	**Date**	**Memory**	**To use Total CPU**	**Remarks**
ASTER	2.05.25	13/10/93	16 MW	31.32	YMP
ASTER	3.03.15	07/02/95	16 MW	22.58	C90 Mode Z
ASTER	3.05.24	27/11/95	16 MW	22.30	C90 Mode Z

---

11 Modeling
H

11.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Solvor **gradient combined** (Solveur **GCPC**) **with renumerotation** (RCMK).

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“WITHOUT”
AFFE_CHAM_NO
SIZE
“DEPL_R”
[U4.26.01]
CALC_CHAR_CINE
CHAR_CINE
[U4.41.03]
RESO_GRAD
METHOD
“GCPC”
[U4.51.04]

11.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

11.3 Time CPU to use of the two last observations
Values tested in conformity with the reference solution.
Order
Time To use
Time To use
3.05.24
3.02.15
BEGINNING
0.9947
0.7602
LIRE_MAILLAGE
3.0449
3.5489
AFFE_MODELE
0.0761
0.0750
DEFI_MATERIAU
0.4798
0.3836
AFFE_MATERIAU
0.0115
0.0116
AFFE_CHAR_CINE
0.0422
0.0428
CALC_MATR_ELEM
1.5818
1.5637
NUME_DDL
2.4403
2.3971
ASSE_MATRICE
3.2501
3.2363
AFFE_CHAM_NO
0.2949
0.1843
CALC_CHAR_CINE
0.0108
0.0110
FACT_GRAD
1.2575
1.2628

RESO_GRAD
3.4183
3.4349
TEST_RESU
0.0195
0.0197
END
0.0532
0.0424
TOTAL_JOB 3.05.24
18.5089
0.8430
19.3519
TOTAL_JOB 3.02.15
18.3448
0.3324
18.6772

11.4 History of the performances

Code	Version	Date	Memory	To use Total CPU	Remarks
ASTER	2.05.25	13/10/93	16 MW	28.67	YMP
ASTER	3.02.15	07/11/94	16 MW	18.68	C90 Mode Y
ASTER	3.05.24	27/11/95	16 MW	19.35	C90 Mode Z

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12 Modeling
I

12.1 Functionalities tested by modeling

Dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).
Frontal Solvor **multi** with **renumerotation degree minimum**.

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“MANDELEVIUM”
RESO_LDLT
[U4.51.02]

12.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

12.3 Time CPU to use of the two last observations

Values tested in conformity with the reference solution.
Order
Time To use

Time To use
3.05.24
3.02.15
BEGINNING
0.9963
0.7603
LIRE_MAILLAGE
3.0429
3.5500
AFFE_MODELE
0.0760
0.0748
DEFI_MATERIAU
0.4790
0.3836
AFFE_MATERIAU
0.0115
0.0116
AFFE_CHAR_MECA
2.2738
1.9087
CALC_MATR_ELEM
1.7427
1.7246
NUME_DDL
6.0912
6.0898
ASSE_MATRICE
2.7848
2.7653
CALC_VECT_ELEM
4.9629
5.0035
ASSE_VECTEUR
0.2109
0.2143
FACT_LDLT
0.0328
0.0327
RESO_LDLT
0.0810
0.0811
TEST_RESU

0.0199
0.0203
END
0.0555
0.0449
TOTAL_JOB 3.05.24
24.3609
0.9526
25.3135
TOTAL_JOB 3.02.15
24.0031
0.4234
24.4265

12.4 History of the performances

Code	Version	Date	Memory	To use Total CPU	Remarks
ASTER	2.05.25	13/10/93	16 MW	39.64	YMP
ASTER	3.02.15	07/11/94	16 MW	24.43	C90 Mode Y
ASTER	3.05.24	27/11/95	16 MW	25.31	C90 Mode Z

13 Modeling
J

13.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Frontal Solvor **multi** with **renumerotation degree minimum**.

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
"MORSE"
[U4.42.01]
RENUM
"MANDELEVIUM"
AFFE_CHAM_NO
SIZE
"DEPL_R"
[U4.26.01]
CALC_CHAR_CINE
CHAR_CINE
[U4.41.03]
RESO_LDLT
[U4.51.02]

13.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

13.3 Time CPU to use of the two last observations

Values tested in conformity with the reference solution.
Order
Time To use
Time To use
3.05.24
3.02.15
BEGINNING
0.9971
0.7594
LIRE_MAILLAGE
3.0496
3.5502
AFFE_MODELE
0.0764
0.0749
DEFI_MATERIAU
0.4807
0.3835
AFFE_MATERIAU
0.0115
0.0116
AFFE_CHAR_CINE
0.0423
0.0428
CALC_MATR_ELEM
1.5895
1.5661
NUME_DDL
5.9534
5.9512
ASSE_MATRICE
3.1384
3.1357
AFFE_CHAM_NO
4.4731
4.4979
CALC_CHAR_CINE
0.2958
0.1854
FACT_LDLT
0.0115
0.0117
RESO_LDLT

0.0765
0.0737
TEST_RESU
0.0195
0.0199
END
0.0540
0.0431
TOTAL_JOB 3.05.24
21.7904
0.6150
22.4054
TOTAL_JOB 3.02.15
21.6031
0.3189
21.9220

13.4 History of the performances

Code	**Version**	**Date**	**Memory**	**To use Total CPU**	**Remarks**
ASTER	2.05.25	13/10/93	16 MW	35.64	YMP
ASTER	3.02.15	07/11/94	16 MW	21.92	C90 Mode Y
ASTER	3.05.24	27/11/95	16 MW	22.40	C90 Mode Z

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14 Modeling
K

14.1 Functionalities tested by modeling

Dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).
Solvor **gradient combined** (Solveur **GCPC SCAN**) **without renumerotation**.

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
"MORSE"
[U4.42.01]
RENUM
"WITHOUT"
RESO_GRAD
METHOD
"GCPC"
[U4.51.04]
JAGG_DIAG
"SCAN"

14.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

14.3 Time CPU to use of the two last observations

Values tested in conformity with the reference solution.
Order
Time To use
Time To use
3.05.24
3.02.15
BEGINNING
0.9570
0.7181
LIRE_MAILLAGE
3.0341
3.5346
AFFE_MODELE
0.0562
0.0547
DEFI_MATERIAU
0.4656
0.3724
AFFE_MATERIAU
0.0075
0.0075
AFFE_CHAR_MECA
2.2139
1.8901
CALC_MATR_ELEM
1.7216
1.7085
NUME_DDL
1.4976
1.4655
ASSE_MATRICE
2.7756
2.7673
CALC_VECT_ELEM
0.1901
0.1936
ASSE_VECTEUR
0.0287
0.0284
FACT_GRAD
1.3071
1.3092
RESO_GRAD

4.6113
4.6705
TEST_RESU
0.0158
0.0159
END
0.0465
0.0435
TOTAL_JOB 3.05.24
20.3528
0.6655
21.0183
TOTAL_JOB 3.02.15
19.9953
0.1146
20.1099

14.4 History of the performances

Code	Version	Date	Memory	To use Total CPU	Remarks
ASTER	2.05.25	13/10/93	16 MW	31.61	YMP
ASTER	3.02.15	07/11/94	16 MW	20.11	C90 Mode Y
ASTER	3.05.24	27/11/95	16 MW	21.02	C90 Mode Z

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15 Modeling
L

15.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Solvor **gradient combined** (Solveur **GCPC SCAN**) **without renumerotation**.

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“WITHOUT”
AFFE_CHAM_NO
SIZE
“DEPL_R”
[U4.26.01]
CALC_CHAR_CINE
CHAR_CINE
[U4.41.03]
RESO_GRAD
METHOD
“GCPC”
[U4.51.04]
JAGG_DIAG
“SCAN”

15.2 Parameters of execution of the two last observations

Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW

15.3 Time CPU to use of the two last observations

Values tested in conformity with the reference solution.

Order
Time To use
Time To use
3.05.24
3.02.15
BEGINNING
0.9563
0.7179
LIRE_MAILLAGE
3.0335
3.5346
AFFE_MODELE
0.0562
0.0547
DEFI_MATERIAU
0.4656
0.3724
AFFE_MATERIAU
0.0075
0.0075
AFFE_CHAR_CINE
0.0374
0.0381
CALC_MATR_ELEM
1.5660
1.5469
NUME_DDL
1.4040
1.3728
ASSE_MATRICE
3.1339
3.1244
AFFE_CHAM_NO
0.2907
0.1806

CALC_CHAR_CINE
0.0070
0.0072
FACT_GRAD
1.2969
1.3075
RESO_GRAD
4.2371
4.2871
TEST_RESU
0.0153
0.0154
END
0.0450
0.0419
TOTAL_JOB 3.05.24
17.9955
0.7874
18.7829
TOTAL_JOB 3.02.15
17.8389
0.1930
18.0319

15.4 History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks
ASTER
2.05.25
13/10/93
16 MW
27.57
YMP
ASTER
3.02.15
07/11/94
16 MW
18.03
C90 Mode Y
ASTER

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16 Modeling M

16.1 Functionalities tested by modeling

Dualisation of the boundary conditions kinematics (AFFE_CHAR_MECA).

Solvor **gradient combined** (Solveur **GCPC SCAN**) **with renumerotation** (RCMK).

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“WITHOUT”
RESO_GRAD
METHOD
“GCPC”
[U4.51.04]
JAGG_DIAG
“SCAN”

16.2 Parameters of execution of the two last observations

Version: 3.05.24

Date: 27/11/95

Machine: CRAY C98

System: Unicos 8.0 Mode Z

Obstruction memory: 16 MW

16.3 Time CPU to use of the two last observations

Values tested in conformity with the reference solution.

Order	**Time To use**	**Time To use**
	3.05.24	**3.02.15**
BEGINNING	0.9573	0.7182
LIRE_MAILLAGE	3.0392	3.5388
AFFE_MODELE	0.0561	0.0547
DEFI_MATERIAU	0.4660	0.3727
AFFE_MATERIAU	0.0075	0.0075
AFFE_CHAR_MECA	2.2184	1.8911
CALC_MATR_ELEM	1.7240	1.7083
NUME_DDL	2.3929	2.4952
ASSE_MATRICE	2.8752	2.8713
CALC_VECT_ELEM	0.1901	0.1940

ASSE_VECTEUR
0.0286
0.0285
FACT_GRAD
1.2689
1.2684
RESO_GRAD
3.3547
2.9505
TEST_RESU
0.0158
0.0159
END
0.0466
0.0436
TOTAL_JOB 3.05.24
20.0669
0.7356
20.8025
TOTAL_JOB 3.02.15
19.3740
0.1921
19.5661

16.4 History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks
ASTER
2.05.25
13/10/93
16 MW
28.73
YMP
ASTER
3.02.15
07/11/94
16 MW
19.57
C90 Mode Y
ASTER

3.05.24
27/11/95
16 MW
20.80
C90 Mode Z
Handbook of Validation
V1.10 booklet: Benchmarks
HI-75/97/002 - Ind A

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17 Modeling
NR

17.1 Functionalities tested by modeling

No the dualisation of the boundary conditions kinematics (AFFE_CHAR_CINE).
Solvor **gradient combined** (Solveur **GCPC SCAN**) **with renumerotation** (RCMK).

Orders
Keys
AFFE_CHAR_CINE
MECA_IMPO
[U4.25.05]
NUME_DDL
STORAGE
“MORSE”
[U4.42.01]
RENUM
“RCMK”
AFFE_CHAM_NO
SIZE
“DEPL_R”
[U4.26.01]
CALC_CHAR_CINE
CHAR_CINE

[U4.41.03]
RESO_GRAD
METHOD
“GCPC”
[U4.51.04]
JAGG_DIAG
“SCAN”
17.2 Parameters of execution of the two last observations
Version: 3.05.24
Date: 27/11/95
Machine: CRAY C98
System: Unicos 8.0 Mode Z
Obstruction memory: 16 MW
17.3 Time CPU to use of the two last observations
Values tested in conformity with the reference solution.
Order
Time To use
Time To use
3.05.24
3.02.15
BEGINNING
0.9555
0.7187
LIRE_MAILLAGE
3.0361
3.5396
AFFE_MODELE
0.0561
0.0547
DEFI_MATERIAU
0.4657
0.3725
AFFE_MATERIAU
0.0075
0.0075
AFFE_CHAR_CINE
0.0374
0.0382
CALC_MATR_ELEM
1.5660
1.5497
NUME_DDL
2.4135

2.3755
ASSE_MATRICE
3.2384
3.2293
AFFE_CHAM_NO
0.2906
0.1800
CALC_CHAR_CINE
0.0070
0.0072
FACT_GRAD
1.2541
1.2580
RESO_GRAD
2.6638
2.7046
TEST_RESU
0.0153
0.0154
END
0.0450
0.0418
TOTAL_JOB 3.05.24
17.4953
0.4958
17.9911
TOTAL_JOB 3.02.15
17.3232
0.1282
17.4514

17.4 History of the performances

Code
Version
Date
Memory
To use Total CPU
Remarks
ASTER
2.05.25
13/10/93
16 MW
26.13
YMP

ASTER
3.02.15
07/11/94
16 MW
17.45
C90 Mode Y
ASTER
3.05.24
27/11/95
16 MW
17.99
C90 Mode Z
Handbook of Validation
V1.10 booklet: Benchmarks
HI-75/97/002 - Ind A

Code_Aster ®
Version
4.0
Titrate:
YYYY108 - Test-tube CTJ25
Date:
05/01/98
Author (S):
X. DESROCHES, J.R. LÉVESQUE
Key:
V1.10.108-D Page:
18/18

18
Summaries of the results
18.1 Classification in increasing weather

Code_Aster
3.05.24
27/11/95
16 MW
C90 Mode Z
Key
Solvor
Time To use
Time To use
Evolution
3.05.24
3.02.11/15

NR
AFFE_CHAR_CINE GCPC - SCAN RENUM
17.495
17.323
1,01
“RCMK”
L
AFFE_CHAR_CINE GCPC - SCAN without
17.995
17.838
1,01
RENUM
H
AFFE_CHAR_CINE GCPC RENUM “RCMK”
18.509
18.345
1,01
F
AFFE_CHAR_CINE GCPC without RENUM
18.865
18.711
1,01
M
AFFE_CHAR_MECA GCPC - SCAN RENUM
20.067
19.374
1,04
“RCMK”
K
AFFE_CHAR_MECA GCPC - SCAN without
20.353
19.995
1,02
RENUM
E
AFFE_CHAR_MECA GCPC without RENUM
21.245
20.680
1,03
G
AFFE_CHAR_MECA GCPC RENUM “RCMK”
21.582
21.559

1,00
J
AFFE_CHAR_CINE MULT_FRONT
21.790
21.603
1,01
I
AFFE_CHAR_MECA MULT_FRONT
24.361
24.003
1,01
D
AFFE_CHAR_CINE LDLT RENUM “RCMK”
25.317
25.075
1,01
B
AFFE_CHAR_CINE LDLT without RENUM
31.064
30.946
1,00
C
AFFE_CHAR_MECA LDLT RENUM “RCMK”
32.197
27.252
1,18
With
AFFE_CHAR_MECA LDLT without RENUM
33.077
33.396
0,99

18.2 Evolutions between the two last observations

One notes a small overall degradation (<1%) of the total performances.
By observing two modelings implementing MECA_STATIQUE with RENUM: “RCMK”, one important degradation appears:
MECA_STATIQUE
MECA_STATIQUE
Evolution
3.02.11
3.05.24
C
AFFE_CHAR_MECA LDLT RENUM
24.09

Handbook of Validation
V1.10 booklet: Benchmarks
Document: V1.10.110

YYYY110 - Reactor vessel. Modal analysis

Summary:

This three-dimensional problem consists in seeking modes of vibration of a reactor vessel modelled by elements of hull or beams. This test of mechanics of the structures corresponds to an analysis dynamics of an assembled structure having a linear behavior. It includes/understands two modelings (two solveurs of resolution of system linear are tested).

Via this problem, one tests the element of hull DKT, the element of beam of Timoshenko, it calculation of the clean modes by the method of Lanczos.

There are no results of reference. They were only compared with modelings by “beams equivalent " and they were in concord.

This test also makes it possible to ensure a follow-up of the performances in particular of order MODE_ITER_SIMULT
and of the methods of resolution of linear systems LDLT and MULT_FRONT.

---

1 Problem of reference

1.1 Geometry

encass 1
supp_cuv

1.2 Material properties

For the part modelled by hulls (steel):

E = 2.1 1011 Pa
= 0.3
= 7.85 103 kg/m3

For the part modelled by beams:

E = 3.15 1011 Pa
= 0.3
= 7.85 103 kg/m3

1.3 Boundary conditions

The groups of nodes SUPP_CUV and ENCASS1 are embedded (three displacements and the three rotations are blocked).

Code_Aster ®
Version
4.0
Titrate:
YYYY110 Reactor vessel. Modal analysis
Date:
26/08/99
Author (S):

2 Modeling of reference

2.1 Characteristics of modeling

The elements of hull are modelled by DKT and the elements of beam by POU_D_T.

2.2 Functionalities tested

Orders		Keys	
AFFE_MODELE	MODELING	"POUT_D_T"	[U4.22.01]
		"DKT"	
AFFE_CARA_ELEM	HULL	THICK	[U4.24.01]
	BEAM	SECTION	"GENERAL"
AFFE_CHAR_MECA	DDL_IMPO		[U4.25.01]

2.3 Characteristics of the grid

A number of nodes: 5876
A number of meshs and types: 425 POU_D_T, 11032 DKT (TRIA3)

2.4 Boundary conditions

For the groups of nodes SUPP_CUV and ENCASS1 one has (embedding):
DX = DY = DZ = 0.
DRX = DRY = DRZ = 0.

---

3 Reference solution

3.1 Method of calculation used for the reference solution

The reference solution is that obtained on the same grid with Code_Aster (version 3.06.6) on CRAY C98 18/03/96.

3.2 Results of reference: values tested

Eigen frequencies	Reference	Aster 3.06.06	Difference
Mode 1	46.77	46.775	0.012
Mode 2	46.95	46.954	0.009
Mode 3	85.89	85.894	0.005
Mode 4	85.94	85.947	0.009

3.3 Remarks

The structure being slightly nonsymmetrical, one does not obtain perfect double modes.

---

4 Modeling
With

4.1
Functionalities tested by modeling

SOLVEUR LDLT by defect with renumerotation RCMK. Method of Lanczos for calculation of frequencies of vibration.

Orders
Keys
NUME_DDL
RENUM
"RCMK"
[U4.42.01]
MODE_ITER_SIMULT
METHOD
"TRI_DIAG"
[U4.52.02]
CALC_FREQ
OPTION
"BAND"

4.2
Parameters of execution (last observation)

Version: 4.02.09
Date: 28/10/97
Machine: CRAY C98
System:
UNICOS 8.0
Obstruction memory:
50 MW

4.3

Time CPU to use of the last observation

Values tested in conformity with the reference solution.

Order
3.7.0
4.3.0
BEGINNING
0.89
1.06
LIRE_MAILLAGE
19.97
21.19
AFFE_MODELE
0.14
0.15
DEFI_MATERIAU
0.46
0.62
AFFE_MATERIAU
0.03
0.03
DEFI_VALEUR
0.03
0.04
AFFE_CARA_ELEM
16.29
15.59
AFFE_CHAR_MECA
7.53
7.51
CALC_MATR_ELEM (rigidity)
6.10
5.97
CALC_MATR_ELEM (mass)
4.81
4.59
NUME_DDL
0.87
0.86
ASSE_MATRICE (rigidity)
5.44
5.83
ASSE_MATRICE (mass)
5.32

5.67
MODE_ITER_SIMULT
311.95
311.91
TEST_RESU
0.03
0.02
END
0.07
0.06
TOTAL
381.96
383.28

---

5 Modeling
B
5.1
Functionalities tested by modeling

SOLVEUR MULT_FRONT by defect with renumerotation. Method of Lanczos for calculation of frequencies of vibration.

Orders
Keys
NUME_DDL
METHOD
“MULT_FRONT”
[U4.42.01]
RENUM
“MDA”

MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“BAND”

5.2

Parameters of execution (last observation)

Version: 4.02.09
Date: 28/10/97
Machine: CRAY C98
System:
UNICOS 8.0
Obstruction memory:
50 MW

5.3

Time CPU to use of the last observation

Values tested in conformity with the reference solution.

Order

4.03.00
BEGINNING
1.06
LIRE_MAILLAGE
21.18
AFFE_MODELE
0.15
DEFI_MATERIAU
0.62
AFFE_MATERIAU
0.027
DEFI_VALEUR
0.04
AFFE_CARA_ELEM
15.575
AFFE_CHAR_MECA
7.51
CALC_MATR_ELEM (rigidity)
5.98
CALC_MATR_ELEM (mass)
4.6
NUME_DDL
5.73

ASSE_MATRICE (rigidity)
5.48
ASSE_MATRICE (mass)
5.3
MODE_ITER_SIMULT
42.62
TEST_RESU
0.02
END
0.06
TOTAL
118.12

6 Summary of the results

Nothing to announce for the moment.
It is noticed that the change of solvor (passage of method LDLT to the method MULT_FRONT) made it possible to gain approximately a factor 8 on the resolution of the modal problem.

Author (S):
E. CHAMPAIN *Key*

Organization (S): EDF/RNE/AMV

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V1.10 booklet: Benchmarks
Document: V1.10.119

ELSA01 - Nonlinear seismic analysis of a line of piping

Summary:
This test validates calculations of pipes right and bent in dynamics of the nonlinear structures (DYNA_NON_LINE).
A seismic excitation is imposed on the line. This one involves a partial plasticization (1%) elbows *only. The values tested are displacements. The values of reference are displacements resulting tests ELSA realized at the ECA.*
Four modelings are tested: a modeling in elements beams of Timoshenko POU_D_T with plasticity total (linear isotropic work hardening), modeling A, a modeling in elements PIPE with 3 nodes with taking into account of local plasticity (linear kinematic work hardening), modeling B, a modeling in elements PIPE with 4 nodes, modeling C and a modeling D made up of elements DKQ in the elbows and of PIPE with 3 nodes in the right parts.
Calculations carried out let appear that modeling POU_D_T gives correct results for first cycles (0,6 to 21% of variation compared to the values measured in displacements), is far from expensive in computing times but takes on the other hand a long time to implement because of necessary identification of one a significant number of parameters of the total criterion of plasticity. This modeling does not make it possible to reach with the constraints.
Modeling PIPE with 3 nodes gives good results (0,75% to 12,67% of variation compared to measured displacements). It is more expensive in computing times than modeling POU_D_T (7435 dryness CPU 71 dryness) but much faster to implement against since it has the advantage of not to depend on parameters to identify as a preliminary.
The use of the element PIPE to 4 nodes allows a significant profit in terms of a number of elements and thus

of ddl. For a computing time divided by 2 compared to modeling B, the results remain excellent (3,1 to 5% of variation on displacements). Analysis of the test by modelings PIPE on a number of cycles more important shows than the behavior of material is represented better by a kinematic work hardening
linear that a linear isotropic work hardening.
Lastly, calculation by a mixed modeling (DKT/PIPE) is much more expensive in computing times (12874 dryness CPU) for a less precision (0,6% to 21% of variation).
Very realistic results obtained by modelings PIPE over the total duration of the test comparatively with modelings POU_D_T as their fast time of implementation show, in spite of times of calculation more important, interest of this type of modeling for the nonlinear seismic analysis of pipings.

1
Problem of reference

1.1 Geometry

The system considered is the line of piping ELSA used during tests of seismic characterization of piping at laboratory EMSI of the ECA. The line is a simplification of a segment of line of piping REFERENCE MARK RRA05 of diameter 6 austenitic steel '' 316L. Piping forms a quadrant in
plan OYZ. It is made up of five right sections and four elbows with 90°. On the right section in top of this quadrant is welded a rigid mass which simulates a valve.

1528
C
Units: mm
819
B
With
O

Characteristics of the line:
Tubular section of external ray Rext = 81,775 mm and thickness ep = 7,345 mm
Radius of curvature of the elbows: Rc = 228,6 mm

Characteristic of the rod:
Tubular section of external ray Rext = 38,05 mm and thickness ep = 4,5 mm

Characteristic of the valve:
Lx = 343 mm
Ly = 408 mm
Lz = 200 mm
Mass: M = 275 kg

1.2
Material properties

Density of the right parts: = 13027 kg/m3 Poisson's ratio: = 0,3
Density of the elbows: = 14737 kg/m3
Density of the rod: = 6860 kg/m3
Young modulus of the line: E = 1,9.105 MPa
Young modulus of the rod: E = 1,8 1011 Pa
Elastic limit:

y = 242,4 MPa
Linear slope of work hardening: H = 7670 MPa
Constant of Prager: C = 5,33 109 MPa

N.B.:

The line being filled with water at rest, densities of the elbows and the parts right-hand sides were modified in order to take account of the mass of the fluid.
Handbook of Validation

V1.10 booklet: Benchmarks
HT-62/01/012/A

1.3
Boundary conditions, loadings and initial conditions

Embedding in A and B and blocking of the vertical movements out of C.

Pressure interns P = 12 MPa.

Loading: seism according to identical direction OX for the 2 points of supports A and B (structure mono-supported). It corresponds to the acceleration measured on the level of the mobile plate (see accélérogramme on the following figure). Computing times over the total duration of the test being very important [bib2], calculation presented was carried out until T = 1,1 S (approximately 2 periods).

The structure is initially at rest (null speeds and displacements).

30
20
10
] - 2
.s
0
m
[
N
io
R
At
-10
Accélé
-20

-30
-40
0
2
4
6
8
10
12
14
Time [S]

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is given by experimental displacements and the results of calculations of each modeling obtained at the time of the study to test nonthe regression.

2.2

Results of reference

The comparison relates to displacements of the valve in the direction of the excitation for different moments. The results of various modelings are compared initially with measurements and in the second time, to test nonthe regression, with the results obtained with Code_Aster at the time of the study.

Experimental results:

Moment (S) Displacement (m)
0,66 -20,1
10-3
0,75 +53,0
10-3
0,86 -28,9
10-3
1,06 +67,5
10-3

Results of the calculation of modeling A to test nonthe regression:

Moment (S) Displacement (m)
0,66 -20,3
10-3
0,75 +52,6
10-3
0,86 -27,0
10-3
1,06 +81,6
10-3

Results of the calculation of modeling B to test nonthe regression:

Moment (S) Displacement (m)
0,66 -20,2
10-3
0,75 +52,2
10-3
0,86 -28,5
10-3
1,06 +76,0
10-3

Results of the calculation of modeling C to test nonthe regression:

Moment (S) Displacement (m)
0,66 -20,0
10-3
0,75 +52,0
10-3
0,86 -29,2
10-3
1,06 +71,8
10-3

Results of the calculation of modeling D to test nonthe regression:

Moment (S) Displacement (m)
0,66 -20,4
10-3
0,75 +52,7
10-3
0,86 -25,0
10-3
1,06 +81,7
10-3

2.3

Uncertainties on the solution

On the level of the precision of displacements, the report/ratio of test [bib1] made state of a precision of the order of 1/10 Misters.

2.4 References bibliographical

[1]
BULAND P., CARRIES J., CANDA Mr., MAHE Mr., "seismic Tests of a section of line of piping REFERENCE MARK RRA05 ", Report ECA DMT/CEA/95/545.
[2]
CHAMPAIN E., "Project CACIP: Validation of the development relating to the taking into account of plasticity in the pipes ", Notes HP-52/99/029.
[3]
MASSIN P., PROIX J.M., "Finite elements of right pipe and curve with ovalization, swelling and warping in elastoplasticity ", Note HI-74/99/024/A.
[4]
RCC-M - Edition June 1988.
Handbook of Validation

V1.10 booklet: Benchmarks
HT-62/01/012/A

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3 Modeling
With

3.1
Characteristics of modeling

The line is modelled in beams of Timoshenko (POU_D_T). They are circular and hollow for pipes and full for the rod. The valve is modelled by a discrete element in translation/rotation (DIS_TR). The rod is modelled in POU_D_T like by a discrete element in translation (DIS_T) in its top.

Inertias of the bent parts are divided by the lawful factors of flexibility [bib4] so to take account of the effects of ovalization. The factors of flexibility are given by:

16
. 5
1
F
=
.

RCCM

P.rmoy

1 +

. X

E. E
K

with:
4
1
E: thickness
er
3
3

R
=
C
moy
R
R
and X
C
=
6

moy: average radius
R 2
K

Rc: radius of curvature
moy
E rmoy
P: internal pressure
E: Young modulus

Plasticity during the tests having remained localised on the level of the elbows (1% of deformation plastic approximately), one admits that only the elements in the bent parts have a behavior elastoplastic (linear isotropic work hardening) and that the right parts have a behavior rubber band. The parameters of the total criterion of plasticity were identified on the calculation of an elbow in monotonous inflection (while comparing with the results of reference obtained by the elements PIPE), them values selected are:

·
y = Z = 0,84
·
y = Z = 4,0 10-3
·
Limiting normal effort: Np = 9,081 105 NR
·
Moment of the first plasticization of the elbows: Me = 8,48 103 N.m
·
Plastic bending moment limits elbows: Mp = 25.103 N.m
·
Limiting torque: Mpx = 7,067 104 N.m

One calculates the seismic response until T = 1,1 S with a step of calculation of 10-2 seconds. The diagram of integration in time used is that of NEWMARK (alpha = 0,25 delta = 0,5). The problem incremental nonlinear is solved by the method of NEWTON for which the matrix used in the total iterations is the elastic matrix at the time of the phase of the prediction then the matrix tangent reactualized with each iteration for the following iterations.

3.2
Characteristics of the grid

Grid of an elbow: 30 elements POU_D_T

Ddl numbers: 2512

A number of nodes: 342
A number of meshs and types: 340 SEG2 including 331 for piping, 3 for the valve and 6 for the rod.
2 POI1 (1 for the valve and 1 for the top of the rod)
A sight of the grid is given on the following figure.

3.3 Functionalities tested

Orders

AFFE_MODELE AFFE
MODELING
"POU_D_T"
AFFE_CARA_ELEM BEAM
SECTION
"CIRCLE"
DEFI_MATERIAU ECRO_LINE

VMIS_POUTRE

ELAS

AFFE_CHAR_MECA DDL_IMPO

LIAISON_UNIF

LIAISON_SOLIDE

MACRO_MATR_ASSE CHARGES

CALC_CHAR_SEISME MONO_APPUI
"YES"

AFFE_CHAR_MECA VECT_ASSE

DYNA_NON_LINE COMP_INCR
RELATION
"VMIS_POU_LINE"

"ELAS"
RECU_FONCTION NOM_CHAM
DEPL

4
Results of modeling A

4.1 Values tested

Values of displacements (m) of the valve in the direction of the excitation (direction X) to different moments.

Moment (S)
Displacement
Aster *(m)*

% difference
measured (m)
0,66 -20,1
10-3 -20,3
10-3 1,24
0,75 +53,0
10-3 +52,6
10-3 -0,68
0,86 -28,9
10-3 -27,0
10-3 -6,61
1,06 +67,5
10-3 +81,6
10-3 20,95

Evolution of displacements of the valve calculated and measured according to time:

0,08
0,06
reference
modeling A
0,04
winnow [m]
has
0,02
acement of L
pl
Die
0
-0,02
-0,04
0
0,2
0,4
0,6
0,8
1
Time [S]

4.2
Parameters of execution of the last observation

Version: 5.03.18

Machine: SGI Origin 2000

Obstruction memory: 30 Mo
Time CPU To use: 71 seconds
Handbook of Validation

V1.10 booklet: Benchmarks
HT-62/01/012/A

4.3
Time CPU to use by order at the time of the last observation

Order
Time CPU To use

5.03.18
AT THE BEGINNING OF 0.26
LIRE_MAILLAGE 0.23
DEFI_GROUP 0.03
AFFE_MODELE 0.03
AFFE_CARA_ELEM 0.92
DEFI_MATERIAU 0.11
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.11
DEFI_MATERIAU 0.11
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.11
AFFE_MATERIAU 0.02

AFFE_CHAR_MECA 0.55
DEFI_FONCTION 0.01
CALC_MATR_ELEM 0.19
NUME_DDL 0.12
ASSE_MATRICE 0.04
CALC_MATR_ELEM 0.16
ASSE_MATRICE 0.02
CALC_CHAR_SEISME 0.03
AFFE_CHAR_MECA 0.02
DEFI_VALEUR 0.00
DEFI_VALEUR 0.00
DEFI_LIST_REEL 0.01
DYNA_NON_LINE 65.14
RECU_FONCTION 0.08
TEST_FONCTION 0.01
TEST_FONCTION 0.01
AT THE END OF 0.44
TOTAL_JOB 70.83

---

5 Modeling B

5.1

Characteristics of modeling

The line is modelled in elements PIPE in the right parts and the bent parts of piping. The rod is on the other hand always modelled in beams and the valve by a discrete element in translation/rotation.
The element PIPE used is the element with 3 nodes comprising 2 layers and 16 sectors. Three modes of Fourier allow to describe ovalization, the swelling and the warping of the sections.

As previously, it is admitted that only the elements in the bent parts have one elastoplastic behavior (kinematic work hardening) and that the right parts have one elastic behavior.

One uses a step of times of 102 S for temporal integration. The seismic answer is calculated until T = 1,1 S. the diagram of integration in time used is that of NEWMARK (alpha = 0,25 delta = 0,5). The nonlinear incremental problem is solved by the method of NEWTON for which stamp used in the total iterations is the elastic matrix at the time of the phase of the prediction then the tangent matrix reactualized with each iteration for the following iterations.

5.2
Characteristics of the grid

Grid of an elbow: 30 elements PIPE with 3 nodes

Ddl numbers: 14827

A number of nodes: 673
A number of meshs and types: 211 SEG3 (left right and bent piping) for the elements PIPE
9 SEG2 (3 for the valve and 6 for the rod) for elements POU_D_T
2 POI1 (1 for the valve and 1 for the top of the rod)
A sight of the grid is given on the following figure.

5.3 Functionalities tested

Orders

AFFE_MODELE AFFE
MODELING
“PIPE”

“POU_D_T”
AFFE_CARA_ELEM BEAM

ORIENTATION
CARA
“GENE_TUYAU”
DEFI_MATERIAU ECRO_LINE

PRAGER

AFFE_CHAR_MECA DDL_IMPO

LIAISON_UNIF

LIAISON_SOLIDE

FORCE_TUYAU

MACRO_MATR_ASSE CHARGES

CALC_CHAR_SEISME MONO_APPUI
“YES”

AFFE_CHAR_MECA VECT_ASSE

DYNA_NON_LINE COMP_INCR RELATION
“VMIS_ECMI_LINE”

“ELAS”

TUYAU_NCOU

TUYAU_NSEC

RECU_FONCTION NOM_CHAM
DEPL

6
Results of modeling B

6.1 Values tested

Values of displacements (m) of the valve in the direction of the excitation (direction X) to different moments.

Moment (S)

Displacement
Aster *(m)*
% difference
measured (m)
0,66 -20,1
10-3 -20,2
10-3 0,75
0,75 +53,0
10-3 +52,2
10-3 -1,55
0,86 -28,9
10-3 -28,5
10-3 -1,25
1,06 +67,5
10-3 +76,0
10-3 12,67

Evolution of displacements of the valve calculated and measured according to time:

0,08
0,06
reference
modeling B
0,04
winnow [m]
has
0,02
acement of L
pl
Die
0
-0,02
-0,04
0
0,2
0,4
0,6
0,8
1
Time [S]

6.2
Parameters of execution of the last observation

Version: 5.03.18

Machine: SGI Origin 2000

Obstruction memory: 300 Mo
Time CPU To use: 7436 seconds
Handbook of Validation

V1.10 booklet: Benchmarks
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
ELSA01 - Nonlinear seismic analysis of piping

Date:
22/11/01
Author (S):
E. CHAMPAIN *Key*
:
V1.10.119-A Page:
13/22

6.3
Time CPU to use by order at the time of the last observation

Order
Time CPU To use

5.03.18
AT THE BEGINNING OF 0.27
LIRE_MAILLAGE 0.29
DEFI_GROUP 0.03
AFFE_MODELE 0.03
AFFE_CARA_ELEM 1.06
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.11
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.11

DEFI_MATERIAU 0.12
AFFE_MATERIAU 0.02
AFFE_CHAR_MECA 0.96
AFFE_CHAR_MECA 0.04
DEFI_FONCTION 0.00
DEFI_FONCTION 0.00
CALC_MATR_ELEM 18.28
NUME_DDL 1.51
ASSE_MATRICE 0.42
CALC_MATR_ELEM 108.15
ASSE_MATRICE 0.46
CALC_CHAR_SEISME 0.08
AFFE_CHAR_MECA 0.02
DEFI_VALEUR 0.00
DEFI_VALEUR 0.00
DEFI_LIST_REEL 0.01
DYNA_NON_LINE 7300.69
RECU_FONCTION 0.12
TEST_FONCTION 0.01
TEST_FONCTION 0.01
AT THE END OF 0.50
TOTAL_JOB 7435.77

---

7 Modeling
C

7.1
Characteristics of modeling

The line is modelled in elements PIPE with 4 nodes in the right parts and the bent parts piping. The rod is on the other hand always modelled in beams and the valve by an element discrete in translation/rotation.
The element PIPE used is the element comprising 2 layers and 16 sectors. Three modes of Fourier allow to describe ovalization, the swelling and the warping of the sections.
As previously, it is admitted that only the elements in the bent parts have one elastoplastic behavior (kinematic work hardening) and that the right parts have one elastic behavior.

One uses a step of times of 102 S for temporal integration. The seismic answer is calculated until T = 1,1 S. the diagram of integration in time used is that of NEWMARK (alpha = 0,25 delta = 0,5). The nonlinear incremental problem is solved by the method of NEWTON for which stamp used in the total iterations is the elastic matrix at the time of the phase of the prediction then the tangent matrix reactualized with each iteration for the following iterations.

7.2
Characteristics of the grid

Grid of an elbow: 5 elements PIPE with 4 nodes

Ddl numbers: 5026

A number of nodes: 161
A number of meshs and types: 75 SEG4 (left right and bent piping) for the elements PIPE
9 SEG2 (3 for the valve and 6 for the rod) for elements POU_D_T
2 POI1 (1 for the valve and 1 for the top of the rod)
A sight of the grid is given on the following figure.

7.3 Functionalities tested

Orders

CREA_MAILLAGE MODI_MAILLE
OPTION
"SEG3_4"
AFFE_MODELE AFFE
MODELING
"PIPE"

"POU_D_T"
AFFE_CARA_ELEM BEAM

ORIENTATION
CARA
"GENE_TUYAU"
DEFI_MATERIAU ECRO_LINE

PRAGER

AFFE_CHAR_MECA DDL_IMPO

LIAISON_UNIF

LIAISON_SOLIDE

FORCE_TUYAU

MACRO_MATR_ASSE CHARGES

CALC_CHAR_SEISME MONO_APPUI
“YES”

AFFE_CHAR_MECA VECT_ASSE

DYNA_NON_LINE COMP_INCR
RELATION
“VMIS_ECMI_LINE”

“ELAS”
TUYAU_NCOU

TUYAU_NSEC

RECU_FONCTION NOM_CHAM
DEPL

Code_Aster ®
Version
5.0

Titrate:
ELSA01 - Nonlinear seismic analysis of piping

Date:
22/11/01
Author (S):
E. CHAMPAIN *Key*
:
V1.10.119-A Page:
16/22

8
Results of modeling C

8.1 Values
tested

Values of displacements (m) of the valve in the direction of the excitation (direction X) to different moments.

Moment (S)
Displacement
Aster *(m)*
% difference
measured (m)
0,66 -20,1
10-3 -20,0
10-3 -0,4
0,75 +53,0
10-3 +52,0
10-3 -1,9
0,86 -28,9
10-3 -29,2
10-3 1,2
1,06 +67,5
10-3 +71,8
10-3 6,4

Evolution of displacements of the valve calculated and measured according to time:

0,08
0,06
reference
modeling C
0,04
winnow [m]
has
0,02
acement of L
pl
Die
0
-0,02
-0,04
0
0,2
0,4
0,6
0,8
1
Time [S]

8.2
Parameters of execution of the last observation

Version: 5.04.01

Machine: SGI Origin 2000

Obstruction memory: 300 Mo
Time CPU To use: 3387 seconds
Handbook of Validation

V1.10 booklet: Benchmarks
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
ELSA01 - Nonlinear seismic analysis of piping

8.3
Time CPU to use by order at the time of the last observation

Order
Time CPU To use

5.04.01
AT THE BEGINNING OF 0.37
LIRE_MAILLAGE 0.11
DEFI_GROUP 0.03
CREA_MAILLAGE 0.05
AFFE_MODELE 0.03
AFFE_CARA_ELEM 0.34
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.13
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.12
DEFI_MATERIAU 0.12
AFFE_MATERIAU 0.02
AFFE_CHAR_MECA 0.31
AFFE_CHAR_MECA 0.03
DEFI_FONCTION 0.01
DEFI_FONCTION 0.01
CALC_MATR_ELEM 10.62
NUME_DDL 0.47
ASSE_MATRICE 0.18
CALC_MATR_ELEM 62.11
ASSE_MATRICE 0.16
CALC_CHAR_SEISME 0.04
AFFE_CHAR_MECA 0.02
DEFI_VALEUR 0.00
DEFI_VALEUR 0.00
DEFI_LIST_REEL 0.00
DYNA_NON_LINE 3305.68

RECU_FONCTION 0.16
TEST_FONCTION 0.01
TEST_FONCTION 0.01
IMPR_COURBE 0.02
AT THE END OF 4.48

TOTAL_JOB 3386.79

9 Modeling D

9.1 Characteristics of modeling

The line is modelled in elements PIPE with 3 nodes in the right parts and in elements DKQ in the bent parts of piping. The elements pipes make it possible not to model them right parts contiguous to the elbows in elements DKQ. The rod is on the other hand always modelled in beams and the valve by a discrete element in translation/rotation.
The element PIPE used is the element comprising 2 layers and 16 sectors. Three modes of Fourier allow to describe ovalization, the swelling and the warping of the sections.
As previously, it is admitted that only the elements in the bent parts have one elastoplastic behavior (kinematic work hardening) and that the right parts have one elastic behavior.

The pressure applied in the elbows is modified to hold account owing to the fact that in the hulls pressure is applied to the average surface of the element in not in skin interns (P=110,2 bars with place of 120 bars).
One uses a step of times of 102 S for temporal integration. The seismic answer is calculated until T = 1,1 S. the diagram of integration in time used is that of NEWMARK (alpha = 0,25 delta = 0,5). The nonlinear incremental problem is solved by the method of NEWTON for which stamp used in the total iterations is the elastic matrix at the time of the phase of the prediction then the tangent matrix reactualized with each iteration for the following iterations.

9.2
Characteristics of the grid

Grid of an elbow: 1200 elements DKQ (50 in the section and 24 in the curve)

Ddl numbers: 39027

A number of nodes: 5437
A number of meshs and types: 4800 DKQ (left bent piping)
75 SEG3 (left right piping) for the elements PIPE
9 SEG2 (3 for the valve and 6 for the rod) for elements POU_D_T
2 POI1 (1 for the valve and 1 for the top of the rod)
A sight of the grid is given on the following figure.

9.3 Functionalities tested

Orders

AFFE_MODELE AFFE MODELING "PIPE"

"DKT"

"POU_D_T"
AFFE_CARA_ELEM BEAM

ORIENTATION
CARA
"GENE_TUYAU"
HULL

DEFI_MATERIAU ECRO_LINE

PRAGER

AFFE_CHAR_MECA DDL_IMPO

LIAISON_UNIF

LIAISON_SOLIDE

FORCE_COQUE

FORCE_TUYAU

MACRO_MATR_ASSE CHARGES

CALC_CHAR_SEISME MONO_APPUI
"YES"

AFFE_CHAR_MECA VECT_ASSE

DYNA_NON_LINE COMP_INCR RELATION
"VMIS_ECMI_LINE"

"ELAS"

COQUE_NCOU

TUYAU_NCOU

TUYAU_NSEC

RECU_FONCTION NOM_CHAM
DEPL

---

10 Results of modeling D

10.1 Values tested

Values of displacements (m) of the valve in the direction of the excitation (direction X) to different moments.

Moment (S)
Displacement
Aster (m)
% difference
measured (m)
0,66 -20,1
10-3 -20,4
10-3 1,5
0,75 +53,0
10-3 +52,7
10-3 -0,6
0,86 -28,9
10-3 -25,0
10-3 -13,4
1,06 +67,5
10-3 +81,7
10-3 21,0

Evolution of displacements of the valve calculated and measured according to time:

0,1
0,08
reference
modeling D
0,06
0,04
winnow [m]
has
0,02
acement of L
pl
Die
0
-0,02
-0,04
0
0,2
0,4

0,6
0,8
1
Time [S]

10.2 Parameters of execution of the last observation

Version: 5.05

Machine: SGI Origin 2000

Obstruction memory: 900 Mo
Time CPU To use: 12314 seconds

10.3 Time CPU to use by order at the time of the last observation

Order
Time CPU To use

5.05
AT THE BEGINNING OF 0.31
LIRE_MAILLAGE 4.29
DEFI_GROUP 0.09
AFFE_MODELE 0.07
AFFE_CARA_ELEM 2.75

DEFI_MATERIAU 0.13
DEFI_MATERIAU 0.14
DEFI_MATERIAU 0.13
DEFI_MATERIAU 0.13
DEFI_MATERIAU 0.13
DEFI_MATERIAU 0.13
AFFE_MATERIAU 0.02
AFFE_CHAR_MECA 29.61
AFFE_CHAR_MECA 3.18
AFFE_CHAR_MECA 0.06
DEFI_FONCTION 0.00
DEFI_FONCTION 0.01
CALC_MATR_ELEM 13.22
NUME_DDL 30.14
ASSE_MATRICE 2.26
CALC_MATR_ELEM 69.66
ASSE_MATRICE 1.26
CALC_CHAR_SEISME 0.33
AFFE_CHAR_MECA 0.02
DEFI_VALEUR 0.00
DEFI_VALEUR 0.00
DEFI_LIST_REEL 0.00
DYNA_NON_LINE 12144.95
RECU_FONCTION 0.38
TEST_FONCTION 0.01
TEST_FONCTION 0.01
DEFI_FONCTION 0.03
DEFI_FONCTION 0.04
DEFI_FONCTION 0.03
DEFI_FONCTION 0.03
DEFI_FONCTION 0.03
DEFI_FONCTION 0.03
DEFI_FONCTION 0.04
DEFI_FONCTION 0.03
DEFI_FONCTION 0.03
DEFI_FONCTION 0.04
DEFI_FONCTION 0.03
DEFI_FONCTION 0.03
DEFI_FONCTION 0.04
DEFI_FONCTION 0.03
DEFI_FONCTION 0.03
IMPR_COURBE 0.23
AT THE END OF 0.88

---

11 Summary of the results

Modeling A, starting from POU_D_T, gives correct results (0,6 to 21% of variation by report/ratio with the measured values) and is far from expensive in computing times (71 dryness CPU). It requires, by
against, a rather important time of modeling since the criterion of total plasticity depends on one certain number of parameters (coefficients numerical of the criterion of plasticity, limiting moments, factors of flexibility) which must be identified. Moreover, calculation over one longer duration shows that the linear isotropic work hardening of the beams is not representative of the behavior of material under seismic loading (the use of a kinematic work hardening in total plasticity
redévelopper a new element beam would require). Lastly, one cannot reach the fields of constraints.

Modeling B, containing elements PIPE with 3 nodes with linear kinematic work hardening,
give good results (0,75% to 12,7% of variation compared to measured displacements). Because of numbers more important of degrees of freedom (14827 ddl against 2512 for modeling A), it is
more expensive in computing times than modeling POU_D_T (7435 dryness CPU against 71 dryness). However, its implementation is much faster to since it has the advantage of not
to depend on parameters to identify as a preliminary.

The use of the element PIPE to 4 nodes in modeling C allows a significant profit in
terms of a number of elements and thus of ddl (5026 ddl). For a computing time divided by 2 by report/ratio with modeling B, the results are excellent (0,4 to 6,4% of variation). Analysis of the test by

modelings PIPE on a more significant number of cycles shows than the behavior of material is represented better by a linear kinematic work hardening than an isotropic work hardening linear.

Modeling D, made up of elements DKT in the elbows and PIPE with 3 nodes in right parts is much more expensive in computing times than preceding modelings (12314 dryness CPU). It gives results correct but all the same less precise than the 3 others modelings (0,6% to 21% of variation compared to measured displacements).

Very realistic results obtained by modelings PIPE over the total duration of the test compared to modelings POU_D_T like their fast time of implementation show, in spite of the times computings more important, interest of this type of modeling for nonlinear seismic analysis of pipings.

Handbook of Validation

V1.10 booklet: Benchmarks
HT-62/01/012/A

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom
Date:
01/12/98
Author (S):
B. QUINNEZ
Key:
V2.01.002-E Page:
1/24
Organization (S): EDF/IMA/MMN
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
Document: V2.01.002
SDLD02 - System mass-arises with 8 degrees
of freedom
Summary:
This two-dimensional problem consists in seeking the frequencies and the modes of vibration of a structure
mechanics made up of masses and springs. This case-test of Mechanics of the Structures corresponds to one
analyze dynamic of a discrete model having a linear behavior.
This test allows a complete validation of the options of modeling of discrete rigidity and mass (without

finite elements) offered by order AFFE_CARA_ELEM [U4.24.01]. Four different modelings are proposed: two modelings for the discrete elements in translation and two others for the elements discrete in translation/rotation. In addition, various functionalities of orders MODE_ITER_INV [U4.52.01] (calculation of values and clean vectors per iteration reverses), MODE_ITER_SIMULT [U4.52.02]
(calculation of the values and vectors clean by the method of Lanczos) and NORME_MODE [U4.64.02] (definition of
normalizes of a clean vector) are tested.
This test refers to a test VPCS, but it was modified. Indeed, the Code_Aster test directs the system mechanics on an axis 3y = 4x, which makes it possible to validate the entry of the data in local reference mark.

1
Problem of reference
1.1 Geometry
U
U
1
2
U
U
3
8

With
m
m
m

m
B
X, U
K
K
K
K
P1
P2
P3
P8
Specific masses: mP = m = m = ... = m = m
1
P2
P3
P8
Stiffnesses of connection: kAP1 = kP1P2 = kP2P3 = ... = kP8B = K

1.2
Material properties

Comes out from linear elastic translation
K = 105 N/m
Specific mass
m = 10 kg

1.3
Boundary conditions and loadings

Embedded points A and b: (U = 0).

1.4 Conditions
initial

Without object for the modal analysis.

2
Reference solution
2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLD02/89 of the guide VPCS which presents method of calculation in the following way:

The problem led to seek the eigenvalues and clean vectors of:

(Km
I)
I = 0
K
K

0

K 2k K

m

K =
..

M =
..

K
2k
K

m

K

K

0

from where:

1

K

N +1- I

F =

I

cos

m

(n+) 1 2

I = 1, 2, ..., N

N = a number of masses

Ti calculated by resolution of the linear system.

2.2

Results of reference

the first 8 Eigen frequencies and the first and eighth clean vectors normalized such as:

T

Test V.P.C.S. provides modes normalized to M = 10. Normalized modes are presented:

·

T

with the unit generalized mass: M = 1; the components of reference are

divided by 10,

·

with the generalized stiffness what amounts dividing the preceding components by I,

· with the largest component of displacement.

2.3

Uncertainty on the solution

Analytical solution.

2.4 References

bibliographical

[1]

Mr. LALANNE, P. BERTHIER, J. DERHAGOPIAN. Mechanics of the linear vibrations. Paris: MASSON, 2° edition, chapter 3, p. 100-101 (1986)

3 Modeling
With
3.1
Characteristics of modeling

Discrete element of rigidity in translation DIS_T
Y
0.4
0.3
P
P
P
1
P
3
P
6
P
X
2
4
P5
7
P8
X

Characteristics of the elements:
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:
with nodal masses all nodes
M_T_D_N

in absolute reference mark
(m = 10.)
matrices of rigidity all meshs
K_T_D_L
in local reference mark
(Kx = 1. 105)
with the nodes ends
K_T_D_N
in local reference mark
(Kx = 1. 105)
Limiting conditions:
DDL_IMPO: (ALL: "YES" DZ: 0.)
LIAISON_DDL: (such as 3Dy=4Dx in all the nodes)
Names of the nodes: P1, P2,…., P8
Not A = N1
= N2

3.2
Characteristics of the grid

A number of nodes: 8
A number of meshs and types: 7 SEG2

3.3 Functionalities
tested
Orders
Keys

AFFE_CARA_ELEM
DISCRETE
GROUP_MA
"K_T_D_L"
[U4.24.01]
NODE
"K_T_D_N"
"M_T_D_N"
ORIENTATION
GROUP_NO
"ANG_NAUT"
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
LIAISON_DDL
NODE
AFFE_MATERIAU
ALL

[U4.23.02]
AFFE_MODELE
ALL
“MECHANICAL”
“DIS_T”
[U4.22.01]
GROUP_NO
“DIS_T”
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
CALC_FREQ
OPTION
“ADJUSTS”
[U4.52.01]
FREQ
CALC_MODE
OPTION
“DIRECT”
RECU_CHAMP
“DEPL”
NUME_ORDRE
[U4.62.01]
FREQ
NORM_MODE
“MASS_GENE”
[U4.64.02]
NORM_MODE
“RIGI_GENE”
[U4.64.02]
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom
Date:
01/12/98
Author (S):

4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% Difference
tolerance
Number of the mode
valley. relative
clean
1
5.5274
5.5274
0.
104
2
10.8868
10.8868
-
-
3
15.9155
15.9155
-
-
4
20.4606
20.4606
-
-
5
24.3840
24.3840
-
-
6
27.5664

27.5664
-
-
7
29.9113
29.9113
-
-
8
31.3474
31.3474
-
-
Normalized mode with 1 with the largest component
Nature of the clean mode
Not
Reference
Aster
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 1
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
-1.
-1.
1
P6
0.8793
0.87938
P7
0.6527
0.65270

P8
0.3473
0.34729
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 8
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
1.
1.
8
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass
Nature of the clean mode
Not
Reference
Aster
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Translation 1
P3
1.0327E1
1.0327E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
1
P6
1.0327E1
1.0327E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
P1
4.0781E2
4.0788E2
P2
7.6654E2

7.6657E2
Translation 8
P3
1.0327E1
1.0328E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
8
P6
1.0327E1
1.0328E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
Maximum error lower than: 0.03%.
Mode normalized with the unit generalized stiffness
Nature of the clean mode
Not
Reference
Aster
P1
1.1742E3
1.1744E3
P2
2.2072E3
2.2072E3
Translation 1
P3
2.9735E3
2.9738E3
(Dy)
P4
3.3813E3
3.3817E3

P5
3.3813E3
3.3817E3
1
P6
2.9735E3
2.9738E3
P7
2.2072E3
2.2072E3
P8
1.1742E3
1.1744E3
P1
2.0705E4
2.0709E4
P2
3.8918E4
3.8920E4
Translation 8
P3
5.2432E4
5.2436E4
(Dy)
P4
5.9621E4
5.9628E4

P5
5.9621E4
5.9628E4
8
P6
5.2432E4
5.2436E4
P7
3.8918E4
3.8920E4
P8
2.0705E4
2.0709E4
Maximum error lower than: 0.03%.

4.2 Remarks

Calculations carried out by:
MODE_ITER_INV
OPTION: “ADJUSTS”
LIST_FREQ: (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32.)
CALC_MODE: (OPTION: “DIRECT”)

Contents of the file results:
the first 8 Eigen frequencies, clean vectors and modal parameters

4.3 Parameters of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
6 seconds

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom

5 Modeling

B

5.1 Characteristics of modeling

Discrete element of rigidity in translation DIS_T
Y
0.4
0.3
P
P
P
1
P
3
P
6
P
X
2
4
P5
7
P8
X

Characteristics of the elements:
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:
nodal masses all nodes
M_T_N
in absolute reference mark
(m = 10.)
matrices of rigidity all meshs
K_T_L
in local reference mark

(Kx = 1. 105)
with the nodes ends
K_T_N
in local reference mark
(Kx = 1. 105)
Limiting conditions:
DDL_IMPO: (ALL: "YES" DZ: 0.)
LIAISON_DDL: (such as 3Dy=4Dx in all the nodes)
Names of the nodes: : P1, P2,…., P8

5.2

Characteristics of the grid

A number of nodes: 8
A number of meshs and types: 7 SEG2

5.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
DISCRETE
GROUP_MA
"K_T_L"
[U4.24.01]
NODE
"K_T_N"
"M_T_N"
ORIENTATION
GROUP_NO
"ANGL_NAUT"
AFFE_MODELE
ALL
"MECHANICAL"
"DIS_T"
[U4.22.01]
GROUP_NO
"DIS_T"
MODE_ITER_SIMULT
METHOD
"TRI_DIAG"
[U4.52.01]
CALC_FREQ
OPTION
"PLUS_PETITE"
NMAX_FREQ

IMPR_STURM
FREQ_MIN
[U4.73.01]
FREQ_MAX
NORM_MODE
“MASS_GENE”
or
“RIGI_GENE”
[U4.64.02]
NORM_MODE
“AVEC_CMP”
or
“SANS_CMP”
[U4.64.02]
NORM_MODE
NODE
CMP
[U4.64.02]
NORM_MODE
“STANDARD”
“TRAN” or “EUCL”
or “EUCL_TRAN”
[U4.64.02]

---

6 Results of modeling B

6.1 Values tested

Identification
Reference
Aster
% Difference
tolerance
Number of the mode
valley. relative
clean
1
5.5274
5.5274
0.
104
2
10.8868
10.8868
-
-
3
15.9155
15.9155
-
-
4
20.4606
20.4606
-
-
5
24.3840
24.3840
-
-
6
27.5664
27.5664
-
-
7
29.9113
29.9113
-
-

8
31.3474
31.3474
-
-
Normalized mode with 1 with the largest component
Nature of the clean mode
Not
Reference
Aster
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 1
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
-1.
-1.
1
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
P1
0.3473
0.34729
P2
0.6527

0.65270
Translation 8
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
1.
1.
8
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass
Nature of the clean mode
Not

Reference
Aster
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Translation 1
P3
1.0327E1
1.0327E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
1
P6
1.0327E1
1.0327E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Translation 8
P3
1.0327E1
1.0328E1
(Dy)
P4
1.1743E1

1.1744E1

P5
1.1743E1
1.1744E1
8
P6
1.0327E1
1.0328E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
Maximum error lower than: 0.03%.
Mode normalized with the unit generalized stiffness
Nature of the clean mode
Not
Reference
Aster
P1
1.1742E3
1.1744E3
P2
2.2072E3
2.2072E3
Translation 1
P3
2.9735E3
2.9738E3
(Dy)
P4
3.3813E3
3.3817E3

P5
3.3813E3
3.3817E3
1
P6
2.9735E3
2.9738E3

P7
2.2072E3
2.2072E3
P8
1.1742E3
1.1744E3
P1
2.0705E4
2.0709E4
P2
3.8918E4
3.8920E4
Translation 8
P3
5.2432E4
5.2436E4
(Dy)
P4
5.9621E4
5.9628E4

P5
5.9621E4
5.9628E4
8
P6
5.2432E4
5.2436E4
P7
3.8918E4
3.8920E4
P8
2.0705E4
2.0709E4
Maximum error lower than: 0.03%.

6.2 Remarks

Calculations carried out by:
MODE_ITER_SIMULT
METHOD: “TRI_DIAG”
CALC_FREQ:
OPTION = “PLUS_PETITE”
NMAX_FREQ = 8

Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters
6.3 Parameters
of execution
Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
16.686 seconds

---

7 Modeling
C
7.1
Characteristics of modeling
Transposition of the test of reference to the case of the degrees of freedom of rotation (from torsion + inertia comes out)
by using the discrete element of rigidity in translation/rotation DIS_TR.
Y
0.4
0.3
P
P
P
1
P
3

P
6
P
X
2
4
P5
7
P8
X
Characteristics of the elements:
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:
with nodal masses all nodes
M_TR_D_N
in absolute reference mark
(Ixx = 10.)
matrices of rigidity all meshs
K_TR_D_L
in local reference mark
(KRx = 1. 105)
with the nodes
K_TR_D_N
in local reference mark
(KRx = 1. 105)
ends
Limiting conditions:
DDL_IMPO: (ALL: “YES” DX: 0. , DZ: 0. , DRZ: 0.)
LIAISON_DDL: (such as 3DRY=4DRY in all the nodes)
Names of the nodes: : P1, P2,…., P8

7.2
Characteristics of the grid

A number of nodes: 8
A number of meshs and types: 7 SEG2

7.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
DISCRETE
GROUP_MA

"K_TR_D_L"
[U4.24.01]
NODE
"K_TR_D_N"
"M_TR_D_N"
ORIENTATION
GROUP_NO
"ANGL_NAUT"
AFFE_MODELE
ALL
"MECHANICAL"
"DIS_TR"
[U4.22.01]
GROUP_NO
"DIS_TR"
MODE_ITER_INV
CALC_FREQ
OPTION
"ADJUSTS"
[U4.52.01]
FREQ
CALC_MODE
OPTION
"DIRECT"
NORM_MODE
"MASS_GENE"
or "RIGI_GENE"
[U4.64.02]

12/24

8

Results of modeling C

8.1 Values

tested

Identification

Reference

Aster

% Difference

tolerance

Number of the mode

valley. relative

clean

1
5.5274
5.5274
0.
104
2
10.8868
10.8868
-
-
3
15.9155
15.9155
-
-
4
20.4606
20.4606
-
-
5
24.3840
24.3840
-
-
6
27.5664
27.5664
-
-

7
29.9113
29.9113
-
-
8
31.3474
31.3474
-
-

Normalized mode with 1 with the largest component
Nature of the clean mode
Not
Reference
Aster

P1
0.3473
0.34729
P2
0.6527
0.65270
Rotation 1
P3
0.8793
0.87938
(DRY)
P4
-1.
-1.

P5
-1.
-1.
1
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729

P1
0.3473
0.34729
P2
0.6527
0.65270
Rotation 8
P3
0.8793
0.87938
(DRY)
P4
-1.
-1.

P5
1.
1.
8
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
Maximum error lower than: 0.03%.
Mode normalized with the unit generalized mass
Nature of the clean mode
Not
Reference
Aster
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Rotation 1
P3
1.0327E1

1.0327E1
(DRY)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
1
P6
1.0327E1
1.0327E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Rotation 8
P3
1.0327E1
1.0328E1
(DRY)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
8
P6
1.0327E1
1.0328E1
P7
7.6654E2

7.6657E2
P8
4.0781E2
4.0788E2
Maximum error lower than: 0.03%.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom
Date:
01/12/98
Author (S):
B. QUINNEZ
Key:
V2.01.002-E Page:
13/24
Mode normalized with the unit generalized stiffness
Nature of the clean mode
Not
Reference
Aster
P1
1.1742E3
1.1744E3
P2
2.2072E3
2.2072E3
Rotation 1
P3
2.9735E3
2.9738E3
(DRY)
P4
3.3813E3
3.3817E3

P5
3.3813E3

3.3817E3
1
P6
2.9735E3
2.9738E3
P7
2.2072E3
2.2072E3
P8
1.1742E3
1.1744E3
P1
2.0705E4
2.0709E4
P2
3.8918E4
3.8920E4
Rotation 8
P3
5.2432E4
5.2436E4
(DRY)
P4
5.9621E4
5.9628E4

P5
5.9621E4
5.9628E4
8
P6
5.2432E4
5.2436E4
P7
3.8918E4
3.8920E4
P8
2.0705E4
2.0709E4
Maximum error lower than: 0.03%.

8.2 Remarks

Calculations carried out by:
MODE_ITER_INV

OPTION: “ADJUSTS”
LIST_FREQ: (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32.)
CALC_MODE: (OPTION: “DIRECT”)

Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

8.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5.8 seconds

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

---

9 Modeling D

9.1 Characteristics of modeling

Transposition of the test of reference to the case of the degrees of freedom of rotation (from torsion + inertia comes out)
by using the discrete element of rigidity in translation/rotation: DIS_TR.

Y
0.4
0.3
P
P
P
1
P
3
P
6
P
X
2
4
P5
7
P8
X

Characteristics of the elements:
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:

with nodal masses all nodes
M_TR_N
in absolute reference mark
(Ixx = 10.)
matrices of rigidity all meshs
K_TR_L
in local reference mark
(KRx = 1. 105)
with the nodes
K_TR_N
in local reference mark
(KRx = 1. 105)
ends
Limiting conditions:
DDL_IMPO: (ALL: “YES” DX: 0. , DY: 0. , DZ: 0. , DRZ: 0.)
LIAISON_DDL: (such as 3DRY=4DRY in all the nodes)
Names of the nodes: P1, P2,…., P8

9.2

Characteristics of the grid

A number of nodes: 8
A number of meshs and types: 7 SEG2

9.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
DISCRETE
GROUP_MA
“K_TR_L”
[U4.24.01]
NODE
“K_TR_N”
“M_TR_N”
ORIENTATION
GROUP_NO
“ANGL_NAUT”
AFFE_MODELE
ALL
“MECHANICAL”
“DIS_TR”
[U4.22.01]
GROUP_NO
“DIS_TR”

MODE_ITER_INV
CALC_FREQ
OPTION
“ADJUSTS”
[U4.52.01]
FREQ
CALC_MODE
OPTION
“DIRECT”
RECU_CHAMP
“DEPL”
NUME_ORDRE
[U4.62.01]
FREQ
NORM_MODE
“MASS_GENE”
or
“RIGI_GENE”
[U4.64.02]

---

10 Results of modeling D

10.1 Values tested

Identification
Reference
Aster
% Difference

tolerance
Number of the mode
valley. relative
clean
1
5.5274
5.5274
0.
104
2
10.8868
10.8868
-
-
3
15.9155
15.9155
-
-
4
20.4606
20.4606
-
-
5
24.3840
24.3840
-
-
6
27.5664
27.5664
-
-
7
29.9113
29.9113
-
-
8
31.3474
31.3474
-

-
Normalized mode with 1 with the largest component
Nature of the clean mode
Not
Reference
Aster
P1
0.3473
0.34729
P2
0.6527
0.65270
Rotation 1
P3
0.8793
0.87938
(DRY)
P4
-1.
-1.

P5
-1.
-1.
1
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
P1
0.3473
0.34729
P2
0.6527
0.65270
Rotation 8
P3
0.8793

0.87938
(DRY)
P4
-1.
-1.

P5
1.
1.
8
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
Maximum error lower than: 0.03%.
Mode normalized with the unit generalized mass
Nature of the clean mode
Not
Reference
Aster
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Rotation 1
P3
1.0327E1
1.0327E1
(DRY)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1

1
P6
1.0327E1
1.0327E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Rotation 8
P3
1.0327E1
1.0328E1
(DRY)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
8
P6
1.0327E1
1.0328E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
Maximum error lower than: 0.03%.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom
Date:
01/12/98
Author (S):
B. QUINNEZ
Key:
V2.01.002-E Page:
16/24

Mode normalized with the unit generalized stiffness

Nature of the clean mode
Not
Reference
Aster
P1
1.1742E3
1.1744E3
P2
2.2072E3
2.2072E3
Rotation 1
P3
2.9735E3
2.9738E3
(DRY)
P4
3.3813E3
3.3817E3

P5
3.3813E3
3.3817E3
1
P6
2 9735E3
2.9738E3
P7
2.2072E3
2.2072E3
P8

1.1742E3
1.1744E3
P1
2.0705E4
2.0709E4
P2
3.8918E4
3.8920E4
Rotation 8
P3
5.2432E4
5.2436E4
(DRY)
P4
5.9621E4
5.9628E4

P5
5.9621E4
5.9628E4
8
P6
5.2432E4
5.2436E4
P7
3.8918E4
3.8920E4
P8
2.0705E4
2.0709E4
Maximum error lower than: 0.03%.

10.2 Remarks

Calculations carried out by:
MODE_ITER_INV
OPTION: “ADJUSTS”
LIST_FREQ: (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32.)
CALC_MODE: (OPTION: “DIRECT”)

Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

10.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5.6 seconds
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom
Date:
01/12/98
Author (S):
B. QUINNEZ
Key:
V2.01.002-E Page:
17/24

11 Modeling
E

11.1 Characteristics of modeling

Discrete element of rigidity in translation 2D_DIS_T
Y
0.4
0.3
P
P
P
1
P
3
P
6
P
X
2
4
P5
7

P8
X
Characteristics of the elements:
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:
with nodal masses all nodes
M_T_D_N
in absolute reference mark
(m = 10.)
matrices of rigidity all meshs
K_T_D_L
in local reference mark
(Kx = 1. 105)
with the nodes ends
K_T_D_N
in local reference mark
(Kx = 1. 105)
Limiting conditions:
LIAISON_DDL: (such as 3Dy=4Dx in all the nodes)
Names of the nodes: P1, P2,…., P8
Not A = N1
= N2

11.2 Characteristics of the grid

A number of nodes: 8
A number of meshs and types: 7 SEG2

11.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
DISCRETE
GROUP_MA
“K_T_D_L”
[U4.24.01]
NODE
“K_T_D_N”
“M_T_D_N”
ORIENTATION
GROUP_NO
“ANG_NAUT”
AFFE_CHAR_MECA

DDL_IMPO
ALL
[U4.25.01]
LIAISON_DDL
NODE
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
ALL
“MECHANICAL”
“2D_DIS_T”
[U4.22.01]
GROUP_NO
“2D_DIS_T”
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
CALC_FREQ
OPTION
“ADJUSTS”
[U4.52.01]
FREQ
CALC_MODE
OPTION
“DIRECT”
RECU_CHAMP
“DEPL”
NUME_ORDRE
[U4.62.01]
FREQ
NORM_MODE
“MASS_GENE”
[U4.64.02]
NORM_MODE
“RIGI_GENE”
[U4.64.02]

---

12 Results of modeling E

12.1 Values tested

Identification	**Reference**	**Aster**	**% Difference**	**tolerance**
Number of the mode	**valley. relative clean**			
1	5.5274	5.5274	0.	104
2	10.8868	10.8868	-	-
3	15.9155	15.9155	-	-
4	20.4606	20.4606	-	-

5
24.3840
24.3840
-
-
6
27.5664
27.5664
-
-
7
29.9113
29.9113
-
-
8
31.3474
31.3474
-
-
Normalized mode with 1 with the largest component
Nature of the clean mode
Not
Reference
Aster
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 1
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
-1.
-1.

1
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 8
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
1.
1.
8
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
Maximum error lower than: 0.03%.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Mode normalized with the unit generalized mass

Nature of the clean mode
Not
Reference
Aster
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Translation 1
P3
1.0327E1
1.0327E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
1
P6
1.0327E1
1.0327E1
P7
7.6654E2
7.6657E2
P8

4.0781E2
4.0788E2
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Translation 8
P3
1.0327E1
1.0328E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
8
P6
1.0327E1
1.0328E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
Maximum error lower than: 0.03%.
Mode normalized with the unit generalized stiffness
Nature of the clean mode
Not
Reference
Aster
P1
1.1742E3
1.1744E3
P2
2.2072E3
2.2072E3
Translation 1

P3
2.9735E3
2.9738E3
(Dy)
P4
3.3813E3
3.3817E3

P5
3.3813E3
3.3817E3
1
P6
2.9735E3
2.9738E3
P7
2.2072E3
2.2072E3
P8
1.1742E3
1.1744E3
P1
2.0705E4
2.0709E4
P2
3.8918E4
3.8920E4
Translation 8
P3
5.2432E4
5.2436E4
(Dy)
P4
5.9621E4
5.9628E4

P5
5.9621E4
5.9628E4
8
P6
5.2432E4
5.2436E4

P7
3.8918E4
3.8920E4
P8
2.0705E4
2.0709E4
Maximum error lower than: 0.03%.

12.2 Remarks

Calculations carried out by:
MODE_ITER_INV
OPTION: "ADJUSTS"
LIST_FREQ: (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32.)
CALC_MODE: (OPTION: "DIRECT")

Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

12.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
6 seconds

---

13 Modeling
F

13.1 Characteristics of modeling

Discrete element of rigidity in translation/rotation: 2D_DIS_TR

Y
0.4
0.3
P
P
P
1
P
3
P
6
P
X
2
4
P5
7
P8
X

Characteristics of the elements:
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:
with nodal masses all nodes
M_T_D_N
in absolute reference mark
(m = 10.)
matrices of rigidity all meshs
K_T_D_L
in local reference mark
(Kx = 1. 105)
with the nodes ends
K_T_D_N
in local reference mark
(Kx = 1. 105)
Limiting conditions:
DDL_IMPO: (ALL: “YES” DRZ: 0.)
LIAISON_DDL: (such as 3Dy=4Dx in all the nodes)
Names of the nodes: P1, P2,…., P8
Not A = N1

= N2

13.2 Characteristics of the grid

A number of nodes: 8

A number of meshs and types: 7 SEG2

13.3 Functionalities

tested

Orders

Keys

AFFE_CARA_ELEM
DISCRETE
GROUP_MA
“K_T_D_L”
[U4.24.01]
NODE
“K_T_D_N”
“M_T_D_N”
ORIENTATION
GROUP_NO
“ANG_NAUT”
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
LIAISON_DDL
NODE
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
ALL
“MECHANICAL”
“2D_DIS_TR”
[U4.22.01]
GROUP_NO
“2D_DIS_TR”
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
CALC_FREQ
OPTION
“ADJUSTS”
[U4.52.01]

FREQ
CALC_MODE
OPTION
“DIRECT”
RECU_CHAMP
“DEPL”
NUME_ORDRE
[U4.62.01]
FREQ
NORM_MODE
“MASS_GENE”
[U4.64.02]
NORM_MODE
“RIGI_GENE”
[U4.64.02]
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

14
Results of modeling F
14.1 Values
tested
Identification
Reference
Aster
% Difference
tolerance
Number of the mode
valley. relative
clean

1
5.5274
5.5274
0.
104
2
10.8868
10.8868
-
-
3
15.9155
15.9155
-
-
4
20.4606
20.4606
-
-
5
24.3840
24.3840
-
-
6
27.5664
27.5664
-
-
7
29.9113
29.9113
-
-
8
31.3474
31.3474
-
-

Normalized mode with 1 with the largest component
Nature of the clean mode
Not

Reference
Aster
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 1
P3
0.8793
0.87938
(Dy)
P4
-1.
-1.

P5
-1.
-1.
1
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
P1
0.3473
0.34729
P2
0.6527
0.65270
Translation 8
P3
0.8793
0.87938
(Dy)
P4
-1.

-1.

P5
1.
1.
8
P6
0.8793
0.87938
P7
0.6527
0.65270
P8
0.3473
0.34729
Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass
Nature of the clean mode
Not
Reference
Aster
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2

Translation 1
P3
1.0327E1
1.0327E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
1
P6
1.0327E1
1.0327E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
P1
4.0781E2
4.0788E2
P2
7.6654E2
7.6657E2
Translation 8
P3
1.0327E1
1.0328E1
(Dy)
P4
1.1743E1
1.1744E1

P5
1.1743E1
1.1744E1
8
P6
1.0327E1

1.0328E1
P7
7.6654E2
7.6657E2
P8
4.0781E2
4.0788E2
Maximum error lower than: 0.03%.
Mode normalized with the unit generalized stiffness
Nature of the clean mode
Not
Reference
Aster
P1
1.1742E3
1.1744E3
P2
2.2072E3
2.2072E3
Translation 1
P3
2.9735E3
2.9738E3
(Dy)
P4
3.3813E3
3.3817E3

P5
3.3813E3
3.3817E3
1
P6
2.9735E3
2.9738E3
P7
2.2072E3
2.2072E3
P8
1.1742E3
1.1744E3
P1
2.0705E4

2.0709E4
P2
3.8918E4
3.8920E4
Translation 8
P3
5.2432E4
5.2436E4
(Dy)
P4
5.9621E4
5.9628E4

P5
5.9621E4
5.9628E4
8
P6
5.2432E4
5.2436E4
P7
3.8918E4
3.8920E4
P8
2.0705E4
2.0709E4
Maximum error lower than: 0.03%.

14.2 Remarks

Calculations carried out by:
MODE_ITER_INV
OPTION: “ADJUSTS”
LIST_FREQ: (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32.)
CALC_MODE: (OPTION: “DIRECT”)

Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

14.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords

Time CPU To use:
6 seconds

15
Summary of the results

For all the options of modeling of the discrete elements of rigidity and mass offered by AFFE_CARA_ELEM the solutions obtained are those of the reference solution (frequencies and modes clean with various standardizations).

Code_Aster ®
Version
4.0
Titrate:
SDLD02 Système mass-arises with 8 degrees of freedom
Date:
01/12/98
Author (S):
B. QUINNEZ
Key:
V2.01.002-E Page:
24/24
Intentionally white left page.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
5.0

Titrate:
Transitory SDLD04 Response of a system mass-springs
Date:
30/08/01
Author (S):
Fe WAECKEL, *L. VIVAN Key*
:
V2.01.004-C Page:
1/8

Organization (S): EDF/RNE/AMV, CS IF

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
Document: V2.01.004

SDLD04 - Transitory response of a system mass-springs subjected to an acceleration imposed

Summary

This test consists in calculating the not deadened transitory response of a linear system mass-springs embedded
free subjected to an imposed acceleration.

One tests the discrete element in traction and compression, the calculation of the clean modes, the static modes and it
calculation of the transitory response of a system subjected to an imposed acceleration. Direct calculation is compared
response to its calculation by modal recombination.

This case test is from guide VPCS. The reference solution is an analytical calculation. Errors on results obtained are normal taking into account the step of time chosen for numerical integration.

1
Problem of reference

1.1 Geometry

One calculates the response of a linear system composed of three masses and three springs to one acceleration imposed on the level of its point of anchoring (A):

y
k1
k2
k3
X
(T)
m1
m
m
1
2
m3
With
B
C
D

1.2
Properties of materials

- ***stiffnesses of connection: K = k1 = k2 = k3 = 1000 N/m;***
- ***specific masses: m = m1 = m2 = m3 = 1 kg.***

1.3
Boundary conditions and loadings

Boundary conditions

Only authorized displacements are the translations according to axis X.
Point A is embedded: dx = Dy = dz = drx = dry = drz = 0.

Loading

The point of anchoring A is subjected to an acceleration, function increasing of time, according to direction X: (T) = 2.105.t2 (T vary from 0 to 0,1 S).

1.4 Conditions initial

The system is initially at rest: with T = 0, dx (0) =0 and dx/dt (0) = 0 in any point.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

One initially calculates the Eigen frequencies fi and the clean vectors Nor associated standardized compared to the matrix of mass. One calculates then the generalized response of the system mono-excited by solving analytically the integral of Duhamel [bib1]. Lastly, one restores on the basis physique displacement relating to point D.

Calculation of the Eigen frequencies

The matrices of mass and stiffness are as follows:

m 0 0
2 - 1
0

M = 0 m 0, K

= K - 1
2 -

1

0 0

m
0 -

1

1

The Eigen frequencies are solution of the equation
[
det K - 2M] = 0, is

3
K
- 2
5
+
6 - 1 = 0 where = and =
.
m
0

Calculation of the generalized response of the mono-excited system

(T) = a.t2 with A = 2.105.

In the absolute reference mark, the fundamental equation of the dynamics of the system mass-springs not
deadened is written: MR. X
& + K X
has
= 0 have.

Absolute displacement Xa breaks up into a uniform displacement of drive in translation
X and in a relative displacement X
E
R: X
X
X
has =
+
R
E.
The equation of the movement in the relative reference mark is written then: MR. X
& + K X = - MR. X
R
R
& = Q
S

1

1

2
with &X
(T) A.
S =
= T 2 and =
1 and thus Q = a.t m
1 .

1

1

The equation of the movement projected on the basis of dynamic mode standardized compared to stamp of mass is written:
T

. Mr.
& (T) + 2 (T)
I
=
(T) = - p (T) (T)
I
I
I
T
.
. Mr.
I
I
I

The response of this linear system, to one moment T is given by the integral of Duhamel:

T
1
p (T) T
& (T) =
- p (T) (T) .sin (T -)
I
D = -
a.t 2 sin (T -

)
I

I
I

I
D.
I
I
0
0

Version
5.0

Titrate:
Transitory SDLD04 Response of a system mass-springs
Date:
30/08/01
Author (S):
Fe WAECKEL, L. VIVAN Key
:
V2.01.004-C Page:
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T

However, according to [bib1], a.t 2 sin (T -) D =

T 2
2
+
(cos T
I
I -)
1

.
I
I
0

a. p (T).

Thus X
I
I
= . = -
2
2
1
2
T +
(cos T
R

I
I
I -).
I

I

I

2.2 Results of reference

One takes for results of reference the three Eigen frequencies of the system and relative displacement xr at the point D, for various moments ranging between 0 and 0,1 S.

2.3 Uncertainty on the solution

No if one calculates the integral of Duhamel analytically [bib1], [bib2].

2.4 References bibliographical

[1]
J.S. PRZEMIENIECKI: Theory of matrix structural analysis. New York, Mac Graw-Hill, 1968, p. 351-357
[2]
S.P. TIMOSHENKO, D.H. YOUNG and W. WEAVER: Vibrations problems in engineering 4th edition, New York, Wiley & Sounds, 1974, p. 284-321
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
Transitory SDLD04 Response of a system mass-springs
Date:

3 Modeling
With

3.1
Characteristics of modeling

The springs and specific masses are modelled by discrete elements with 3 degrees of freedom "DIS_T":

Y
K
K
K

1
2
3
X
NO1
NO2
NO3
NO4

Node NO1 is embedded and subjected to an imposed acceleration (T). Displacement is calculated relative of node NO4.

Calculations by modal synthesis
One considers the complete base of the clean modes. Temporal integration is carried out with algorithms of Newmark, Euler and Devogelaere with a step of times of 0,001 S. calculations all the steps of time are filed.
One considers a damping reduces no one for the whole of the calculated modes.
I

The loading is taken into account in the form of vector projected on the modal basis EXCIT: (VECT_GENE) or in the form of modal component EXCIT: (NUME_MODE) or both with the time.

Direct calculations
Temporal integration is carried out either with the algorithm of Newmark or with the explicit algorithm
differences centered with a step in times of 0,001 S. calculations are filed all the ten steps time.

Note:

As the diagram of the centered differences can be used only with one matrix of mass diagonal, one calculates the elementary matrices with option MASS_MECA_DIAG in the operator CALC_MATR_ELEM.

Taking into account of an initial state
In the two types of calculation, one checks that the relative displacement obtained of a calculation carried out in one
time is identical to that obtained in several times, i.e. while regarding as initial state, it result of the last step of calculated time:

ETAT_INIT: (RESU_GENE: …) for a calculation by modal synthesis;
ETAT_INIT: (DYNA_TRAN) or
ETAT_INIT: (DEPL_INIT: …
VITE_INIT: .) for a direct calculation.

Taking into account of the modes neglected by static correction:
One considers a modal base made up of the first two clean modes and one has supplements it by a mode corresponding to the static response of the system studied to a unit loading of type force imposed in the direction X (key words MODE_CORR and CORR_STAT in L `operator DYNA_TRAN_MODAL).

3.2
Characteristics of the grid

A number of nodes: 4
A number of meshs and types: 3 DIS_T

3.3 Functionalities
tested

Orders

Keys Doc. V5
AFFE_MODELE GROUP_MA
“MECHANICAL”
“DIS_T”
[U4.41.01]
DISCRETE AFFE_CARA_ELEM
NODE
M_T_D_N [U4.42.01]

GROUP_MA
K_T_D_L

CALC_MATR_ELEM OPTION
MASS_MECA_DIAG

[U4.61.01]
MODE_ITER_SIMULT PLUS_PETITE
MAX_FREQ

[U4.52.03]
CALC_CHAR_SEISME MONO_APPUI

[U4.63.01]
MACRO_PROJ_BASE

[U4.63.11]
AFFE_CHAR_MECA FORCE_NODALE

[U4.44.01]
MACRO_ELAS_MULT CHAR_MECA_GLOBAL

[U4.51.02]
CAS_CHARGE
CHAR_MECA

DYNA_TRAN_MODAL METHOD
NEWMARK

[U4.53.21]

DEVOGE

EULER

ETAT_INIT
RESU_GENE

MODE_CORR

EXCIT
CORR_STAT

DYNA_LINE_TRAN METHOD
NEWMARK

[U4.53.02]

DIFF_CENTRE

ETAT_INIT
DEPL_INIT
VITE_INIT

DYNA_TRANS

4
Results of modeling A

4.1
Values tested of modeling A

Eigen frequencies (in Hz) of the system:

Number of the mode	Analytical	Code_Aster	relative error %
1	2,239	2,240	0,038
2	6,275	6,276	0,015
3	9,069	9,069	0

Values of the relative displacement of node NO4 for various moments:

Transitory calculation by modal synthesis
One tests the taking into account of a loading in the form of vector projected on the modal basis, under
form of modal component, in the form of projected vector and of modal component
at the same time as well as the taking into account of the neglected modes.

Code_Aster

Code_Aster

Time (S)
Reference
Loading of the type
Error
Loading of the type
Error
generalized vector
relative % modal component
relative
Algorithm of
Algorithm of Euler
%
Newmark
0,02 2,700E03 2,680E03
0,741 2,660E03
-1,481
0,04 4,260E02 4,272E02
0,279 4,264E02 0,091
0,05 1,041E01 1,042E01
0,134 1,041E01 0,015
0,06 2,158E01 2,161E01
0,121 2,159E01 0,038
0,08 6,813E01 6,819E01
0,094 6,816E01 0,049
0,10 1,658E+00 1,659E+00 0,082
1,659E+00
0,055

Type of loading
Time (S)
Reference
Code_Aster
relative error %
0,02
5,400E03
5,320E03
-1,482
Generalized vector
0,04
8,520E02
8,528E02
0,091
and 0,05
2,082E01
2,082E01
0,015
modal component
0,06 4,316E01
4,318E01
0,038
simultanéement 0,08
1,363E+00 1,363E+00
0,049
(Euler) 0,10
3,316E+00 3,318E+00
0,055
0,02
4,000E03
3,985E03
-0,373
Generalized vector
0,04
4,640E02
4,640E02
0,01
Devogelaere 0,05
1,085E01 1,086E01
0,084
(more correction
0,06 2,203E01

2,204E01
0,039
statics) 0,08
6,842E01 6,843E01
0,021
0,10
1,659E+00
1,659E+00
0,026

The results with incomplete modal base without static correction are not tested. One illustrates below interest of the static correction:

Displacement of node NO4 (in meters) according to time

Complete base
Incomplete base
Incomplete base with

without correction
static correction
statics

Direct transitory calculation
One compares displacements calculated with the N04 node according to various diagrams of integration:

Time (S)
Reference
Code_Aster
Error
Code_Aster
Error
Diagram of
relative %
Diagram of
relative %
Newmark
centered differences
0,02 2,700E03 2,680E03 0,741 2,660E03 1,482
0,04 4,260E02 4,272E02
0,279 4,264E02 0,091
0,05 1,041E01 1,042E01
0,134 1,041E01 0,015
0,06 2,158E01 2,161E01
0,121 2,159E01 0,038
0,08 6,813E01 6,819E01
0,094 6,745E01
-1,004
0,10 1,658E+00 1,659E+00 0,082 1,645E+00 0,803

Taking into account of an initial state:
As waited, the relative displacements calculated in once are strictly identical to those obtained by regarding as initial state the result of the last step of calculated time.

4.2 Parameters of execution

Version: STA 5.02
Machine: SGI Origin 2000
Time CPU to use: 5,9 seconds

5
Summary of the results

The reference solution is an analytical calculation. The errors on the results obtained are normal taking into account the step of time chosen for numerical integration.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.021 document

SDLD21 - System mass-arises to 8 ddl
with viscous shock absorber

Summary:

This one-way problem consists in carrying out a harmonic analysis of a mechanical structure composed of a whole of mass-springs with shock absorbers viscous and subjected to an excitation sinusoidal. This test of mechanics of the structures corresponds to a dynamic analysis of a discrete model
having a linear behavior. It includes/understands three modelings.

Via this problem, one tests the discrete elements in translation (mass, arises, shock absorber), the definition of a force of specific excitation harmonic, the operator of calculation modal (MODE_ITER_SIMULT
[U4.52.03]) into quadratic and the operator of harmonic calculation of answer (DYNA_LINE_HARM [U4.54.02]).
In addition, several operators of postprocessing are tested: RECU_FONCTION [U4.62.03], TEST_FONCTION
[U4.72.02], RECU_CHAMP [U4.62.01].

Results obtained (field of displacement, speed and acceleration for various frequencies of excitation) are in concord with the results of guide VPCS.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/03/008/A

Code_Aster ®
Version
7.0

Titrate:
SDLD21 - System mass-arises to 8 ddl with viscous shock absorber
Date:
23/06/03
Author (S):
O. NICOLAS

Key: V2.01.021-C Page:
2/10

1
Problem of reference

1.1 Geometry

U1
U2
U3
U8
K
K
K
K
With
m
m
m
m
B
X, U
P1
P2
P3
P8
C
C
C
C

Specific masses:
mP = m = m = ... = m = m
1
P2
P3
P8

Stiffnesses of connection:
kAP1 = kP1P2 = kP2P3 = ... = kP8B = K

Viscous damping:
cAP1 = cP1P2 = cP2P3 = ... = cP8B = C

1.2
Material properties

Comes out from linear elastic translation
K =
105 N/m
Specific mass
m =
10 kg
One-way viscous damping
C =
50 N (m/s)

1.3
Boundary conditions and loadings

Boundary conditions:
Embedded points A and b: (U = 0).

Loading: Force concentrated sinusoidal of variable frequency at the P4 point

Not P
=
4
Fx
F
4
0 sin *T*

= 2 *F* 5 Hz F 40 Hz
F0 = constant = 1 NR
Other points P
F = 0
I
xi

1.4 Conditions initial

Without object for the study of the permanent harmonic mode.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The system of differential equations of the second order coupled is form:

M u&+ C u& + K U = F
2 - 1

10

- 1 2
- 1

10

-
with *M*

1
2
.
=
.
C = 50

.
.
.

10

10

.
.
- 1

- 1 2

2 - 1

- 1 2
- 1

5
-
+
1
2
.
K = 10

.
.
.

.
.
- 1

- 1 2

The solution with a harmonic excitation **F** = **F0** E *J T j2* = -1
(
) is form *U* =u0 *ejt*, it
who leads to: **K** - **M2** + *J* **C**
(
) *u0* =F0
This system can be solved for all, either directly, or by using the modal transformation with
to leave the real clean modes obtained by the conservative system associated **K** - **m2**
(
) =0.
It admits N solutions clean (8 in this case) associated 2i and vectors *I* gathered in
2

spectral matrix =
[ ]
[ ]
I and the modal matrix = *I*.
The modal transformation consists in writing: **u0** = **Q** what leads to:

[-2 **I+** *J*] **Q** = *T* **F0**
I is the identity,
here is diagonal =
[ ]
(
)
II bus damping is proportional **C** = **K**.
N
T
The answer is written: *U*
I
I

0 =
F
2
0
i=1 I - 2 + *J II*
One obtains the exact solution by taking all the clean modes.
One deduces some: &u = *J U*
and
&u
2
= - *U*
0
0
0
0

2.2
Results of reference

Displacement according to X of the P4 point for certain frequencies.

2.3
Uncertainty on the solution

Semi-analytical solution.

2.4 Reference
bibliographical

[1]
J. PIRANDA: Note of use of the software of modal analysis MODAN - Version 0.2 (1990).
Laboratory of Mechanics Applied - University of Frank County - Besancon (France).

---

3 Modeling
With

3.1
Characteristics of modeling

Discrete element of rigidity in translation

y
With
P
P
B
X
1
2
P3
P4
P5

P6
P7
P8

Characteristics of the elements
DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity
K_T_D_L

and matrices of damping
A_T_D_L

Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: “YES” DY: 0. , DZ: 0.)
with the nodes ends

(GROUP_NO: AB DX: 0.)

Names of the nodes:
Not A = N1
P1 = N2
Not B = N10
P2 = N3
....

P8 = N9

3.2
Characteristics of the grid

A number of nodes: 10
A number of meshs and types: 9 SEG2

3.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA “K_T_D_L”

GROUP_MA
“A_T_D_L”
GROUP_MA
“M_T_D_N”
“MECHANICAL” AFFE_MODELE VERY “DIS_T”

GROUP_NO
“DIS_T”
AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE
DYNA_LINE_HARM MATR_AMOR

DEFI_LIST_REEL BEGINNING

INTERVAL
RECU_FONCTION LIST_FREQ

TEST_FONCTION

TEST_RESU

IMPR_RESU

LIRE_RESU

3.4
Results of modeling A

Parts real and imaginary of component DX of the displacement of the P4 point.

Frequency Reference
Aster %
Difference
5.00
1.0237 E4
1.02369 E4
0.0004
8.5187 E6
8.51874 E6
5.50
4.5066 E4
4.50662 E4
0.0004
7.7914 E4
7.79143 E4
6.00
9.4101 E5
9.41096 E5
0.0002
1.0585 E5
1.05851 E5
10.00
8.4143 E7
8.41427 E7
0.0024
1.0335 E6
1.03346 E6
15.00
1.2656 E5

1.26556 E5
0.0032
5.6652 E6
5.66517 E6
20.00
2.9784 E6
2.97844 E6
0.0003
6.6970 E6
6.69700 E6
25.00
1.2536 E6
1.25362 E6
0.0008
5.2703 E6
5.27033 E6
30.00
2.0904 E6
2.09042 E6
0.0009
5.4821 E6
5.48215 E6
35.00
4.5447 E6
4.54473 E6
0.0011
1.1190 E6
1.11903 E6
39.50
2.6895 E6
2.68949 E6
0.0003
3.0505 E7
3.05048 E7

Parts real and imaginary of component DX the speed of the P4 point.

Frequency Reference
Aster %
Difference
5.00
2.6762 E4
2.6762 E4

0.000
3.2160 E3
3.21603 E3
5.50
2.6925 E2
2.69252 E2
0.001
1.5574 E2
1.55737 E2
6.00
3.9904 E4
3.99052 E4
0.000
3.5475 E3
3.54752 E3
10.00
6.4937 E5
6.49347 E5
0.002
5.2869 E5
5.28685 E5
15.00
5.3393 E4
5.33929 E4
0.003
1.1928 E3
1.19276 E3
20.00
8.4157 E4
8.41570 E4
0.001
3.7428 E4
3.74282 E4
25.00
8.2786 E4
8.27862 E4
0.001
1.9691 E4
1.96919 E4
30.00
1.0333 E3
1.03334 E3
0.001

3.9403 E4
3.94035 E4
35.00
2.4608 E4
2.46089 E4
0.001
9.9943 E4
9.99439 E4
39.50
7.5709 E5
7.57086 E5
0.000
6.6749 E4
6.67494 E4

Parts real and imaginary of component DX of the acceleration of the P4 point.

Frequency Reference
Aster %
Difference
5.00
1.0103 E1
1.01035 E1
0.000
8.4076 E3
8.40766 E3

5.50
5.3819 E1
5.38190 E1
0.000
9.3047 E1
9.30470 E1
6.00
1.3374 E1
1.33738 E1
0.000
1.5044 E2
1.50439 E2
10.00
3.3218 E3
3.32182 E3
0.002
4.0801 E3
4.07996 E3
15.00
1.1242 E1
1.12415 E1
0.003
5.0322 E2
5.03217 E2
20.00
4.7033 E2
4.70337 E2
0.001
1.0575 E1
1.05755 E1
25.00
3.0931 E2
3.09320 E2
0.001
1.3004 E1
1.30040 E1
30.00
7.4273 E2
7.42739 E2
0.001
1.9478 E1
1.94780 E1
35.00

2.1979 E1
2.19788 E1
0.001
5.4116 E2
5.41178 E2
39.50
1.6566 E1
1.65662 E1
0.000
1.8789 E2
1.87898 E2

3.5 Remarks

Contents of the file results:

Values of the displacement of component DX of the P4 point for all the frequencies from 5 to 40 Hz by step of 0.5 (Case initial test of VPCS).

Values the speed and the acceleration of component DX of the P4 point for some frequencies of vibration.

---

4 Modeling
B

4.1
Characteristics of modeling

Discrete element of rigidity in translation

y
With
P
P
B
X
1
2
P3
P4
P5
P6
P7
P8

Characteristics of the elements
DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity
K_T_D_L

and matrices of damping
A_T_D_L

Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: "YES" DY: 0. , DZ: 0.)
with the nodes ends

(GROUP_NO: AB DX: 0.)

Names of the nodes:
Not A = N1
P1 = N2
Not B = N10
P2 = N3

....

P8 = N9

4.2
Characteristics of the grid

A number of nodes: 10
A number of meshs and types: 9 SEG2

4.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA “K_T_D_L”

GROUP_MA
“A_T_D_L”
GROUP_MA
“M_T_D_N”
“MECHANICAL” AFFE_MODELE VERY “DIS_T”

GROUP_NO
“DIS_T”
AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE
MODE_ITER_SIMULT

MACRO_PROJ_BASE

DYNA_LINE_HARM MATR_AMOR

REST_BASE_PHY

DEFI_LIST_REEL BEGINNING

INTERVAL

RECU_FONCTION LIST_FREQ

TEST_FONCTION

TEST_RESU

4.4
Results of modeling B

Parts real and imaginary of component DX of the displacement of the P4 point.

Frequency Reference
Aster %
Difference
5.00
1.0237 E4
1.02369 E4
0.0004
8.5187 E6
8.51874 E6
5.50
4.5066 E4
4.50662 E4
0.0004

7.7914 E4
7.79143 E4
6.00
9.4101 E5
9.41096 E5
0.0002
1.0585 E5
1.05851 E5
10.00
8.4143 E7
8.41427 E7
0.0024
1.0335 E6
1.03346 E6
15.00
1.2656 E5
1.26556 E5
0.0032
5.6652 E6
5.66517 E6
20.00
2.9784 E6
2.97844 E6
0.0003
6.6970 E6
6.69700 E6
25.00
1.2536 E6
1.25362 E6
0.0008
5.2703 E6
5.27033 E6
30.00
2.0904 E6
2.09042 E6
0.0009
5.4821 E6
5.48215 E6
35.00
4.5447 E6
4.54473 E6
0.0011
1.1190 E6

1.11903 E6
39.50
2.6895 E6
2.68949 E6
0.0003
3.0505 E7
3.05048 E7

4.5 Remarks

Contents of the file results:

Values of the displacement of component DX of the P4 point for all the frequencies from 5 to 40 Hz by step of 0.5 (Case initial test of VPCS).

Values the speed and the acceleration of component DX of the P4 point for some frequencies of vibration.

---

5 Modeling
C

5.1
Characteristics of modeling

Discrete element of rigidity in translation

y
With
P
P
B
X
1
2
P3
P4
P5
P6
P7
P8

Characteristics of the elements
DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity
K_T_D_L

and matrices of damping
A_T_D_L

Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: “YES” DY: 0. , DZ: 0.)
with the nodes ends

(GROUP_NO: AB DX: 0.)

Names of the nodes:
Not A = N1
P1 = N2
Not B = N10
P2 = N3
....

P8 = N9

5.2
Characteristics of the grid

A number of nodes: 10
A number of meshs and types: 9 SEG2

5.3 Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA “K_T_D_L”

GROUP_MA
“A_T_D_L”
GROUP_MA
“M_T_D_N”
“MECHANICAL” AFFE_MODELE VERY “DIS_T”

GROUP_NO
“DIS_T”
AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE
MODE_ITER_SIMULT MATR_AMOR

DYNA_LINE_HARM AMOR_REDUIT

DEFI_LIST_REEL BEGINNING

INTERVAL
RECU_FONCTION LIST_FREQ

5.4
Results of modeling C

Eigen frequencies of the structure for the sequence numbers from 1 to 5.

Sequence number	**Reference**	***Aster*** %	**Difference**
1	5.5271	5.5271848238694	0.002
2	10.8868	1.088524727521	-0.014
3	15.9155	1.5910519939851	-0.031
4	20.4606	20.449995091940	-0.052
5	24.384	24.366059022201	-0.074

Damping reduce structure for the sequence numbers from 1 to 5.

Sequence number	Reference	*Aster* %	Difference
1	0.00868241	8.6824088833463D-03	1.29E-05
2	0.017101	1.7101007166284D-02	4.19E-05
3	0.025	2.5000000000002D-02	9.19E-12
4	0.0321394	3.2139380484326D-02	6.07E-05
5	0.0383022	3.8302222155950D-02	5.78E-05

6 Summary of the results

The results obtained are excellent, which is normal for a direct integration.

1/8

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
Document: V2.01.022

SDLD22 - Transient of a system mass-arises
to 8 ddl with viscous shock absorber

Summary:

The mechanical structure considered is made up of a linear one-way whole of mass-springs with shock absorbers viscous and subjected to a transitory excitation of crenel type.

Two modelings are developed. The first retains only the degree of freedom in axial translation of masses, the second considers the axial translation and rotation.

This problem makes it possible to test:

- ***discrete elements (masses, springs, shock absorbers) in translation-rotation,***
- ***the definition of a force of specific excitation transitory,***
- ***the operator of transitory calculation of response by modal recombination (DYNA_TRAN_MODAL***

[U4.53.21]), as well as the recovery with initial conditions (modeling A),

·

the operator of calculation of direct transitory response with the diagram to step of adaptive time (DYNA_LINE_TRAN [U4.53.02]) (modeling B).

In addition, several operators of postprocessing are tested: RECU_FONCTION [U4.32.03], TEST_FONCTION
[U4.92.02], RECU_CHAMP [U4.71.01].

The results obtained (field of displacements, speeds) are in concord with the results of the guide VPCS, taken for reference solution.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

1
Problem of reference

1.1 Geometry

U1
U2
U3
U8
K
K
K
K
With
m
m
m
m
B
X, U
P1
P2
P3
P8
C
C
C
C

Specific masses:
mP = m = m = ... = m = m
1
P2
P3
P8

Stiffnesses of connection:
kAP1 = kP1P2 = kP2P3 = ... = kP8B = K

Viscous damping:
cAP1 = cP1P2 = cP2P3 = ... = cP8B = C

1.2
Material properties

Comes out from linear elastic translation
K =
105 N/m
Specific mass
m =
10 kg
One-way viscous damping
C =
50 N (m/s)

1.3
Boundary conditions and loadings

Boundary conditions: embedded points A and B (U = 0).

Loading: force concentrated at the P4 point in the shape of crenel:

Not P
=

=
4
F
F (T)

0 T 1s F (T) 1 NR
x4
T > 1s F (T) = 0.
Other points P
F = 0.
I
xi

1.4 Conditions
initial

For T = 0, in any point, U = 0 and
= 0 .
dt

2
Reference solution

The reference solution is from guide VPCS.

2.1
Method of calculation used for the reference solution

Numerical integration selected to obtain this solution rests on a diagram of integration by finished differences, of the method type - Newmark improved, with step of time of 0.001s [bib2].

1
1
1

1

M *+*
C *+*
K un+2 *= (N*
F *+2 + N*
F *1 +*
+
N
F*)*
2
T
2 T
3

3

2
1

1
1
1

+
M
K U
+
+
-
M *+*
C
K U
2
T

3
N 1
2

T
2 T
3
N

The displacement of item 4 according to time takes the following form:

Appear 2.1-a: Point 4: displacement according to time

2.2
Results of reference

Displacement according to X of the P4 point.

2.3
Uncertainty on the solution

Precision of the diagram of Newmark.

2.4 References
bibliographical

[1]
Card-index SDLD22/90 of commission VPCS.
[2]
NEWMARK NR. Mr.: "A method of computation for structural dynamics", proceeding ASCE
J. Eng. Mech. Div E-3, July 1959, pp 67-94.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

Code_Aster ®
Version
6.0

Titrate:

3 Modeling With

3.1 Characteristics of modeling

This modeling allows the validation of integration by modal recombination.

Discrete element of rigidity in translation

y
With
P
P
B
X
1
2
P3
P4
P5
P6
P7
P8

Characteristics of the elements

DISCRETE with
nodal masses
M_T_D_N
M_T_N

matrices of rigidity

K_T_D_L
K_T_L
matrices
of damping
A_T_D_L A_T_L

Blocking of the DDL in Y and Z of all the nodes

DDL_IMPO: (ALL: “YES” DY: 0. , DZ: 0.)

Boundary conditions with the extreme nodes

(GROUP_NO: AB DX: 0.)

Names of the nodes:

Not A = N1
P1 = N2
Not B = N10
P2 = N3
....

P8 = N9

Modal recombination with all the modes (either 8),

diagram of EULER, resumption of the first calculation with T = 0.455 S

no time used: T = 1. E3 S.

3.2
Characteristics of the grid

A number of nodes: 10

A number of meshs and types: 9 SEG2

3.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA "K_T_D_L"

GROUP_MA
"A_T_D_L"

GROUP_NO
"M_T_D_N"

"MECHANICAL" AFFE_MODELE VERY
"DIS_T"

GROUP_NO

"DIS_T"

AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE

MODE_ITER_INV ADJUSTS

DYNA_TRAN_MODAL MATR_AMOR EULER

NOT
0.001

DEFI_LIST_REEL BEGINNING

INTERVAL

RECU_FONCTION LIST_INST

REST_BASE_PHYS INTERPOL "FLAX"

4
Results of modeling A

4.1 Values
tested

Time Reference Aster %
Difference
0.09
4.02 E5
4.022 E5
0.05
0.18
4.22 E6
3.973 E6
-5.8
0.27
3.89 E5
3.902 E5
0.32
0.37
5.98 E6
5.750 E6

-3.83
0.46
3.73 E5
3.746 E5
0.43
0.54
7.14 E6
6.977 E6
-2.27
0.63
3.64 E5
3.646 E5
0.16
0.72
8.07 E6
7.923 E6
-1.81
0.81
3.58 E5
3.586 E5
0.18
0.9
8.76 E6
8.861 E6
-1.12
0.99
3.52 E5
3.531 E5
0.317
1.08
3.08 E5
3.072 E5
-0.23
1.18
3.02 E5
3.014 E5
-0.17
1.27
2.88 E5
2.878 E5
0.06
1.36
2.80 E5

2.791 E5
0.31
1.45
2.65 E5
2.652 E5
0.09

4.2 Remarks

Relative minima (T = 0.18, 0.54,…) do not have a very good precision during the phase of excitation with a step T = 0.001.

---

5 Modeling
B

5.1
Characteristics of modeling

This modeling allows, in addition to a new use of the modal recombination, the validation of direct integration with adaptive step.

Discrete element of rigidity in translation and rotation

y
With
P
P
B
X
1
2
P3
P4
P5
P6
P7
P8

Characteristics of the elements:

DISCRETE:
with nodal masses
M_TR_D_N
M_TR_N

and matrices of rigidity
K_TR_D_L
K_TR_L

and matrices of damping
A_TR_D_L A_TR_L

Boundary conditions and directions blocked:

in all the nodes
DDL_IMPO:
(ALL: "YES" DY: 0. , DZ: 0.)
(ALL: "YES" DRX: 0. DRY: 0 DRZ: 0)
with the nodes ends

(GROUP_NO: AB DX: 0.)

Direct integration by DYNA_LINE_TRAN, algorithm ADAPT, not of time max 103 S.

Integration by modal recombination on all the modes, diagram of Euler.

5.2
Characteristics of the grid

A number of nodes: 10

A number of meshs and types: 9 SEG2

5.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA
“K_TR_D_L”

GROUP_MA
“A_TR_D_L”

GROUP_MA
“M_TR_D_N”

“MECHANICAL” AFFE_MODELE VERY
“DIS_T”

GROUP_NO

“DIS_T”

AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE

CALC_MATR_ELEM OPTION
“MASS_MECA_DIAG”

MODE_ITER_INV ADJUSTS

DYNA_TRAN_MODAL MATR_AMOR

NOT
0.001

RECU_FONCTION LIST_INST

REST_BASE_PHYS INTERPOL “FLAX”

DYNA_LINE_TRAN ADAPT

6
Results of modeling B

6.1 Values tested

Transient by modal recombination

Time Reference Aster % Difference
0.09
4.02 E5
4.022 E5
0.05
0.18
4.22 E6
3.973 E6
-5.8
0.27
3.89 E5
3.902 E5
0.32
0.37
5.98 E6
5.750 E6
-3.83
0.46
3.73 E5
3.746 E5
0.43
0.54
7.14 E6
6.977 E6
-2.27
0.63
3.64 E5
3.646 E5
0.16
0.72
8.07 E6
7.923 E6
-1.81
0.81
3.58 E5
3.586 E5
0.18
0.9
8.76 E6
8.861 E6
-1.12

0.99
3.52 E5
3.531 E5
0.317
1.08
3.08 E5
3.072 E5
-0.23
1.18
3.02 E5
3.014 E5
-0.17
1.27
2.88 E5
2.878 E5
0.06
1.36
2.80 E5
2.791 E5
0.31
1.45
2.65 E5
2.652 E5
0.09

Direct transient

Time Reference Aster % Difference
0.09
4.02 E5
4.022 E5
0.06
0.18
4.22 E6
4.000 E6
-5.19
0.27
3.89 E5
3.900 E5
0.27
0.37
5.98 E6

5.764 E5
-3.60
0.46
3.73 E5
3.743 E5
0.36
0.54
7.14 E6
6.990 E6
-2.10
0.63
3.64 E5
3.645 E5
0.14
0.72
8.07 E6
7.936 E6
-1.64
0.81
3.58 E5
3.586 E5
0.17
0.9
8.76 E6
8.663 E6
-1.09
0.99
3.52 E5
3.531 E5
0.32
1.08
3.08 E5
3.078 E5
-0.04
1.18
3.02 E5
3.023 E5
0.11
1.27
2.88 E5
2.884 E5
0.15
1.36

2.80 E5
2.798 E5
-0.03
1.45
2.65 E5
2.657 E5
0.28

6.2 Remarks

Modelings A and B lead to the same results.

Relative minima (T = 0.18, 0.54,…) do not have a very good precision during the phase of excitation with a step T = 0.001.

7
Summary of the results

This test is to be supplemented while using:

· *a step of time T = 1. E 4,*
· *other diagrams of integration.*

Code_Aster ®
Version
5.0

Titrate:
SDLD23 System of masses and springs under random excitation
Date:
30/08/01
Author (S):
J. PIGAT

Key: V2.01.023-B Page:
1/6

Organization (S): EDF/RNE/AMV

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.023 document

SDLD23 - System of masses and springs under random excitation

Summary:

This test is in the course of validation within the framework of the VPCS.

It comprises a whole of eight specific masses and nine springs excited by an imposed random force on one of the masses.

The excitation is of white vibration type. It is given by the spectral concentration of power of the exiting force.

The movement of the excited mass is calculated by a stochastic approach according to different frequential discretizations for the answer.

One also calculates in postprocessing the spectral moments of the answer.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

1
Problem of reference

1.1 Geometry

dx
K
P1
K
P2
K
P

K
8
m
m
C
C
C
C

The excitation is a seismic movement of type forces imposed applied to the P4 point in the direction dx.

One is interested in the DSP of displacement of the P4 node.

1.2
Material properties

Specific masses:
m = 10 kg
Elastic springs:
K = 105 N/m
Shock absorbers:
C = 50 N (m/s)

1.3
Boundary conditions and loadings

The problem is unidimensional in direction X (1 ddl by mass).

The excitation is a DSP of constant force of level 1, between 3 and 13 Hz.

1
DSP
(N2/Hz)
3
13
Frequency (Hz)

2
Reference solution

2.1
Method of calculation used for the reference solution

The solution taken for reference results from test SDLD23 of guide VPCS [bib1].

2.2
Results of reference

Peak of the response to the first Eigen frequency.

Values of the first spectral moments for various discretizations.

2.3 Reference

Guide VPCS.

V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

---

3 Modeling
With

3.1
Characteristics of modeling

Discrete element in translation of the type DIS_T

Modeling respects the geometry.

Characteristics of the elements:

With the P1 nodes in P8: matrices of masses of the type M_T_D_N with m = 10 kg.
Elements of spring: a matrix of stiffness of the type K_T_D_L with Kx = 105 N/m
Elements of damping: a matrix of damping of the type A_T_D_L with cx = 50 N/m

Boundary conditions:

All the DDL are blocked except the DDL dx.

Modal damping is calculated by the operator of modal calculation, it is reinjected like modal damping in random dynamic calculation.

3.2
Characteristics of the grid

A number of nodes: 10
A number of meshs and types: 9 SEG2, 10 POI1

3.3 Functionalities tested

Orders

DEFI_INTE_SPEC PAR_FONCTION

DYNA_ALEA_MODAL BASE_MODALE AMOR

EXCIT
SIZE
"EFFO"
ANSWER

REST_SPEC_PHYS

POST_DYNA_ALEA MOMENT

---

4 Results of modeling A

4.1 Values tested

DSP of displacement to the P4 node

Identification	**Reference**	***Aster***	**% Difference**
ABSOLUTE: F = 5.5259 Hz	0.1059E5	0.1059E5	0%

Spectral moments for the discretization by defect (50 points per peak)

Identification	**Reference**	***Aster***	**% Difference**
Spectral moment n°0	1.585 10-7	1.618 10-7	2.11%
Spectral moment n°2	1.902 10-4	1.942 10-4	2.12%
Spectral moment n°4	2.322 10-1	2.370 10-1	2.09%
Spectral moment n°6	2.941 102	3.001 102	2.05%
Spectral moment n°8	4.143 105	4.226 105	2.00%

Spectral moments for the discretization with regular step 0.25 Hz (40 steps)

Identification	**Reference**	***Aster***	**% Difference**
Spectral moment n°0	1.585 10-7	2.339 10-7	47.61%
Spectral moment n°2	1.902 10-4	2.790 10-4	46.73%
Spectral moment n°4			

2.322 10-1 3.368
10-1 45.05%
Spectral moment n°6
2.941 102 4.173
102 41.91%
Spectral moment n°8
4.143 105 5.600
105 35.17%

Spectral moments for the discretization with regular step 0.05 Hz (200 steps)

Identification Reference *Aster* %
Difference
Spectral moment n°0
1.585 10-7 1.577
10-7 -0.44%
Spectral moment n°2
1.902 10-4 1.893
10-4 -0.46%
Spectral moment n°4
2.322 10-1 2.311
10-1 -0.48%
Spectral moment n°6
2.941 102 2.928
102 -0.43%
Spectral moment n°8
4.143 105 4.130
105 -0.30%

Spectral moments for the discretization with regular step 0.025 Hz (400 steps)

Identification Reference *Aster* %
Difference
Spectral moment n°0
1.585 10-7 1.585
10-7 0.02%
Spectral moment n°2
1.902 10-4 1.902
10-4 0.01%
Spectral moment n°4
2.322 10-1 2.322
10-1 -0.02%
Spectral moment n°6
2.941 102 2.941

102 0.00%
Spectral moment n°8
4.143 105 4.144
105 0.03%

4.2 Parameters of execution

Version: 5.02

Machine: SGI ORIGIN 2000
System:

Obstruction memory: 8 megawords,
time CPU To use:
3.60 seconds

5
Summary of the results

The preceding tables highlight the importance of the smoothness of the discretization frequential of the DSP response for the calculation of the spectral moments.

The user can choose the step: the frequency band is then discretized in a uniform way and it or the peaks can be badly represented: it is the case with 40 steps of 0.25 Hz, which involves an error of more than 40% at the spectral time.

More one refines the discretization, better is the result.

To avoid refining unnecessarily far from the peaks, one proposes a discretization by rather broad defect supplemented by a refinement of 50 points of discretization around each peak.

In the case of this test which includes/understands one peak, this discretization by defect makes it possible to estimate
spectral moments with a precision of about 2%.

Handbook of Validation

V2.01 booklet: Linear dynamics of the discrete systems

V2.01.025 document

SDLD25 - System mass-arises with shock absorber
viscous proportional (spectral answer)

Summary

This one-way problem consists in carrying out a spectral seismic analysis of a mechanical structure composed of a whole of mass-springs with viscous shock absorbers subjected to a seismic request provided in the shape of a spectrum of response of pseudo oscillators in acceleration.
Via this problem, one tests modal combination SRSS of operator COMB_SISM_MODAL [U4.54.04]. In addition, several operators of preprocessing are tested; DEFI_FONCTION and DEFI_NAPPE.
The results obtained are in concord with the results of guide VPCS.
This test is also a test of resorption of LICE. There are no differences between the ASTER results and them
LICE results.

1
Problem of reference
1.1 Geometry
U1
U2
U3
U8
K
K
K
K
With
m
m
m
m
B
X, U
P1
P2
P3
P8
C
C
C
C
Specific masses:

mP = m = m = ... = m = m
1
P2
P3
P8
Stiffnesses of connection:
kAP1 = kP1P2 = kP2P3 = ... = kP8B = K
Viscous depreciation:
cAP1 = cP1P2 = cP2P3 = ... = cP8B = C

1.2

Material properties

Comes out from linear elastic translation
K =
105 N/m
Specific mass
m =
10 kg
One-way viscous damping
C =
50 N (m/s)

1.3

Boundary conditions and loadings

Not A and b: embedded (U = 0)
Spectrum of acceleration to supports Ý
Ý
U (F, has) normalized with 1. ms2
Points A and b: Ý
Ý
U = Ý
Ý
U (F, has)
ms2
25
0.5%
5%
10
1
1
3
13
33
frequency (Hz)
Handbook of Validation

2 Reference solution

2.1 Method of calculation used for the reference solution

Comparison with other codes.

Guide VPCS: test in preparation.

2.2 Results of reference

Absolute acceleration according to X at the points A, P1, P2, P3, P4.

2.3 References bibliographical

[1] Guide VPCS: Second edition to be appeared.

[2] J. PIRANDA: Note of use of the software of modal analysis MODAN - Version 0.2. Laboratory of Mechanics Applied - University of Frank County Besancon (1990).

Code_Aster ®
Version
4.0
Titrate:
SDLD25 Système mass-arises with viscous shock absorber
Date:
05/01/98
Author (S):

3 Modeling
With
3.1
Characteristics of modeling
y
With
P
P
P
P
P
P
P
B
X
P
1
2
3
4
5
6
7
8
Characteristics of the elements:
DISCRETE:
with nodal masses
M_T_D_N
and matrices of rigidity
K_T_D_L
and matrices of damping
A_T_D_L
Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: “YES” DY: 0. , DZ: 0.)
with the nodes ends
(GROUP_NO: AB DX: 0.)
Names of the nodes:

Not A = N1
P1 = N2
Not B = N10
P2 = N3
....
P8 = N9
3.2
Characteristics of the grid
A number of nodes: 10
A number of meshs and types: 9 SEG2
3.3 Functionalities
tested
Orders
Keys
AFFE_MODELE
ALL
“MECHANICAL”
“DIS_T”
[U4.22.01]
GROUP_NO
“DIS_T”
AFFE_CARA_ELEM
DISCRETE
GROUP_MA
“K_T_D_L”
[U4.24.01]
GROUP_MA
“A_T_D_L”
GROUP_NO
“M_T_D_N”
COMB_SISM_MODAL
[U4.54.04]

---

4 Results of modeling A

4.1 Values tested

Identification	**Reference**	**Aster**	**% difference**
Eigen frequencies			
1	5.53	5.527	-0.04
2	10.89	10.886	-0.02
3	15.92	15.915	-0.02
4	20.46	20.460	0.00
5	24.38	24.383	0.01
6	27.57	27.566	-0.01
7	29.91	29.911	0.00
8			

31.35
31.347
-0.01
Size localization
ACCE_ABSOLU A DX
1.0
1.0
1.0
P1 DX
10.69
10.45
2.24
P2 DX
19.26
19.03
1.19
P3 DX
25.46
25.32
0.55
P4 DX
29.16
28.95
0.73

4.2 Remarks

Mode
1
2
3
4
5
6
7
8
Damping (in %)
0.868
1.710
2.500
3.213
3.830
4.331
4.698
4.924

Spectrum
23.19
19.54
9.033
3.928
2.282
1.601
1.283
1.136

4.3 Parameters
of execution

Version: 3.05.02
Machine: CRAY
System: UNICOS 8.0
Obstruction memory: 8 megawords
Time CPU To use: 5.75 seconds

5
Summary of the results

One obtains a good agreement between the Aster solution and the reference solution which comes from other codes.
The Aster results are identical to the LICE results until the second decimal.

6.4

Titrate:
SDLD27 - System mass-arises with 8 degrees of freedom

Date:
17/02/04
Author (S):
***E. BOYERE** Key*
:
V2.01.027-C Page:
1/14

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.027 document

SDLD27 - System mass-arises with 8 degrees of freedom with viscous shock absorber not proportional (analyzes modal)

Summary:

This two-dimensional problem consists in seeking the frequencies, the modes of vibration and them depreciation of a mechanical structure made up of masses, springs and shock absorbers viscous. It

case-test of Mechanics of the Structures corresponds to a dynamic analysis of a discrete model having one linear behavior.

This test allows a complete validation of the options of discrete modeling of rigidity, of damping viscous and of mass (without finite elements) offered by order AFFE_CARA_ELEM [U4.42.01]. Five different modelings are proposed: the modeling of the discrete elements is either in translation, or in translation/rotation and is written either in total reference mark, or in local reference mark. In addition, different functionalities of orders MODE_ITER_INV [U4.52.04] (search for eigenvalues per iteration opposite), MODE_ITER_SIMULT [U4.52.03] (search for eigenvalues by the method of Lanczos) and NORME_MODE [U4.52.11] (definition of the standard of a clean vector) are tested for this problem quadratic.

This test refers to a test VPCS, but it was modified. Indeed, the Aster test directs the mechanical system on an axis 3y = 4x, which makes it possible to validate the entry of the data in local reference mark. The results obtained are in concord with the results of reference.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

1
Problem of reference

1.1 Geometry

U1
U2
U3
U8
K
K
K
K
With
m
m
m
m
B
X, U
p1
p2
p3
p8
DC
C
C
Cd

Specific masses:
mP = m = m = ... = m = m
1
P2
P3
P8

Stiffnesses of connection:
kAP1 = kP1P2 = kP2P3 = ... = kP8B = K

Viscous damping:
cP1P2 = cP2P3 = ... = CP7P8 = C
cAP1 = DC
CP8B = Cd

1.2 Material properties

Comes out from linear elastic translation
K =
105 N/m
Specific mass
m =
10 kg
One-way viscous shock absorbers
C =
50 N (m/s)

DC =
250 N (m/s)

Cd =
25 N (m/s)

1.3 Boundary conditions and loadings

Embedded points A and B: (U = 0).

1.4 Conditions

initial

Without object for the modal analysis.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

Code_Aster ®
Version
6.4

Titrate:
SDLD27 - System mass-arises with 8 degrees of freedom

Date:
17/02/04
Author (S):
E. BOYERE *Key*
:
V2.01.027-C Page:
3/14

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLD27 of guide VPCS.

The problem led to seek the eigenvalues and clean vectors of the dissipative system according to:

M&u + ***C*** *&u* + ***Ku*** *= 0*

with ***M*** *stamps of mass,* ***C*** *stamps damping,* ***K*** *stamps rigidity.*

One associates this dissipative problem, the conservative problem: ***Ku*** + ***Mu&*** *= 0. In form harmonic, it is written* ***K*** *- 2M = 0.*

Are = [2v] the spectral diagonal matrix of the eigenvalues of this conservative system and = [v] the corresponding matrix of the clean vectors.

T
T
v are standardized such as:

M = Id

K =.

The solutions of the dissipative system are form:

U U is
=
2
O
from where (ms + Cs + K))uo = 0.

One breaks up uo in the base of the v. There is then U
Q
O =, from where:

(Is2 + s+) Q = 0 with = T
C (full matrix)

This problem with the eigenvalues is solved by a method of power reverses while taking for initial estimate S = J
v
v.

2.2
Results of reference

8 depreciation and Eigen frequencies of the system, as well as 1st and the 8th mode (complexes).

2.3
Uncertainty on the solution

Semi-analytical solution.

2.4 References
bibliographical

[1]
J. PIRANDA - Note of use of the software of modal analysis MODAN - Version 0.2 (1990)

Laboratory of Mechanics Applied - University of Franche-Comté - Besancon (France)
[2]
Guide VPCS. Complement Groups Dynamic. September 94
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

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3 Modeling With

3.1 Characteristics of modeling

Discrete element of rigidity in translation DIS_T

y
With
P
P
B
X
1
2
P3
P4
P5
P6
P7

P8

Characteristics of the elements

DISCRETE:

with nodal masses

in all the nodes
M_T_D_N
in absolute reference mark
(m = 10.)
matrices of rigidity

in all the meshs
M_T_D_L
in absolute reference mark
(Kx = 1.105)
matrices of damping

internal meshs
A_T_D_L
in absolute reference mark
(Cx = 50.)
initial mesh
A_T_D_L
in absolute reference mark
(Cx = 250.)
net final
A_T_D_L
in absolute reference mark
(Cx = 25.)

Limiting conditions:

DDL_IMPO:
(ALL: “YES” DY: 0. , DZ: 0.)

with the nodes ends
(NODE: (A B) DX: 0.)

Names of the nodes: With, P1, P2,…., P8, B

3.2
Characteristics of the grid

A number of nodes:
10
A number of meshs and types:
9 SEG2 and 8 POI1

3.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM
GROUP_MA
"K_T_D_L"

"A_T_D_L"

NODE
"M_T_D_N"
AFFE_CHAR_MECA DDL_IMPO
ALL

LIAISON_DDL
NODE

AFFE_MATERIAU ALL

AFFE_MODELE ALL
"MECHANICAL"
"DIS_T"
GROUP_NO

"DIS_T"
DEFI_MATERIAU ELAS

MODE_ITER_SIMULT METHOD
“TRI_DIAG”

CALC_FREQ
OPTION
“PLUS_PETITE”

NMAX_FREQ

NORM_MODE NORMALIZES MASS_GENE

4
Results of modeling A

4.1 Values
tested

Frequency Reference
Aster *%*
Difference
Order of the clean mode 1
5.53
5.529

-0.015
Order of the clean mode 2
10.90
10.896
-0.037
Order of the clean mode 3
15.93
15.927
-0.019
Order of the clean mode 4
20.45
20.452
-0.011
Order of the clean mode 5
24.34
24.336
-0.019
Order of the clean mode 6
27.49
27.486
-0.019
Order of the clean mode 7
29.84
29.835
-0.01
Order of the clean mode 8
31.29
31.295
0.015

Damping Reference
***Aster** %*
Difference
Order of the clean mode 1
1.521e-2
1.5209e-2
-0.007
Order of the clean mode 2
2.877e-2
2.8757e-2
-0.043
Order of the clean mode 3
3.960e-2

3.9565e-2
-0.09
Order of the clean mode 4
4.709e-2
4.7034e-2
-0.119
Order of the clean mode 5
5.098e-2
5.0917e-2
-0.1240
Order of the clean mode 6
5.183e-2
5.1770e-2
-0.126
Order of the clean mode 7
5.115e-2
5.1084e-2
-0.128
Order of the clean mode 8
5.036e-2
5.0296e-2
-0.126

Nature of the mode
Not Mode
proper clean Mode Aster
% Difference
clean
Reference in 103
Real part
Real part
Imaginary part
Imaginary part

P1
4.07, -4.56
4.0735, -4.5552
0.096

P2
7.97, -8.28
7.9652, -8.2846
0.058
Translation 1

P3
10.9, -11.0
10.882, -11.026
0.205
(Dy)
P4
12.5, -12.5
12.468, -12.541
0.315
1
P5
12.5, -12.4
12.594, -12.398
0.168
P6
11.1, -10.9
11.058, -10.865
0.349
P7
8.24, -8.04
8.2355, -8.0376
0.045
P8
4.41, -4.25
4.4055, -4.2529
0.088

P1
2.23, -1.14
2.2336, -1.1391
0.15

P2
-3.71, 2.98
-3.7107, 2.9759
0.087
Translation 8
P3
4.75, -4.41
4.7547, -4.4145
0.101
(Dy)
P4

-5.25, 5.27
-5.2487, 5.2688
0.024
8
P5
5.14, -5.43
5.1389, -5.4291
0.019
P6
-4.44, 4.88
-4.4401, 4.8766
0.052
P7
3.23, -3.69
3.2340, -3.6852
0.128
P8
-1.66, 2.01
-1.6596, 2.0121
0.081

Clean mode normalized with the unit modal mass: T
T
*I **C** I + 2 I I **M** I = 1*

: is the eigenvalue associated damping and the Eigen frequency.

4.2
Contents of the file results

8 depreciation and Eigen frequencies, as well as the associated clean vectors.

---

5 Modeling
B

5.1
Characteristics of modeling

Discrete element of rigidity in translation DIS_T

Y
0.4
0.3
P
P
P
1
P2
3
P4
P5
6
P7
P8
X
X

Characteristics of the elements
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:

with nodal masses

in all the nodes
M_T_D_N
in absolute reference mark
(m = 10.)
matrices of rigidity

in all the meshs
K_T_D_L
in local reference mark
(Kx = 1.105)
with the nodes ends
K_T_D_N
in local reference mark
(Kx = 1.105)
matrices of damping

internal meshs
A_T_D_L
in local reference mark
(Cx = 50.)
initial mesh
A_T_D_N
in local reference mark
(Cx = 250.)
net final
A_T_D_N
in local reference mark
(Cx = 25.)

Limiting conditions:
DDL_IMPO:
(ALL: "YES" DZ: 0.)
LIAISON_DDL:
(such as 3Dy=4Dx in all the nodes)

Names of the nodes: P1, P2,…., P8

5.2
Characteristics of the grid

A number of nodes:
8
A number of meshs and types:
7 SEG2

The points P1 and P8 are connected to a fixed fictitious point by nodal springs (K_T_D_N, A_T_D_N) it who allows not to model the nodes A and B.

5.3 Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA
“K_T_D_L”

“A_T_D_L”

NODE
“K_T_D_N”

“A_T_D_N”

GROUP_NO
“M_T_D_N”
AFFE_CHAR_MECA DDL_IMPO ALL

LIAISON_DDL
NODE

AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE VERY
“DIS_T”
GROUP_NO

“DIS_T”
DEFI_MATERIAU ELAS

MODE_ITER_INV CALC_FREQ
OPTION

"ADJUSTS"

FREQ

NORM_MODE NORMALIZES
MASS_GENE

6
Results of modeling B

6.1 Values
tested

Frequency Reference
Aster *%*
Difference
Order of the clean mode 1
5.53
5.529
0.015
Order of the clean mode 2
10.90
10.897
0.025
Order of the clean mode 3

15.93
15.934
0.026
Order of the clean mode 4
20.45
20.469
0.093
Order of the clean mode 5
24.34
24.360
0.082
Order of the clean mode 6
27.49
27.510
0.075
Order of the clean mode 7
29.84
29.849
0.030
Order of the clean mode 8
31.29
31.298
0.028

Damping Reference
Aster *%*
Difference
Order of the clean mode 1
1.521e2
1.5208e2
-0.007
Order of the clean mode 2
2.877e2
2.8743e2
-0.093
Order of the clean mode 3
3.960e2
3.9497e2
-0.259
Order of the clean mode 4
4.709e2
4.6910e2
-0.381

Order of the clean mode 5
5.098e2
5.0792e2
-0.369
Order of the clean mode 6
5.183e2
5.1689e2
-0.270
Order of the clean mode 7
5.115e2
5.1056e2
-0.184
Order of the clean mode 8
5.036e2
5.0290e2
-0.139

Nature of the mode
Not Mode
proper clean Mode Aster
% Difference
clean
Reference in 103
Real part
Real part
Imaginary part
Imaginary part

P1
-2.442, 2.736
-2.4440 , 2.7331
0.0963

P2
-4.782, 4.968
-4.7791 , 4.9707
0.0577
Translation 1
P3
-6.54 , 6.6
-6.5293 , 6.6158
0.2048
(Dy)
P4

-7.5 , 7.5
-7.4801 , 7.4725
0.3155
1
P5
-7.5 , 7.44
-7.5177 , 7.4388
0.1679
P6
-6.66 , 6.54
-6.6351 , 6.5189
0.3491
P7
-4.944, 4.824
-4.9413 , 4.8226
0.0445
P8
-2.646, 2.55
-2.6433 , 2.5518
0.0877

P1
-1.338, 0.684
-1.2892 , 0.7585
5.9257

P2
-2.226, 1.788
-2.2318 , 1.7719
0.5976
Translation 8
P3
-2.85 , 2.646
-2.8521 , 2.6475
0.0659
(Dy)
P4
-3.15 , 3.162
-3.1509 , 3.1548
0.1615
8
P5
-3.084, 3.258

-3.0841 , 3.2532
0.1064
P6
-2.664, 2.928
-2.6657 , 2.9208
0.1855
P7
-1.938, 2.214
-1.9401 , 2.2089
0.1851
P8
-0.996, 1.206
-1.0061 , 1.1985
0.8025

Clean mode normalized with the unit modal mass: T
T
*I **C** I + 2 I I **M** I = 1*

: is the eigenvalue associated damping and the Eigen frequency.

6.2
Contents of the file results

8 depreciation and Eigen frequencies, as well as the associated clean vectors.

7 Modeling
C

7.1
Characteristics of modeling

Discrete element of rigidity in translation DIS_T

Y
0.4
0.3
P
P
P
1
P2
3
P4
P5
6
P7
P8
X
X

Characteristics of the elements
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:

with nodal masses

in all the nodes
M_T_N
in absolute reference mark
(m = 10.)
matrices of rigidity

in all the meshs
K_T_L
in local reference mark
(Kx = 1.105)
with the nodes ends
K_T_N
in local reference mark
(Kx = 1.105)
matrices of damping

in all the meshs
A_T_L
in local reference mark
(Cx = 50.)
with the initial node
A_T_N
in local reference mark
(Cx = 250.)
with the final node
A_T_N
in local reference mark
(Cx = 25.)

Limiting conditions:
DDL_IMPO:
(ALL: "YES" DZ: 0.)
LIAISON_DDL:
(such as 3Dy=4Dx in all the nodes)

Names of the nodes: P1, P2,…., P8

7.2
Characteristics of the grid

A number of nodes:
8
A number of meshs and types:
7 SEG2

The points P1 and P8 are connected to a fixed fictitious node by nodal springs (K_T_N, A_T_N).

7.3 Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA
“K_T_L”

“A_T_L”

NODE
“K_T_N”

“A_T_N”

GROUP_NO
“M_T_N”
AFFE_CHAR_MECA DDL_IMPO ALL
LIAISON_DDL
NODE

AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE VERY
“DIS_T”
GROUP_NO

“DIS_T”
DEFI_MATERIAU ELAS

MODE_ITER_INV CALC_FREQ
OPTION
“SEPARATE”

FREQ

NORM_MODE NORMALIZES
MASS_GENE

Handbook of Validation

8
Results of modeling C

8.1 Values tested

Frequency Reference
Aster *%*
Difference
Order of the clean mode 1
5.53
5.529
-0.015
Order of the clean mode 2
10.90
10.897
-0.025
Order of the clean mode 3
15.93
15.934
0.026
Order of the clean mode 4
20.45
20.469
0.0931

Order of the clean mode 5
24.34
24.360
0.082
Order of the clean mode 6
27.49
27.510
0.074
Order of the clean mode 7
29.84
29.849
0.032
Order of the clean mode 8
31.29
31.298
0.027

Damping Reference
***Aster** %*
Difference
Order of the clean mode 1
1.521e2
1.5208e2
-0.007
Order of the clean mode 2
2.877e2
2.8743e2
-0.093
Order of the clean mode 3
3.960e2
3.9497e2
-0.26
Order of the clean mode 4
4.709e2
4.6911e2
-0.379
Order of the clean mode 5
5.098e2
5.0790e2
-0.373
Order of the clean mode 6
5.183e2
5.1691e2

-0.269
Order of the clean mode 7
5.115e2
5.1062e2
-0.171
Order of the clean mode 8
5.036e2
5.0283e2
-0.151

Nature of the mode
Not Mode
proper clean Mode Aster
% Difference
clean
Reference in 103
Real part
Real part
Imaginary part
Imaginary part

P1
-2.442 , 2.736
-2.4441, 2.7331
0.096

P2
-4.782 , 4.968
-4.7791, 4.9707
0.058
Translation 1
P3
-6.54 , 6.6
-6.5293, 6.6158
0.205
(Dy)
P4
-7.5 , 7.5
-7.5481, 7.4725
0.315
1
P5
-7.5 , 7.44
-7.5177, 7.4388

0.168
P6
-6.66 , 6.54
-6.6351, 6.5189
0.349
P7
-4.944 , 4.824
-4.9413, 4.8226
0.044
P8
-2.646 , 2.55
-2.6433, 2.5518
0.088

P1
-1.338 , 0.684
-1.2889, 0.7533
5.651

P2
-2.226 , 1.788
-2.2326, 1.7638
0.879
Translation 8
P3
-2.85 , 2.646
-2.8538, 2.6402
0.178
(Dy)
P4
-3.15 , 3.162
-3.1525, 3.1519
0.233
8
P5
-3.084 , 3.258
-3.0846, 3.2560
0.046
P6
-2.664 , 2.928
-2.6650, 2.9280
0.027
P7

-1.938 , 2.214
-1.9388, 2.2171
0.11
P8
-0.996 , 1.206
-1.0050, 1.2038
0.594

Clean mode normalized with the unit modal mass: T
T
I ***C*** *I + 2 I I* ***M*** *I = 1*

is the eigenvalue associated damping and the Eigen frequency.

8.2
Contents of the file results

8 depreciation and Eigen frequencies, as well as the associated clean vectors.

---

9 Modeling
D

9.1
Characteristics of modeling

Transposition of the test of reference to the case of the degrees of freedom of rotation (comes out from torsion +
inertia) by using the discrete element of rigidity in translation/rotation.
Y
0.4
0.3
P
P
P
1
P2
3
P4
P5
6
P7
P8
X
X

Characteristics of the elements
ORIENTATION:
in all the nodes
with an angle = 53.130102°
DISCRETE:

with nodal masses

in all the nodes
M_TR_D_N
in local reference mark
(m = 10.)
matrices of rigidity

in all the meshs
K_TR_D_L
in local reference mark
(KRx = 1.105)

with the nodes ends
K_TR_D_N
in local reference mark
(KRx = 1.105)
matrices of damping

in all the meshs
A_TR_D_L
in local reference mark
(CRx = 50.)
with the initial node
A_TR_D_N
in local reference mark
(CRx = 250.)
with the final node
A_TR_D_N
in local reference mark
(CRx = 25.)
Limiting conditions:
DDL_IMPO:
(ALL: "YES" DX: 0. , DY: 0. , DZ: 0. , DRZ: 0.)
LIAISON_DDL:
(such as 3DRy=4DRx in all the nodes)
Names of the nodes: P1, P2,…., P8

9.2
Characteristics of the grid

A number of nodes:
8
A number of meshs and types:
7 SEG2

The nodes P1 and P8 are connected to a fixed fictitious node by nodal springs (K_TR_N, A_TR_N).

9.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM
GROUP_MA

"K_TR_D_L"

"A_TR_D_L"

NODE
"K_TR_D_N"

"A_TR_D_N"

GROUP_NO
"M_TR_D_N"
AFFE_CHAR_MECA DDL_IMPO
ALL

LIAISON_DDL
NODE

AFFE_MATERIAU ALL

AFFE_MODELE ALL
"MECHANICAL"
"DIS_TR"
GROUP_NO

"DIS_TR"
DEFI_MATERIAU ELAS

"CLOSE" MODE_ITER_INV CALC_FREQ OPTION

FREQ

NORM_MODE NORMALIZES MASS_GENE

9.4
Contents of the file results

Results obtained with:
CALC_FREQ: (LIST_FREQ: (6. , 10. , 15. , 19. , 24. , 29. , 29. , 31.))
CALC_MODE: (NMAX_MODE: 75)
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems

10 Results of modeling D

10.1 Values tested

Frequency Reference
Aster %
Difference
Order of the clean mode 1
5.53
5.529
-0.015
Order of the clean mode 2
10.90
10.897
-0.025
Order of the clean mode 3
15.93
15.934
0.027
Order of the clean mode 4
20.45
20.469
0.095
Order of the clean mode 5
24.34

24.359
0.079
Order of the clean mode 6
27.49
27.512
0.082
Order of the clean mode 7
29.84
29.853
0.042
Order of the clean mode 8
31.29
31.293
0.013

Damping Reference
Aster %
Difference
Order of the clean mode 1
1.521e2
1.5210e2
0.003
Order of the clean mode 2
2.877e2
2.8747e2
-0.079
Order of the clean mode 3
3.960e2
3.9525e2
-0.189
Order of the clean mode 4
4.709e2
4.6924e2
-0.352
Order of the clean mode 5
5.098e2
5.0899e2
-0.159
Order of the clean mode 6
5.183e2
5.1550e2
-0.539
Order of the clean mode 7

5.115e2
5.1180e2
-0.059
Order of the clean mode 8
5.036e2
5.0160e2
-0.396

Nature of the mode
Not Mode
proper clean Mode Aster
% Difference
clean
Reference in 103
Real part
Real part
Imaginary part
Imaginary part

P1
-2.442 , 2.736
-2.4438, 2.7338
0.076

P2
-4.782 , 4.968
-4.7789, 4.9712
0.064
Rotation 1
P3
-6.54 , 6.6
-6.5293, 6.6160
0.207
(DRx)
P4
-7.5 , 7.5
-7.4810, 7.4724
0.316
1
P5
-7.5 , 7.44
-7.5177, 7.4387
0.169
P6

-6.66 , 6.54
-6.6352, 6.5187
0.350
P7
-4.944 , 4.824
-4.9414, 4.8227
0.045
P8
-2.646 , 2.55
-2.6434, 2.5515
0.082

P1
-1.338 , 0.684
-1.2674, 0.6692
4.799

P2
-2.226 , 1.788
-2.2225, 1.6307
5.509
Rotation 8
P3
-2.85 , 2.646
-2.8626, 2.5198
3.261
(DRx)
P4
-3.15 , 3.162
-3.1703, 3.1001
1.458
8
P5
-3.084 , 3.258
-3.1022, 3.2965
0.949
P6
-2.664 , 2.928
-2.6763, 3.0414
2.883
P7
-1.938 , 2.214
-1.9423, 2.3489

4.590
P8
-0.996 , 1.206
-1.0038, 1.2906
5.437

Clean mode normalized with the unit modal mass: T
T
I C I + 2 I I M I = 1

is the eigenvalue associated damping and the Eigen frequency.

10.2 Contents of the file results

8 depreciation and Eigen frequencies, as well as the associated clean vectors.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

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11 Modeling E

11.1 Characteristics of modeling

Transposition of the test of reference to the case of the degrees of freedom of rotation (comes out from torsion + inertia) by using the discrete element of rigidity in translation/rotation: DIS_TR

Y
0.4
0.3
P
P
P
1
P2
3
P4
P5
6
P7
P8
X
X

Characteristics of the elements
ORIENTATION:
in all the nodes

with an angle = 53.130102°
DISCRETE:

with nodal masses

in all the nodes
M_TR_N
in local reference mark
(Ixx = 10.)
matrices of rigidity

in all the meshs
K_TR_L
in local reference mark
(KRx = 1.105)
with the nodes ends
K_TR_N
in local reference mark
(KRx = 1.105)
matrices of damping

in all the meshs
A_TR_L
in local reference mark
(CRx = 50.)
with the initial node
A_TR_N
in local reference mark
(CRx = 250.)
with the final node
A_TR_N
in local reference mark
(CRx = 25.)

Limiting conditions:
DDL_IMPO:
(ALL: "YES" DX: 0. , DY: 0. , DZ: 0. , DRZ: 0.)

LIAISON_DDL:
(such as 3DRy=4DRx in all the nodes)
Names of the nodes: P1, P2,…., P8

11.2 Characteristics of the grid

A number of nodes:
8
A number of meshs and types:
7 SEG2

The nodes P1 and P8 are connected to a fixed fictitious node by nodal springs (K_TR_N, A_TR_N).

11.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA
"K_TR_L"

"A_TR_L"

NODE
"K_TR_N"

"A_TR_N"

GROUP_NO
"M_TR_N"
AFFE_CHAR_MECA DDL_IMPO ALL
LIAISON_DDL
NODE

AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE VERY
"DIS_TR"
GROUP_NO

"DIS_TR"
DEFI_MATERIAU ELAS

MODE_ITER_SIMULT METHOD
“TRI_DIAG”

CALC_FREQ
OPTION
“CENTER”

FREQ

NMAX_FREQ

NORM_MODE NORMALIZES
MASS_GENE

---

12 Results of modeling E

12.1 Values tested

Frequency Reference
Aster %
Difference
Order of the clean mode 1

5.53
5.529
0.0154
Order of the clean mode 2
10.90
10.896
0.0374
Order of the clean mode 3
15.93
15.927
0.0190
Order of the clean mode 4
20.45
20.452
0.0113
Order of the clean mode 5
24.34
24.336
0.0185
Order of the clean mode 6
27.49
27.487
0.0105
Order of the clean mode 7
29.84
29.835
0.0163
Order of the clean mode 8
31.29
31.295
0.0154

Damping Reference
Aster %
Difference
Order of the clean mode 1
1.521e2
1.5209e2
-0.007
Order of the clean mode 2
2.877e2
2.8757e2
-0.043

Order of the clean mode 3
3.960e2
3.9565e2
-0.09
Order of the clean mode 4
4.709e2
4.7034e2
-0.119
Order of the clean mode 5
5.098e2
5.0917e2
-0.124
Order of the clean mode 6
5.183e2
5.1764e2
-0.126
Order of the clean mode 7
5.115e2
5.1084e2
-0.128
Order of the clean mode 8
5.036e2
5.0296e2
-0.126

Nature of the mode
Not Mode
proper clean Mode Aster
% Difference
clean
Reference in 103
Real part
Real part
Imaginary part
Imaginary part

P1
-2.442 , 2.736
-2.4440, 2.7331
0.096

P2
-4.782 , 4.968
-4.7791, 4.9707

0.058
Rotation 1
P3
-6.54 , 6.6
-6.5293, 6.6158
0.205
(DRx)
P4
-7.5 , 7.5
-7.5481, 7.4725
0.315
1
P5
-7.5 , 7.44
-7.5177, 7.4388
0.168
P6
-6.66 , 6.54
-6.6351, 6.5189
0.349
P7
-4.944 , 4.824
-4.9413, 4.8226
0.045
P8
-2.646 , 2.55
-2.6433, 2.5518
0.088

P1
-1.338 , 0.684
-1.3401, 0.6834
0.150

P2
-2.226 , 1.788
-2.2264, 1.7855
0.087
Rotation 8
P3
-2.85 , 2.646
-2.8528, 2.6488
0.101

(DRx)
P4
-3.15 , 3.162
-3.1492, 3.1613
0.024
8
P5
-3.084 , 3.258
-3.0833, 3.2575
0.019
P6
-2.664 , 2.928
-2.6640, 2.9259
0.052
P7
-1.938 , 2.214
-1.9404, 2.2111
0.128
P8
-0.996 , 1.206
-0.9958, 1.2072
0.081

Clean mode normalized with the unit modal mass: T
T
I C I + 2 I I M I = 1

: is the eigenvalue associated damping and the Eigen frequency.

12.2 Contents of the file results

8 depreciation and Eigen frequencies, as well as the associated clean vectors.

---

13 Summary of the results

For all the options of modeling of the discrete elements of rigidity, of mass and of damping offered by AFFE_CARA_ELEM the solutions obtained are those of the solution of reference (frequencies and clean modes).

Organization (S): EDF/EP/AMV
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
Document: V2.01.029

SDLD29 - Transient masses spring with 8 ddl and viscous damping nonproportional

Summary:
This problem corresponds to a transitory analysis by modal recombination of a linear discrete system constituted of 8 degrees of freedom. This system has a non-proportional damping. A force transient of the crenel type is applied into 1 degree of freedom.
In this problem the elements DISCRETE with modal masses are tested (M_T_D_N), matrices of

rigidity
(K_T_D_L) and matrices of damping (A_T_D_L) in a modeling.
The problem has a reference solution suggested by commission VPCS. Variations with
Code_Aster do not exceed 1,8%.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLD29 Transitoire masses spring with 8 ddl
Date:
01/12/98
Author (S):
A.C. LIGHT
Key:
V2.01.029-C Page:
2/6

1
Problem of reference
1.1 Geometry

U
U
U
2
U
1
3
8
B
With
m
m
m
m
X, U
K
K
K
K
P1

P
P
P
2
3
8
DC
C
C
Cd
Specific masses:
mP = m = m = ... = m = m
1
P2
P3
P8
Stiffnesses of connection:
kAP1 = kP1P2 = kP2P3 = ... = kP8B = K
Viscous damping:
cP1P2 = cP2P3 = ... = CP7P8 = C
cAP1 = DC
CP8B = Cd
1.2
Material properties
Comes out from linear elastic translation
K =
105 N/m
Specific mass
m =
10 kg
Damping of connection
C =
50 N (m/s)
DC =
250 N (m/s)
Cd =
25 N (m/s)
1.3
Boundary conditions and loadings
Embedded points A and B: U = 0
Loading: *Force concentrated not periodical at the P4 point*
Fx
Not P4

Fx
F (T) = 1N = constant
4
4 = F (T) 0 ² T ² 1s
T > 1s
F (T) = 0
1
0
1
T

1.4 Conditions
initial

For T = 0, in any point P
=
I: U = 0,
0.
dt

---

2 *Reference solution*

2.1 *Method of calculation used for the reference solution*

Numerical integration (approximate) by the direct method using a diagram of integration numerical by finished differences, the step of time used must be sufficiently small to obtain one sufficiently precise solution. With one of the diagrams used (method - Newmark improved), the step appointed time was of 0.001s.
Method of - Newmark improved (NEWMARK NR. Mr., "A method of computation for structural

dynamics " proceeding ASCE J. Eng. Mech. Div E-3, July 1959, pp 67-94) use the diagram of integration according to:

1 [

***M**]*

1

+

[] 1

C** + [**K**] **U

2

*(**n+2**)*

T

2t

3

1

=

*[(**P** + + + +*

+

-

***N2**]*

*[**Pn 1**] [**Pn**]) 2 [**M**] 1 [**K**] **U***

M

C

K

U

2

*(**n+1**)*

1 [ ] 1 [ ] 1[ ]

2

*(**N**)*

3

T

3

+ **-**

+

-

T
2t
3

Indices N, N + 1, N + 2 respectively indicate the calculations carried out at time tn,
T
= +
= +
[ ] [ ] [ ]
N +1
tn
T and tn +2 tn 2t, where T is the increment of appointed time. ***M****,* ***C*** *and* ***K*** *are*
respectively the matrices masses, damping and stiffness, ***U***
() is the vector displacement and ***P***
( )
the vector forces associated.

Point 4: displacement according to time

2.2
Results of reference

Displacement at the P4 point according to time, cf graph above.

2.3
Uncertainty on the solution

· position of the extremas: T < 0.015
· maximum amplitude: U/U < 0.5%

2.4 References
bibliographical

[1]
Card-index SDLD29/90 of commission VPCS
Handbook of Validation

---

3 Modeling
With
3.1
Characteristics of modeling
Discrete element of rigidity in translation
y
With
P
P
P
P
P
P
P
B
X
P
1
2
3
4
5
6
7
8
Characteristics of the elements
DISCRETE:
with nodal masses
M_T_D_N
and matrices of rigidity
K_T_D_L
and matrices of damping
A_T_D_L
Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: "YES" DY: 0. , DZ: 0.)
with the nodes ends
(GROUP_NO: AB DX: 0.)
Names of the nodes:

Not A = N1
P1 = N2
Not B = N10
P2 = N3
P8 = N9
Modal recombination with all the modes (8)
no time used
dt = 1.E3 S
diagram of EULER

3.2
Characteristics of the grid

A number of nodes:
10
A number of meshs and types:
9 SEG2

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
DISCRETE
GROUP_MA
“K_T_D_L”
[U4.24.01]
GROUP_NO
“M_T_D_N”
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
GROUP_NO
AFFE_MODELE
ALL
“MECHANICAL”
“DIS_T”
[U4.22.01]
GROUP_NO
“DIS_T”
MODE_ITER_INV
“ADJUSTS”
[U4.52.01]
DYNA_TRAN_MODAL
[U4.54.03]

4
Results of modeling A

4.1 Values
tested

Time (S)	Reference	Aster	% Difference
0.09	3.97 E-5	3.95 E-5	0.503
0.18	5.10 E-6	5.03 E-5	1.38
0.27	3.77 E-5	3.77 E-5	0
0.36	7.30 E-6	7.28 E-6	0.293
0.45			

3.59 E-5
3.59 E-5
0
0.54
8.81 E-6
8.77 E-6
0.486
0.63
3.47 E-5
3.47 E-5
0.034
0.72
1.01 E-5
1.00 E-5
0.514
0.81
3.36 E-5
3.36 E-5
0
0.91
1.11 E-5
1.14 E-5
2.36
0.99
3.27 E-5
3.26 E-5
0.171

4.2 Remarks

Contents of the file results: *displacements.*

4.3 Parameters
of execution

Version: NEW3.03
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
200 seconds

5
Summary of the results

One obtains a relatively good agreement between the calculated solution and solution VPCS (<0.7%) except with
moment 0.91 (2.4%). The differences are primarily due to the fact that the moments of test are not given that with 2 significant figures, which does not make it possible to seize the moment sufficiently well of
the extremum.

Organization (S): EDF-R & D /AMA, (*) CS IF

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.030 document

SDLD30 - Spectral seismic response of one system 2 masses and 3 springs multimedia

Summary:

The problem consists in calculating the spectral response of a system 2 masses - 3 springs subjected to one multiple seismic excitation.

One tests the discrete element in traction, the calculation of the clean modes, the static modes and the answer spectral by modal superposition via operator COMB_SISM_MODAL. Various office pluralities are tested at the time of calculation of the answers of supports.

The results obtained are in very good agreement with the analytical results of reference.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

1
Problem of reference

1.1 Geometry

The structure is modelled by a unit of 3 springs and 2 specific masses.

k1
k2

k3

m2
m3

X

NO1
NO2
NO3
NO4

1.2
Material properties

Stiffness of connection: k1 = k2 = K = 1000 N/m; k3 = 10 K = 10000 N/m
specific mass: m2 = m3 = m = 10 kg.

1.3
Boundary conditions and loadings

· boundary conditions
Only authorized displacements are the translations according to axis X.
Points NO1 and NO4 are embedded: DX=DY=DZ=DRX=DRY=DRZ=0.
The other points are free in translation according to direction X: DY=DZ=DRX=DRY=DRZ=0.

· loading
The structure is subjected to a multiple spectral seismic excitation and displacements differentials.
The spectra of answers of oscillator in pseudo acceleration are simplified. Only them values corresponding to the 2 Eigen frequencies of the system are mentioned. They do not depend on damping:
with node NO1:
SRONO1 (f1) = A11 = 7 m/s2
SRONO1 (f2) = A12 = 5 m/s2
DDSNO1 = D1 = -0.04 m
with node NO4:
SRONO4 (f1) = A21 = 12 m/s2
SRONO4 (f2) = A22 = 6 m/s2
DDSNO4 = D2 = 0.06 m

1.4 Conditions
initial

The system is initially at rest.

2
Reference solution

2.1
Method of calculation used for the reference solution

One calculates the spectral response by modal superposition of a system masses spring subjected to two
distinct excitations. One determines the displacement of the masses and the reactions of support to the nodes
NO1 and NO4 following axis X.

One calculates analytically:

- *Eigen frequencies fi,*
- *associated clean vectors Nor standardized compared to the modal mass,*
- *static modes of supports J of the system,*
- *factors of modal participation Pij relating to the supports,*
- *Rmij the maximum of the response of each mode starting from the spectra of excitation,*
- *Rej the contribution of the movement of drive of each support starting from displacements differentials,*
- *Rcj the static term of correction,*
- *primary and secondary components of the response according to the régles of office plurality adopted.*

2.2
Results of reference

· matrix of rigidity K

K
- K
0
0

- K 2k
- K
0
K =

0
- K
K
11
-10k

0
0
-10k
10k

· matrix of mass M

0 0 0 0

0 m 0 0
M =

0 0 m 0

0 0 0 0

· modal calculation in embedded base

(K - iM) = 0
I

2
I = I
K
K
1
=
(13- 85) 2 = (13+ 85)

2m
2m

- Eigen frequencies:
F =/
2
F =/
2
1
1
2
2

- not normalized clean modes:

0

0

1

-1

=

1

(

=

- 9 + 85)

2

2

(9+ 85)

2

0

0

- generalized modal masses

T

µi = iMi:

1 = m

µ

(170-18 85) 2 = m

µ

(170+18 85)

4

4

- clean modes normalized with generalized modal mass unit Ni:

1

2
1 =
NR

=

μ
N2
1
μ2

- modal reactions the IMF:

-1

1

K
0

K
0

Fm =
K
=
1
N1

Fm = K
=

μ
0
2
N2

μ
0
1
2
(
5 9 - 85)
- (
5 9 + 85)

- factors of modal participation
T
ij
P = I M J:

- contribution of the dynamic mode 1 to the movement imposed on node NO1:
T
m
11
P = 1

M 1 =
(13+ 85)
42 μ1
- contribution of the dynamic mode 1 to the movement imposed on node NO4:
T
10m
12
P = 1

M2 =
(-8+ 85)
21 μ1
- contribution of the dynamic mode 2 to the movement imposed on node NO1:

T
21
P =
m
2

M 1 =
(-13+ 85)
42 μ2
- contribution of the dynamic mode 2 to the movement imposed on node NO4:

T
10
22
P =
m
2

M2 =
(8+ 85)
21 μ2
- factor of participation of the dynamic mode 1 in direction X:
1
P X = 11
P + 12
P

- factor of participation of the dynamic mode 2 in direction X:
2
P X = 21
P + 22
P

· static modes of supports J

- static solution with a unit displacement of node NO1:

21

1

1 11
10 0
displacements: =
1
nodal reactions: Fs = K =
K

21 1
1
1

21
0

0
-
1

- static solution with a unit displacement of node NO4:
0
-
1

1 10
10 0
displacements: =
2
nodal reactions: Fs = K =
K

21 20
2
2

21
0

21
1
· response of mode I to the movement of the support J

ij
With
Rmij = ir ij
P
with R =
or Fm
2

I
Ni
I
I

· static correction

- static modes U J solution of Ku J = M J:
0
-122

m 122
m 231
displacements: U =
1

nodal reactions: Fu =

441k 13
1

441
21

0
-130
0
-130

m 130
m 210
displacements: U =
2

nodal reactions: Fu =

441k 50
2

441 420

0
- 500

- static correction relating to the movement of the support J if mode 2 is not retained:

P1jr
Rc
1
=

-

J
Ru J
A2 J

with: Ru = U or Fu and R =
or Fm
2
J
J
J
1
N1
1

1

· contribution of the support J to the movement of drive

Re J = rjDj with rj = J or Fs J

2.3
Uncertainty on the solution

No (exact analytical solution).

---

3 Modeling
With

3.1
Characteristics of modeling

The system is modelled by:

.
3 discrete elements K_T_D_L,
.
2 discrete elements M_T_D_N.

3.2
Characteristics of the grid

The grid consists of 3 meshs SEG2.

3.3 Functionalities
tested

Orders

AFFE_MODELE GROUP_MA
“MECHANICAL”
“DIS_T”

DISCRETE AFFE_CARA_ELEM
NODE
M_T_D_N

NET
K_T_D_L

AFFE_CHAR_MECA DDL_IMPO

MACRO_MATR_ASSE

MODE_ITER_SIMULT CALC_FREQ

METHOD
"SORENSEN"

NORM_MODE NORMALIZES
"MASS_GENE"

MODE_STATIQUE MODE_STAT

PSEUDO_MODE

COMB_SISM_MODAL MODE_CORR

EXCIT

COMB_MODE
"SRSS"

COMB_MULT_APPUI
"QUAD"
"LINE"

DEPL_MULT_APPUI

COMB_DEPL_APPUI
"QUAD"
"LINE"
"ABS"

4
Results of modeling A

4.1 Frequencies
clean

MODE
Reference
Code_Aster
Relative error (%)
1
2,18815E+00 2,18815E+00 0,000
2
5,30484E+00 5,30484E+00 0,000

4.2
Total response on complete modal basis

Modes 1 and 2 are taken into account. Components inertial (primary education) and statics
(secondary)
response are directly cumulated to the level of the supports.

.
calculation n°1

COMB_MODE=' SRSS'
COMB_MULT_APPUI=' QUAD'

- response of the support j=1 (node NO1):
2
2
2

1
R =
1
Rm + Re1 with
2
1
Rm =
11
Rm + Rm21
- response of the support j=2 (node NO4)
:
2
2
R2 = Rm2 + Re2 with
2
2
Rm2 =
12
Rm + Rm22
- total answer:
2
2
R =
1
R + R2

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02 0,000
NO2
5,43820E-02 5,43820E-02 0,000
NO3
5,75544E-02 5,75544E-02 0,000
NO4
6,00000E-02 6,00000E-02 0,000

nodal reactions: REAC_NODA

NODE

Reference
Code_Aster
Relative error (%)
NO1
5,36769E+01 5,36769E+01
0,000
NO4
7,44120E+01 7,44120E+01
0,000

.
calculation n°2

COMB_MODE=' SRSS'
COMB_MULT_APPUI=' LINE'

- response of the support j=1 (node NO1):
2
2
2
1
R =
1
Rm + Re1 with
2
1

Rm =
11
Rm + Rm21
- response of the support j=2 (node NO4)
:
2
2
R2 = Rm2 + Re2 with
2
2
Rm2 =
12
Rm + Rm22
- total answer: R = 1
R + R2

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
7,48259E-02 7,48259E-02
0,000
NO3
6,03377E-02 6,03377E-02
0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
7,34576E+01 7,34576E+01
0,000

NO4
9,72617E+01 9,72617E+01
0,000

4.3 Total response on incomplete modal basis without correction statics

Only mode 1 is taken into account. Components inertial (primary education) and statics (secondary) of
response are directly cumulated to the level of the supports.

.
calculation n°1

COMB_MODE=' SRSS'
COMB_MULT_APPUI=' QUAD'
- response of the support j=1 (node NO1):
2
2
1
R =
1
Rm + Re1 with
1
Rm =
11
Rm
- response of the support j=2 (node NO4):
2
2
R2 = Rm2 + Re2 with Rm2 =
12
Rm
- total answer:
2
2
R =
1
R + R2

absolute displacements: DEPL

NODE
Reference

Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
5,43794E-02 5,43794E-02
0,000
NO3
5,73536E-02 5,73536E-02
0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
5,36743E+01 5,36743E+01
0,000
NO4
5,68312E+01 5,68312E+01
0,000

.
calculation n°2

COMB_MODE=' SRSS'
COMB_MULT_APPUI=' LINE'

- response of the support j=1 (node NO1):
2
2
1
R =
1
Rm + Re1 with
1
Rm =
11
Rm
- response of the support j=2 (node NO4):
2
2
R2 = Rm2 + Re2 with Rm2 =
12
Rm
- total answer: R = 1
R + R2

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
7,48229E-02 7,48229E-02
0,000
NO3
6,01363E-02 6,01363E-02
0,000
NO4
6,00000E-02 6,00000E-02

0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
7,34546E+01 7,34546E+01
0,000
NO4
7,76841E+01 7,76841E+01
0,000

4.4 Total response on incomplete modal basis with correction
statics

Only mode 1 intervenes in the calculation of the answer. The static contribution of neglected mode 2 is
taking into account.

.
calculation n°1

COMB_MODE=' SRSS'
COMB_MULT_APPUI=' QUAD'

- response of the support j=1 (node NO1):
2
2
2
1
R =
1
Rm +
1
Rc + Re1 with
1
Rm =
11
Rm
- response of the support j=2 (node NO4):
2

2
2
R2 = Rm2 + Rc2 + Re2 with Rm2 =
12
Rm
- total answer:
2
2
R =
1
R + R2

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
5,43820E-02 5,43820E-02
0,000
NO3
5,75544E-02 5,75544E-02
0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
5,36769E+01 5,36769E+01
0,000
NO4
7,44120E+01 7,44120E+01
0,000
Handbook of Validation

.
calculation n°2

COMB_MODE=' SRSS'
COMB_MULT_APPUI=' LINE'

- response of the support j=1 (node NO1):
2
2
2
1
R =
1
Rm +
1
Rc + Re1 with
1
Rm =
11
Rm
- response of the support j=2 (node NO4):
2
2
2
R2 = Rm2 + Rc2 + Re2 with Rm2 =
12
Rm

- total answer: R = 1
R + R2

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
7,48259E-02 7,48259E-02
0,000
NO3
6,03377E-02 6,03377E-02
0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
7,34576E+01 7,34576E+01
0,000
NO4
9,72617E+01 9,72617E+01
0,000

4.5
Partition of the components primary and secondary of the answer

The components inertial (primary education) and statics (secondary) are treated separately.

· calculation n°1

- primary response on modal basis supplements (modes 1 and 2)
COMB_MODE=' SRSS'

COMB_MULT_APPUI=' QUAD'

- response of the support j=1 (node NO1):
2
2
RI1 =
11
Rm + Rm21
- response of the support j=2 (node NO4):
2
2
IH 2 =
12
Rm + Rm22
- primary answer:
2
2
IH = RI1 + RI2

relative displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
0,00000E+00 0,00000E+00
-
NO2
4,12562E-02 4,12562E-02
0,000
NO3
6,60152E-03 6,60152E-03
0,000
NO4
0,00000E+00 0,00000E+00
-

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)

NO1
4,12562E+01 4,12562E+01
0,000
NO4
6,60152E+01 6,60152E+01
0,000

-
secondary answer
COMB_DEPL_APPUI=' QUAD'

- secondary answer:
2
2
RII = Re1 + Re2

displacements of drive: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
3,54306E-02 3,54306E-02

0,000
NO3
5,71746E-02 5,71746E-02
0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
3,43386E+01 3,43386E+01
0,000
NO4
3,43386E+01 3,43386E+01
0,000

.
calculation n°2

- primary response on incomplete modal basis without static correction
Only mode 1 intervenes in the calculation of the answer
COMB_MODE=' SRSS'
COMB_MULT_APPUI=' QUAD'

- response of the support j=1 (node NO1): RI1 =
11
Rm
- response of the support j=2 (node NO4): IH 2 =
12
Rm
- primary answer:
2
2
IH = RI1 + RI2

relative displacements: DEPL

NODE

Reference
Code_Aster
Relative error (%)
NO1
0,00000E+00 0,00000E+00
-
NO2
4,12528E-02 4,12528E-02
0,000
NO3
4,52841E-03 4,52841E-03
0,000
NO4
0,00000E+00 0,00000E+00
-

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,12528E+01 4,12528E+01
0,000
NO4
4,52841E+01 4,52841E+01
0,000

- secondary answer
COMB_DEPL_APPUI=' LINE'

- secondary answer: RII = Re1+ Re2

---

displacements of drive: DEPL

NODE	***Reference***	***Code_Aster***	***Relative error (%)***
NO1	*-4,00000E-02*	*-4,00000E-02*	*0,000*
NO2	*7,61905E-03*	*7,61905E-03*	*0,000*
NO3	*5,52381E-02*	*5,52381E-02*	*0,000*
NO4	*6,00000E-02*	*6,00000E-02*	*0,000*

nodal reactions: REAC_NODA

NODE	***Reference***	***Code_Aster***	***Relative error (%)***
NO1	*-4,76190E+01*	*-4,76190E+01*	*0,000*
NO4	*4,76190E+01*	*4,76190E+01*	

0,000

.

calculation n°3

- primary response on incomplete modal basis with static correction
Only mode 1 intervenes in the calculation of the answer
COMB_MODE=' SRSS'
COMB_MULT_APPUI=' QUAD'

- response of the support j=1 (node NO1):
2
2
RI1 =
11
Rm +
1
Rc
- response of the support j=2 (node NO4):
2
2
IH 2 =
12
Rm + Rc2
- primary answer:
2
2
IH = RI1 + RI2

relative displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
0,00000E+00 0,00000E+00
-
NO2
4,12562E-02 4,12562E-02
0,000
NO3
6,60152E-03 6,60152E-03

0,000
NO4
0,00000E+00 0,00000E+00
-

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,12562E+01 4,12562E+01
0,000
NO4
6,60152E+01 6,60152E+01
0,000

- secondary answer
COMB_DEPL_APPUI=' ABS'

- secondary answer: RII = Re1 + Re2

displacements of drive: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
4,95238E-02 4,95238E-02
0,000
NO3
5,90476E-02 5,90476E-02
0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE	**Reference**	**Code_Aster**	**Relative error (%)**
NO1	4,76190E+01	4,76190E+01	0,000
NO4	4,76190E+01	4,76190E+01	0,000

.
calculation n°4

- primary response on incomplete modal basis with static correction

Only mode 1 intervenes in the calculation of the answer.
COMB_MODE=' SRSS'
COMB_MULT_APPUI=' QUAD'

- response of the support j=1 (node NO1):
2
2
RI1 =
11
Rm +
1
Rc

- response of the support j=2 (node NO4):
2
2
IH 2 =
12
Rm + Rc2
- primary answer:
2
2
IH = RI1 + RI2

- secondary answer: test office plurality of DDSs

5 loading cases are defined. The 5 associated elementary static answers are:
- case a: DDSaNO1=-0.04 Ra=r1×DDSaNO1
- case b: DDSbNO4=0.06 Rb=r2×DDSbNO4
- case C: DDScNO4=0.03 Rc=r2×DDScNO4
- case D: DDSdNO1=-0.07 Rd=r1×DDSdNO1
- case E: DDSeNO4=0.05 Re=r2×DDSeNO4

4 combinations are calculated:

.
combination n°1

linear office plurality of the cases has and b: TYPE_COMBI=' LINE' NUME_ORDRE=200

secondary answer: RII = Ra + Rb
1

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
-4,00000E-02 -4,00000E-02
0,000
NO2
7,61905E-03 7,61905E-03
0,000
NO3
5,52381E-02 5,52381E-02

0,000
NO4
6,00000E-02 6,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
-4,76190E+01 -4,76190E+01
0,000
NO4
4,76190E+01 4,76190E+01
0,000

.

combination n°2

absolute office plurality of the cases has and C: TYPE_COMBI=' ABS' NUME_ORDRE=201

secondary answer: RII = Ra + Rc
2

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,00000E-02 4,00000E-02
0,000
NO2
3,52381E-02 3,52381E-02
0,000
NO3
3,04762E-02 3,04762E-02
0,000
NO4
3,00000E-02 3,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
3,33333E+01 3,33333E+01
0,000
NO4
3,33333E+01 3,33333E+01
0,000

.
combination n°3

quadratic office plurality of the cases D and E: TYPE_COMBI=' QUAD' NUME_ORDRE=202

secondary answer:
2
2
RII3 = Rd + Re

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
7,00000E-02 7,00000E-02
0,000
NO2
4,37189E-02 4,37189E-02
0,000
NO3
4,77356E-02 4,77356E-02
0,000
NO4
5,00000E-02 5,00000E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
4,09635E+01 4,09635E+01
0,000
NO4
4,09635E+01 4,09635E+01
0,000

Titrate:
SDLD30 - Spectral seismic response of a system 2 masses 3 springs Dates:
05/03/04
Author (S):
***Y. PONS**, D. NUNEZ*, L. VIVAN* Key*

.

combination n°4

linear office plurality of the cases has and E: TYPE_COMBI=' LINE' NUME_ORDRE=203

secondary answer: RII = Ra Re
4
+

absolute displacements: DEPL

NODE	***Reference***	***Code_Aster***	***Relative error (%)***
NO1	*-4,00000E-02*	*-4,00000E-02*	*0,000*
NO2	*2,85714E-03*	*2,85714E-03*	*0,000*
NO3	*4,57143E-02*	*4,57143E-02*	*0,000*
NO4	*5,00000E-02*	*5,00000E-02*	*0,000*

nodal reactions: REAC_NODA

NODE	***Reference***	***Code_Aster***	***Relative error (%)***
NO1	*-4,28571E+01*	*-4,28571E+01*	*0,000*
NO4	*4,28571E+01*	*4,28571E+01*	

0,000

The total secondary answer is established by the quadratic office plurality of the 4 combinations precedents:

2
2
2
2
RII =
1
RII + RII2 + RII3 + RII4 NUME_ORDRE=204

absolute displacements: DEPL

NODE
Reference
Code_Aster
Relative error (%)
NO1
9,84886E-02 9,84886E-02
0,000
NO2
5,67386E-02 5,67386E-02
0,000
NO3
9,13703E-02 9,13703E-02
0,000
NO4
9,74679E-02 9,74679E-02
0,000

nodal reactions: REAC_NODA

NODE
Reference
Code_Aster
Relative error (%)
NO1
8,30266E+01 8,30266E+01
0,000
NO4
8,30266E+01 8,30266E+01

0,000

5
Summary of the results

The results obtained with Code_Aster are in conformity with the analytical results of reference.

Organization (S): EDF/RNE/AMV

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.101 document

SDLD101 - Simple oscillator under excitation
random

Summary:

An oscillator simple, made up of a mass connected to a support by a spring and a shock absorber, is subjected to
a random excitation transmitted by the support, of imposed acceleration type.

This test uses the functionalities of the stochastic analysis and calculates the spectral concentration of power (DSP)
movement of the mass starting from the excitation of the white vibration type data by its DSP also.

The movement is calculated according to various options: relative, absolute, differential movement.

One calculates then the statistical properties of the response while passing in all the options of random dynamic postprocessing.

1 Problem of reference

1.1 Geometry

AX
K
DX
m

The excitation is a seismic movement of type imposed acceleration AX applied to the support in feel DX.

One is interested in the movement of the mass Mr.

1.2 Material properties

Specific mass:
m = 100 kg
Arises elastic:
K = 105 N/m
Modal damping:

0 = 0.05

1.3
Boundary conditions and loadings

The problem is unidimensional in direction X, and to 1 degree of freedom: the displacement of mass Mr.

The excitation is a spectral concentration of power (DSP), of constant acceleration between 0. and 100 Hz.

It is applied to the support.

2
Reference solution

2.1
Method of calculation used for the reference solution

K
The reference solution is analytical [bib1]. The own pulsation of the oscillator is
,
m

K
that is to say 0 =
= 100 rad/s, and F
m
O = 15,9155 Hz.

Moving absolute, the DSP of the response in noted acceleration G
( )
RR
& & is connected to the DSP of
excitation GEE
& & in acceleration also by:

4 + 4 2 2 2
G () =
0
0
0
.
RR
& &
(2 -2 2
2
2
2
0
)
G
( )
EE
& &
+ 4
0
0
Moving relative, one a:

2
2

G () =
G ().
RR
& &

2 -2 +

2 J
EE
& &

0
0
0
Moving differential, one a:
G () = G
().
RR
& &
EE
& &

2.2
Results of reference

One tests the DSP of the response for 0, 5, 10, 15, 20 Hz in the three cases of movement: absolute, relative and differential.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
C. DUVAL "Dynamic response under random excitation in Code_Aster: principles theoretical and examples of use " - Note HP-61/92.148

---

3 Modeling
With

3.1
Characteristics of modeling

Discrete element in translation of the type DIS_T

P1
K
P2
DX
m

Characteristics of the elements:

With the nodes P1 and P2: matrices of masses of the type M_T_D_N with m = 100 kg.
Between P1 and P2: a matrix of rigidity of the type K_T_D_L with Kx = 106 N/m

Boundary conditions:

All the ddl are blocked except ddl DX of the P2 node.

3.2
Characteristics of the grid

A number of nodes: 2

A number of meshs and types: 1 SEG2, 2 POI1

3.3 Functionalities tested

Orders

MODE_STATIQUE DDL_IMPO AVEC_CMP

DEFI_INTE_SPEC KANAI_TAJIMI

CONSTANT

DYNA_ALEA_MODAL EXCIT

MODE_STAT

ANSWER

REST_SPEC_PHYS

POST_DYNA_ALEA GOING BEYOND

RAYLEIGH

GAUSS

VANMARCKE

MOMENT

TOO BAD

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
Simple Oscillating SDLD101 under random excitation

Date:
30/08/01
Author (S):
J. PIGAT Key
:
V2.01.101-B Page:
5/6

4
Results of modeling A

4.1 Values
tested

Random dynamic response

Identification Reference Aster %
Difference
ABSOLUTE: F = 5. Hz
1.2307
1.2307
0.%
ABSOLUTE: F = 10. Hz
2.7116
2.7116
0.%
ABSOLUTE: F = 15. Hz
47.2154

47.2157
0.%
ABSOLUTE: F = 20. Hz
2.8924
2.8924
0.%
ABSOLUTE: F = 25. Hz
0.47047
0.47047
0.%
RELATIVE: F = 5. Hz
0.01197
0.01197
0.%
RELATIVE: F = 10. Hz
0.04209
0.04209
0.%
RELATIVE: F = 15. Hz
36.9225
36.9258
0.%
RELATIVE: F = 20. Hz
7.1006
7.1006
0.%
RELATIVE: F = 25. Hz
2.7953
2.7953
0.%
DIFFERENTIAL: F = 5. Hz
1.0
1.0
0.%
DIFFERENTIAL: F = 10. Hz
1.0
1.0
0.%
DIFFERENTIAL: F = 15. Hz
1.0
1.0
0.%
DIFFERENTIAL: F = 20. Hz

1.0
1.0
0.%
DIFFERENTIAL: F = 25. Hz
1.0
1.0
0.%

Postprocessing on the response in absolute displacement: spectral moments and parameters statistics

Identification
Aster
version 5.02
Spectral moment n°0
2.5285 102
Spectral moment n°1
2.4524 104
Spectral moment n°2
2.5125 106
Spectral moment n°3
2.7647 108
Spectral moment n°4
3.603 1010
Standard deviation 22.49
Factor of irregularity
0.8324
Frequency connects (Hz)
15.86
Numbers average passages by zero a second
31.73
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

Postprocessing on the response in absolute displacement: statistical functions

The recorded values are those printed in the file result.

Identification Parameter
Aster
Version 5.02
Nb going beyond a second
10.97
25.00
40.55
1.23
60.10
0.025
Distribution of Rayleigh
10.97
0.0342
40.55
0.0062
60.10
0.187
10-3
Distribution of Gauss
10.97
0.0395
40.55

0.0019
60.10
0.396
10-4
Function of distribution of VANMARCKE
40.55
0.0043
10 (seconds)
50.09
0.3291
60.10
0.8688

4.2 Parameters of execution

Version: 5.02

Machine: SGI ORIGIN 2000

System:

Obstruction memory:
8 megawords
Time CPU To use:
2.65 seconds

5 Summary of the results

It is not astonishing that the results awaited for the random dynamic response are obtained with an accuracy of 0%. Indeed the DSP of the answers do not result from an iterative process of resolution, but of an analytical expression bringing into play the modal transfer transfer functions. This analytical expression coincides with the reference solution for this problem.

For postprocessing, there is no reference solution. The results of version 4.03.09 are used to check that the results do not evolve/move from one version to another. Calculation has very well supported the change of platform.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
Document: V2.01.102

SDLD102 - Under transitory structuring:
System 3 masses-4 springs

Summary:

The applicability of this test relates to the dynamics of the structures. It makes it possible to validate the diagram of integration to step of adaptive time of operator DYNA_TRAN_MODAL [U4.54.03] as well as the calculation of linear transitory response on a modal basis calculated by under-structuring (for the 4 diagrams of integration of DYNA_TRAN_MODAL: “EULER”, “DEVOGE”, “NEWMARK” and “ADAPT”). In particular, the case of the application of a damping reduced to the dynamic modes of the bases of projection of the substructures is treaty.

It is a question of determining the transitory response of a system made up of 3 masses and 4 springs, embedded with its ends and subjected to a constant force as from the initial moment. The springs are modelled by elements of the type “DIS_TR” and masses by elements of the type “DIS_T”.

Three modelings are proposed. In the 2 first, the structure is not deadened. Methods of calculation transient by under-structuring with interfaces of the type Craig-Bampton (“CRAIGB”) and Mac Neal (“MNEAL”) are tested. The results of reference which are associated for them result from an analytical calculation. In the third, one imposes a reduced damping of 1% on the dynamic modes of the bases of projection of

substructures. The transitory equation checked by the complete structure was obtained analytically. Its resolution, which acts as reference, was carried out by the Maple software.

---

1 Problem of reference

1.1 Geometry

The studied system is composed of 3 masses (m) and 4 springs (K). The unit is embedded with its ends.

With
B
x3
x2
x1

1.2 Material properties

Stiffness of the springs: K = 1 N/m.
Specific masses: m = 1 kg.

1.3 Boundary conditions and loadings

F
T
Embedded points A and B.
Application to the point x1 of a constant force F = 1 NR, as from the moment T = 0 S.

1.4 Conditions initial

Structure initially at rest.

2 *Reference solution*

2.1 *Method of calculation used for the reference solution*

2.1.1 Not deadened structure

In this case, the reference solution can be obtained analytically:

1 0 0 X
2 - 1 0 X
1
1
1

m 0 1 0 X + K - 1
2
- 1 X = 0
2
2

0
0
1 X

0 - 1 2 X
0
3
3
The own pulsations of the system mass-arises are worth:

K
K
K
2
2
2
=
-

=

=
+
1
(2 2)
2
2
3
(2 2)
m
m
m
respective modal deformations:
2
1
- *2*

=

=

=
1
2
2

0
3
2

2
- 1
- 2
Projected on the basis of clean mode, the transitory equation becomes with like co-ordinates
I
generalized:
8 0 0
4 - 2 2 0
0

+ 2
1
1

m 0 2 0 + 4k
0
1
0
= 2
2
2

0
0
8

0
0
4 + 2 2
- 2
3
3
The system can be solved analytically. One obtains:

2
cos
2 (1 -
T1)
4

1

{ (

1
1
T)} =

cos
2 (1 -
T
2)
2m 2

2

cos
2 (
T
3
-)
1
4 3

The solution on physical basis is obtained by using the transformation of Ritz:

X

1
2
1
- 2

1
X (T)
= X

2
=
= 2
0
2 2

X

3
2 - 1
2 3

2.1.2 Structure

deadened

Damping is applied to the clean modes of the bases of projection of the substructures embedded (reduced damping). In this case, one leads to the transitory equation in co-ordinates generalized following (bib [1]):

8 0 0
3 - 2 2 0
- 1
1
1

m 0 2 0 + 4 2km
0
1
0

2
2

0
0
8

- 1
0
3 + 2 2

3
3
4 - 2 2 0
0

2
1

+ 4k
0

1
0
= 1
2

0
0
4 + 2 2
- 2
3
This system not being uncoupled, it was solved using the Maple software. One obtained
(= 0.01) :
T

-

2

1 -
1

E
cos T

1
4 2

1

T

-

{(
1 1
2

T)}

1 - E
cos T
2m 2
2
2

T
-

2 3

E
cos T
3 -

1
4 2

3

with:
3
1
1 =
1
100
1 6
. 5 10 S 2 =
=
and 3 =

4 8
. 5 10 S
2
2
One thus obtains a formulation close to the case not deadened, but in which intervene of exponential terms which characterize damping.
The solution on physical basis is obtained by using the transformation of Ritz:
X

1
2
1
- 2

1
X (T)
= X

2
=
= 2
0
2 2

X

3
2 - 1
2 3

2.2
Results of reference
Not deadened structure:

Displacement, speed and acceleration of the node x2 at the moment T = 80 S:

-
X (
)
1
80
= 41700
.
10
m
2
-
-
X (
)
1
80
= 4 3011
.
10
m.s 1
2
-
-
X
( )
1
80
= 33749
.
10
m.s 2
2

Deadened structure:

Displacement of the node x2 at the moment T = 80 S:

-
X
1 m
2 80
() = 4.9867 10

2.3

Uncertainty on the solution

Case not deadened: analytical solution.

Deadened case: semi-analytical solution.

2.4 Reference
bibliographical

[1]
C. VARE - Report/ratio HP 61/95/025/A - "Implementation of nonlinear transitory calculation by under-structuring in Code_Aster ".

---

3 Modeling
With
3.1
Characteristics of modeling

The system is divided into 2 substructures:

m
m
m
Substructure 1:
blocking
Substructure 2:
blocking
K
K
NO1
NO3
K
K
NO1
NO3

In situation, the two substructures are connected to the level of the 2nd mass. The dynamic interface

1st substructure consists of a mass m on the level of node NO3 of the grid and coincide with the dynamic interface of the 2nd substructure which does not comprise any mass and is simply blocked on the level of node NO1.

NO1
NO3 NO1
NO3
m
m
Substructure 1
Substructure 2

The clean modes of the complete system are calculated by using the method of calculation modal by under-structuring with interfaces of the type "Craig-Bampton" (blocked interfaces). Bases of each substructure are made up of a dynamic mode and a constrained mode.

The transitory response of the system is calculated on the modal basis calculated by under-structuring. The steps of times used are equal to: 102 S in "EULER", 102 S in "NEWMARK", 102 S in "DEVOGE", 10-1 S in "ADAPT" (for this last, it acts of the step of initial time of the algorithm and of no the maximum time of integration).

3.2
Characteristics of the grid of the substructure

A number of nodes: 3
A number of meshs and types: 2 SEG2

3.3 Functionalities
tested
Orders
Keys

NUME_DDL_GENE
BASE
[U4.55.07]
STORAGE
"DIAG"
PROJ_MATR_BASE
BASE
[U4.55.01]
NUME_DDL_GENE
MATR_ASSE_GENE
PROJ_VECT_BASE
BASE
[U4.55.02]
NUME_DDL_GENE
VECT_ASSE_GENE
DYNA_TRAN_MODAL
METHOD
"ADAPT"

[U4.54.03]
'EULER
“NEWMARK”
“DEVOGE”
REST_BASE_PHYS
MODE_MECA
[U4.64.01]
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

4
Results of modeling A
4.1 Values
tested
Calculation by modal recombination without under-structuring: Method “ADAPT”
Identification
Reference
Aster
% difference
Node x2, displacement (m)
4.1700 101
4.1695 101
Node x2, speed (m.s1)
4.3011 101
4.2972 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
3.3741 101
Calculation by under-structuring

Method: “EULER”
Node x2, displacement (m)
4.1700 101
4.1480 101
Node x2, speed (m.s1)
4.3011 101
4.2972 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
3.3823 101
Method: “DEVOGE”
Node x2, displacement (m)
4.1700 101
4.1700 101
Node x2, speed (m.s1)
4.3011 101
4.3011 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
4.3749 101
Method: “NEWMARK”
Node x2, displacement (m)
4.1700 101
4.1711 101
Node x2, speed (m.s1)
4.3011 101
4.3090 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
3.3763 101
Method: “ADAPT”
Node x2, displacement (m)
4.1700 101
4.1695 101
Node x2, speed (m.s1)
4.3011 101
4.2972 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101

3.3741 101

4.2 Parameters
of execution

Version: 3.4.6
Machine: CRAY C90
Obstruction memory:
8 megawords
Time CPU To use:
39.1 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

This modeling is identical to the precedent if they are only the clean modes of the complete system are calculated by using the method of calculation modal per under-structuring with interfaces of the type "Mac Neal" (free interfaces). The bases of each substructure are made up of a mode dynamics and of a mode of fastener.

The transitory response of the system is calculated on the modal basis calculated by under-structuring.
More precisely, the studied substructures have their free interfaces:

Substructure 1:
Blocked NO1
Free NO3
Substructure 2:
Free NO1
Blocked NO3

The steps of times used are worth: 102 S in "EULER", 102 S in "NEWMARK", 102 S in "DEVOGE", 10-2 S in "ADAPT".

5.2
Characteristics of the grid of the substructure
A number of nodes: 3
A number of meshs and types: 2 SEG2
5.3 Functionalities
tested
Orders
Keys
NUME_DDL_GENE
BASE
[U4.55.07]
STORAGE
"DIAG"
PROJ_MATR_BASE
BASE
[U4.55.01]
NUME_DDL_GENE
MATR_ASSE_GENE
PROJ_VECT_BASE
BASE
[U4.55.02]
NUME_DDL_GENE
*VECT_ASSE_*
REST_BASE_PHYS
MODE_MECA
[U4.64.01]
DYNA_TRAN_MODAL
METHOD
"ADAPT"
[U4.54.03]
"EULER"
"NEWMARK"
"DEVOGE"
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

***Code_Aster* ®**
Version
4.0
Titrate:
SDLD102 Under transitory structuring
Date:

6
Results of modeling B
6.1 Values
tested

Identification
Reference
Aster
% difference
Method: “EULER”
Node x2, displacement (m)
4.1700 101
4.1480 101
Node x2, speed (m.s1)
4.3011 101
4.2972 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
3.3823 101
Method: “NEWMARK”
Node x2, displacement (m)
4.1700 101
4.1711 101
Node x2, speed (m.s1)
4.3011 101
4.3090 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
3.3763 101
Method: “DEVOGE”
Node x2, displacement (m)
4.1700 101
4.1700 101
Node x2, speed (m.s1)
4.3011 101
4.3011 101

< 1%
Node x2, acceleration (m.s2)
3.3749 101
4.3749 101
Method: "ADAPT"
Node x2, displacement (m)
4.1700 101
4.1695 101
Node x2, speed (m.s1)
4.3011 101
4.2973 101
< 1%
Node x2, acceleration (m.s2)
3.3749 101
3.3742 101

6.2 Parameters of execution

Version: 3.4.6
Machine: CRAY C90
Obstruction memory:
8 megawords
Time CPU To use:
14.8 seconds

7 Modeling C

7.1 Characteristics of modeling

The clean modes of the complete system are calculated by using the method of calculation modal by under-structuring with interfaces of the type "Craig-Bampton" (blocked interfaces). Bases of each substructure are made up of a dynamic mode and a constrained mode.

With the dynamic mode of each substructure a damping reduced with 1% is associated.

The transitory response of the deadened system is calculated on the modal basis calculated by under-structuring.

The steps of time taken are equal to: 102 S in "ADAPT", 102 S in "EULER", 102 S in "NEWMARK".

7.2 Characteristics of the grid of the substructure

A number of nodes: 3

A number of meshs and types: 2 SEG2

7.3 Functionalities tested

Orders
Keys
MACR_ELEM_DYNA
AMOR_REDUIT
[U4.55.05]
NUME_DDL_GENE
BASE
[U4.55.07]
STORAGE
"FULL"
PROJ_MATR_BASE
BASE
[U4.55.01]
NUME_DDL_GENE

MATR_ASSE_GENE
PROJ_VECT_BASE
BASE
[U4.55.02]
NUME_DDL_GENE
VECT_ASSE_GENE
REST_BASE_PHYS
MODE_MECA
[U4.64.01]
DYNA_TRAN_MODAL
METHOD
“ADAPT”
[U4.54.03]
“EULER”
“NEWMARK”
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HI-75/98/040 - Ind A

8
Results of modeling C
8.1 Values
tested
Identification
Reference
Aster
% difference
Method: “EULER”
Node *x2*, displacement (m)
4.9867 101
4.9637 101

< 1%
Method: “NEWMARK”
Node *x2*, displacement (m)
4.9867 101
4.9883 101
< 1%
Method: “ADAPT”
Node *x2*, displacement (m)
4.9867 101
4.9863 101
< 1%

8.2 Parameters
of execution

Version: 3.4.6
Machine: CRAY C90
Obstruction memory:
8 megawords
Time CPU To use:
11.0 seconds

9
Summary of the results

The precision on displacement, the speed and the acceleration of the node *x2* at the moment T = 80 S is excellent (relative error < 1%).
This test thus validates the operators of calculation of transitory answer linear on calculated modal basis by dynamic under-structuring (with and without damping), as well as the diagram of integration with no the adaptive time of operator DYNA_TRAN_MODAL.

Code_Aster ®
Version
5.0

Titrate:
Seismic SDLD103 Response of a system 3 masses and 4 springs
Date:
30/08/01
Author (S):
Fe *Key* ***WAECKEL***
:
V2.01.103-B Page:
1/12

Organization (S): EDF/RNE/AMV

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.103 document

SDLD103 - Seismic response of a system
3 masses and 4 springs multimedia

Summary

The problem consists in analyzing the response of a mechanical structure of embed-embedded beam type and
not deadened, modelled by a system 3 masses and 4 springs and subjected to a seismic loading unspecified.

One tests the discrete element in traction and rotation, the calculation of the clean modes and the static modes and calculation
transitory response by modal superposition of a structure subjected to a accélérogramme of translation
(modeling A) or of rotation (modeling B).

The results obtained are in very good agreement with the results of reference (analytical results).
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HT-62/01/012/A

1
Problem of reference

1.1 Geometry

The beam is modelled by a whole of 4 springs and 3 specific masses.

2
X
K 1
K
K

K
2
3
4
Z
1
m 1
m
m
1
m
2
3
NO1
NO2
NO3
NO4
NO5

1.2
Material properties

Stiffness of connection: K = k1 = k2 = k3 = k4 = 104 N/m;
specific mass: m = m1 = m2 = m3 = 10 kg.

1.3
Boundary conditions and loadings

Boundary conditions:
Only authorized displacements are the translations according to axis X.
Points NO1 and NO5 are embedded: dx = Dy = dz = drx = dry = drz = 0.
The other points are free in translation according to direction X: Dy = dz = drx = dry = drz = 0.

Loading:
The points of anchoring NO1 and NO5 each one are subjected to a transverse acceleration (T)
2
1
= At
with A = 2. 105 m/s4 in NO1 and ()
2 T = 0 NO5 m/s2.

1.4 Conditions
initial

The system is at rest: with T = 0, dx ()
0 = 0, dx/dt ()
0 = 0 in any point.

2
Reference solution

2.1
Method of calculation used for the reference solution

The problem consists in calculating the response of a system to five degrees of freedom subjected to two
accelerations (
1 T) and (
2 T) distinct of an unspecified form. It is explained in detail in the reference
[bib2].

One calculates the Eigen frequencies initially fi, the standardized associated clean vectors compared to modal mass Ni and the static modes of the system (analytical values). One calculate then the generalized response of the system multimedia while solving analytically the integral of Duhamel [bib1]. Lastly, one restores on the physical basis the vector of displacements relative (on the active degrees of freedom) Xr, which allows us, after having calculated the vector of displacements of drive Xe, to calculate the vector of absolute displacements

X = X

+ X
has
R
E.

2.2
Results of reference

.
Calculation of the three Eigen frequencies fi, the associated clean vectors standardized compared to modal mass Ni and of the static modes of the system

1
F
1 =
= 3 85 Hz

2 (2 + 2)
,
m 2k

1 - 2
- 1
3 1

1
1

1

F =
= 7,12
2
Hz
,
=
2
0
- 2 and =
2 2 .
2 m 2k
NR

2 m

4 1 3

1
2
1
1

f3 =
= 9 3 Hz

2 (2 - 2)
,
m 2k

.
Calculation of the generalized response of the multimedia system

The fundamental equation of dynamics, in the relative reference mark on the active degrees of freedom is written:
at2
MR. X
& + K X
R
R = (M
+ M xs) X&s with &Xs =
, the vector of the accelerations imposed on

0
level of the various points of anchoring.

The equation of the movement projected on the basis of dynamic mode standardized compared to modal mass is written, by considering only the active degrees of freedom:
NR

2 + 2

m t2 has

&
Q (T) + K Q (T)
T
= -
MR. X = -
2
.
G
NR
& S
4

2 -

2

The response of this linear system, at one moment T, then consists in calculating the integral of Duhamel:

(3+ 2 2) (t2 + (2+ 2) (cos T -
1
) m
1
3

K)
m has

Q (T) = -
(t2 + (cos T -
2
) m
1
2

K)
.
4 K
(

3 - 2 2) 2 2
2

1

(T + (-) (cos T -
3
) mk)

.
Calculation of displacement relating to the active degrees of freedom: Xr = Nor IQ, that is to say:
I

2
m

7 T + 10 + 7 2

(
) (cos T-1) 1+ (cos T
2
) 1 + (10 - 7 2) (cos T
3
) 1 m

K
K

m2 has
m
= -

8
X

R
T + 10 2 + 14
(
) (cos T-1) 1+ (- 10 2 +14) (cos T-3) 1 m
.
8 K

K
K

2
m

5 T + 10 + 7 2
(
) (cos T-1) 1 (cos T
2
) 1 + (10 - 7 2) (cos T
3
) 1 m

K
K

3
T 4
.
Calculation of displacements of drive to the active degrees of freedom: X = X
E
S = has

2 .
48 1

.
Calculation of absolute displacements to the active degrees of freedom: X = X

+ X
has
R
E.

2.3
Uncertainty on the solution

No if one calculates the integral of Duhamel analytically [bib1].

2.4 References
bibliographical

[1]
J.S. PRZEMIENIECKI: Theory of matrix structural analysis. New York, Mac Graw-Hill, 1968, pages 351-357.
[2]
Fe WAECKEL: Documentations use and validation of the developments carried out for
to calculate the seismic response of multimedia structures. HP-52/96/002

---

3 Modeling
With

3.1
Characteristics of modeling

The elements are modelled by discrete elements with 3 degrees of freedom DIS_T.

X
2
K 1
k2
k3
k4
Z
1
NO1
NO2
NO3
NO4
NO5

Node NO1 is subjected to an imposed acceleration (
1 T), node NO5 with (
2 T). It is calculated
relative displacement of nodes NO2, NO3 and NO4 compared to their static deformation, them displacement of drive and their absolute displacement.

Temporal integration is carried out with the algorithms of Euler (not of time: 10-3 second), of Devogelaere (not of time: 10-3 second) and with an algorithm with step of adaptive time.

3.2
Characteristics of the grid

The grid consists of 5 nodes and 4 discrete elements (DIST_T).

3.3 Functionalities
tested

Orders

Keys Doc. V5
AFFE_MODELE GROUP_MA
“MECHANICAL”
“DIS_T”
[U4.41.01]
DISCRETE AFFE_CARA_ELEM
NODE
M_T_D_N
[U4.42.01]

NET
K_T_D_L

AFFE_CHAR_MECA DDL_IMPO

[U4.44.01]
MACRO_MATR_ASSE

[U4.61.21]
MODE_ITER_INV CALC_FREQ
ADJUST
[U4.52.04]
CALC_FONC_INTERP

[U4.32.01]
MODE_STATIQUE DDL_IMPO

[U4.52.14]
CALC_CHAR_SEISME NODE

[U4.63.01]

MACRO_PROJ_BASE

[U4.63.11]
DYNA_TRAN_MODAL EXCIT
MULT_APPUI
“YES” [U4.53.21]
METHOD
EULER

DEVOGE

ADAPT

REST_BASE_PHYS MULT_APPUI
“YES”

[U4.63.21]
MULT_APPUI
“NOT”

RECU_FONCTION RESU_GENE

[U4.32.03]
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4
Results of modeling A

4.1
Values tested of modeling A

4.1.1 Displacements relative nodes NO2, NO3 and NO4

.
Relative displacements of node NO2 with the numerical algorithm of integration of Euler:

Time (S)	Reference	Code_Aster	Error (%)
0,1	8,47734E01	8,47725E01	-0,001
0,3	1,55202E+01	1,55201E+01	0
0,5	4,36449E+01	4,36450E+01	0
0,7	8,50830E+01	8,50832E+01	0
1,0	1,74790E+02	1,74790E+02	0

.
Relative displacements of node NO2 with the numerical algorithm of integration of Devogelaere:

Time (S)	Reference	Code_Aster	Error (%)

0,1 8,47734E01
8,47734E01
0
0,3 1,55202E+01
1,55202E+01
0
0,5 4,36449E+01
4,36449E+01
0
0,7 8,50830E+01
8,50830E+01
0
1,0 1,74790E+02
1,74790E+02
0

.

Displacements relating of node NO2 with the numerical algorithm of integration to step of time adaptive:

Time (S)
Reference
Code_Aster Error
(%)
0,1 8,47734E01
8,47761E01
0,003
0,3 1,55202E+01
1,55201E+01
0
0,5 4,36449E+01
4,36450E+01
0
0,7 8,50830E+01
8,50832E+01
0
1,0 1,74790E+02
1,74790E+02
0

.

Relative displacements of node NO3 with the numerical algorithm of integration of Euler:

Time (S)

Reference
Code_Aster Error
(%)
0,01 9,87666E10
7,32629E05
0
****
0,02 2,49501E07
1,46526E04
0
****
0,03 6,25468E06
2,19789E04
0
****
0,04 6,05829E05
2,93052E04
0
****
0,05 3,47191E04
3,66314E04
0
****
0,06 1,42349E03
1,32757E02
0,012
****
0,07 4,62144E03
2,61852E02
0,022
****
0,08 1,26245E02
3,90946E02
0,026
****
0,09 3,01825E02
5,20040E02
0,022
****
0,1 7,68449E01
7,68420E01
-0,004
0,3 1,76923E+01

1,76922E+01
0
0,5 4,99310E+01
4,99311E+01
0
0,7 9,70711E+01
9,70714E+01
0
1,0 1,99722E+02
1,99722E+02
0

** absolute error*

.
Relative displacements of node NO3 with the algorithm of numerical integration of Devogelaere:

Time (S)
Reference
Code_Aster Error
(%)
0,1 7,68449E01
7,68449E01
0
0,3 1,76923E+01
1,76923E+01

0
0,5 4,99310E+01
4,99310E+01
0
0,7 9,70711E+01
9,70711E+01
0
1,0 1,99722E+02
1,99722E+02
0

.
Displacements relating of node NO3 with the numerical algorithm of integration to step of time adaptive:

Time (S)
Reference
Code_Aster Error
(%)
0,1 7,68449E01
7,68462E01
0,002
0,3 1,76923E+01
1,76922E+01
0
0,5 4,99310E+01
4,99311E+01
0
0,7 9,70711E+01
9,70715E+01
0
1,0 1,99722E+02
1,99722E+02
0

.
Relative displacements of node NO4 with the numerical algorithm of integration of Euler:

Time (S)
Reference
Code_Aster Error
(%)
0,1 4,09632E01
4,09604E01

-0,007
0,3 1,10372E+01
1,10371E+01
0
0,5 3,12415E+01
3,12416E+01
0
0,7 6,05833E+01
6,05835E+01
0
1,0 1,24803E+02
1,24804E+02
0

.
Relative displacements of node NO4 with the numerical algorithm of integration of Devogelaere:

Time (S)
Reference
Code_Aster Error
(%)
0,1 4,09632E01
4,09632E01
0
0,3 1,10372E+01
1,10372E+01
0
0,5 3,12415E+01
3,12415E+01
0
0,7 6,05833E+01
6,05833E+01
0
1,0 1,24803E+02
1,24803E+02
0

.
Displacements relating of node NO4 with the numerical algorithm of integration to step of time adaptive:

Time (S)
Reference
Code_Aster Error

(%)
0,1 4,09632E01
4,09630E01
0
0,3 1,10372E+01
1,10371E+01
0
0,5 3,12415E+01
3,12416E+01
0
0,7 6,05833E+01
6,05835E+01
0
1,0 1,24803E+02
1,24804E+02
0

4.1.2 Absolute displacements of nodes NO2, NO3 and NO4

.
Absolute displacements of node NO2 with the numerical algorithm of integration of Euler:

Time (S)
Reference
Code_Aster Error
(%)
0,1 4,02266E01
4,02275E01
0,002
0,3 8,57298E+01
8,57299E+01
0
0,5 7,37605E+02
7,37605E+02
0
0,7 2,91617E+03
2,91617E+03
0
1,0 1,23252E+04
1,23252E+04
0

.
Absolute displacements of node NO2 with the algorithm of numerical integration of Devogelaere:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 4,02266E01
4,02266E01
0
0,3 8,57298E+01
8,57298E+01
0
0,5 7,37605E+02
7,37605E+02
0
0,7 2,91617E+03
2,91617E+03
0
1,0 1,23252E+04
1,23252E+04
0

.
Absolute displacements of node NO2 with the numerical algorithm of integration to step of time adaptive:

Time (S)
Reference

Code_Aster *Error*
(%)
0,1 4,02266E01
4,02239E01
-0,007
0,3 8,57298E+01
8,57299E+01
0
0,5 7,37605E+02
7,37605E+02
0
0,7 2,91617E+03
2,91617E+03
0
1,0 1,23252E+04
1,23252E+04
0

.
Absolute displacements of node NO3 with the numerical algorithm of integration of Euler:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 6,48847E02
6,49134E02
0,044
0,3 4,98077E+01
4,98078E+01
0
0,5 4,70902E+02
4,70902E+02
0
0,7 1,90376E+03
1,90376E+03
0
1,0 8,13361E+03
8,13361E+03
0

.
Absolute displacements of node NO3 with the numerical algorithm of integration of Devogelaere:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 6,48847E02
6,48847E02
0
0,3 4,98077E+01
4,98077E+01
0
0,5 4,70902E+02
4,70902E+02
0
0,7 1,90376E+03
1,90376E+03
0
1,0 8,13361E+03
8,13361E+03
0

.
Absolute displacements of node NO3 with the numerical algorithm of integration to step of time adaptive:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 6,48847E02
6,48714E02
-0,021
0,3 4,98077E+01
4,98078E+01
0
0,5 4,70902E+02
4,70902E+02
0
0,7 1,90376E+03
1,90376E+03
0
1,0 8,13361E+03
8,13361E+03
0

.

Absolute displacements of node NO4 with the numerical algorithm of integration of Euler:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 7,03506E-03
7,06261E-03
0
0,3 2,27128E+01
2,27129E+01
0
0,5 2,29175E+02
2,29175E+02
0
0,7 9,39833E+02
9,39833E+02
0
1,0 4,04186E+03
4,04186E+03
0

.

Absolute displacements of node NO4 with the algorithm of numerical integration of Devogelaere:

Time (S)	***Reference***	***Code_Aster***	*Error* ***(%)***
0,1	*7,03506E03*	*7,03504E03*	*0*
0,3	*2,27128E+01*	*2,27128E+01*	*0*
0,5	*2,29175E+02*	*2,29175E+02*	*0*
0,7	*9,39833E+02*	*9,39833E+02*	*0*
1,0	*4,04186E+03*	*4,04186E+03*	*0*

.

Absolute displacements of node NO4 with the numerical algorithm of integration to step of time adaptive:

Time (S)	***Reference***	***Code_Aster***	*Error* ***(%)***
0,1	*7,03506E03*	*7,03655E03*	*0*
0,3	*2,27128E+01*	*2,27129E+01*	*0*
0,5	*2,29175E+02*	*2,29175E+02*	*0*
0,7	*9,39833E+02*	*9,39833E+02*	*0*
1,0	*4,04186E+03*	*4,04186E+03*	*0*

4.2 Parameters
of execution

Version: STA 5.02
Machine: SGI Origin 2000
Time CPU to use: 16,4 seconds

---

5 Modeling
B

It is same modeling as the preceding one except for loading which is one accélérogramme of rotation.

5.1
Characteristics of modeling

The elements are modelled by discrete elements with 3 degrees of freedom DIS_T.

X
2
K 1
k2
k3

k4
Z
1
NO1
NO2
NO3
NO4
NO5

Node NO1 is subjected to an imposed acceleration 1 (T), node NO5 to 2 (T). It is calculated relative displacement of nodes NO2, NO3 and NO4 compared to their static deformation, them displacement of drive and their absolute displacement.

Temporal integration is carried out with the algorithm of Euler (not of time: 103 second).

5.2 Characteristics of the grid

The grid consists of 5 nodes and 4 discrete elements (DIST_TR).

5.3 Functionalities tested

Orders

Keys Doc. V5
AFFE_MODELE GROUP_MA
"MECHANICAL"
"DIS_T"
[U4.41.01]
DISCRETE AFFE_CARA_ELEM NODE M_TR_D_N
[U4.42.01]

NET
K_TR_D_L

AFFE_CHAR_MECA DDL_IMPO

[U4.44.01]
MACRO_MATR_ASSE

[U4.61.21]
MODE_ITER_INV CALC_FREQ
ADJUST
[U4.52.04]
CALC_FONC_INTERP

[U4.32.01]
MODE_STATIQUE DDL_IMPO

[U4.52.14]
CALC_CHAR_SEISME NODE

[U4.63.01]
MACRO_PROJ_BASE

[U4.63.11]
DYNA_TRAN_MODAL EXCIT
MULT_APPUI
“YES”
[U4.53.21]
METHOD
EULER

REST_BASE_PHYS MULT_APPUI
“YES” [U4.63.21]
MULT_APPUI
“NOT”

RECU_FONCTION RESU_GENE

[U4.32.03]
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:

6 Results of modeling B

6.1 Values tested of modeling B

6.1.1 Displacements relative nodes NO2, NO3 and NO4

.

Relative displacements of node NO2:

Time (S)	**Reference**	**Code_Aster**	Error **(%)**
0,1	8,47734E01	8,47725E01	-0,001
0,3	1,55202E+01	1,55201E+01	0
0,5	4,36449E+01	4,36450E+01	0
0,7	8,50830E+01	8,50832E+01	0
1,0	1,74790E+02	1,74790E+02	0

.

Relative displacements of node NO3:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 7,68449E01
7,68420E01
-0,004
0,3 1,76923E+01
1,76922E+01
0
0,5 4,99310E+01
4,99311E+01
0
0,7 9,70711E+01
9,70714E+01
0
1,0 1,99722E+02
1,99722E+02
0

.

Relative displacements of node NO4:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 4,09632E01
4,09604E01
-0,007
0,3 1,10372E+01
1,10371E+01
0
0,5 3,12415E+01
3,12416E+01
0
0,7 6,05833E+01
6,05835E+01
0
1,0 1,24803E+02
1,24804E+02
0

6.1.2 Absolute displacements of nodes NO2, NO3 and NO4

.

Absolute displacements of node NO2:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 4,02266E01
4,02275E01
0,002
0,3 8,57298E+01
8,57299E+01
0
0,5 7,37605E+02
7,37605E+02
0
0,7 2,91617E+03
2,91617E+03
0
1,0 1,23252E+04
1,23252E+04
0

.

Absolute displacements of node NO3:

Time (S)
Reference
Code_Aster *Error*
(%)
0,01 9,87666E10
7,32627E05
0
*
0,02 2,49501E07
1,46525E04
0
*
0,03 6,25468E06
2,19788E04
0
*
0,04 6,05829E05
2,93051E04
0
*
0,05 3,47191E04
3,66313E04
0
*
0,06 1,42349E03
1,32757E02 0,012
*
0,07 4,62144E03
2,61852E02 0,022
*
0,08 1,26245E02
3,90946E02 0,026
*
0,09 3,01825E02
5,20040E02 0,022
*
0,10 6,48847E02
6,49134E02 0,044
0,30 4,98077E+01
4,98078E+01 0

0,50 4,70902E+02
4,70902E+02 0
0,70 1,90376E+03
1,90376E+03 0
1,0 8,13361E+03
8,13361E+03
0

** absolute error*

.
Absolute displacements of node NO4:

Time (S)
Reference
Code_Aster *Error*
(%)
0,1 7,03506E-03
7,06264E-03 0
0,3 2,27128E+01
2,27129E+01 0
0,5 2,29175E+02
2,29175E+02 0
0,7 9,39833E+02
9,39833E+02 0
1,0 4,04186E+03
4,04186E+03 0

6.2 Parameters of execution

Version: STA 5.02
Machine: Sgi Origin 2000
Time CPU to use: 14,3 seconds

7 Summary of the results

The results obtained with Code_Aster are in conformity with the results of reference (the error is in general lower than 0,03%).
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.104 document

SDLD104 - Extrapolation of local measurements
on a complete model (discrete)

Summary:

It is about a test of linear dynamics discrete.

The goal is to test order PROJ_MESU_MODAL in the case of a discrete system. This order allows to project experimental dynamic transitory answers in a certain number of points on a modal base of a numerical modeling.

This test contains 2 modelings:

.
projection is done on a basic concept modal of type [mode_meca],
.
projection is done on a basic concept modal of type [base_modale].

For 2 modelings, provided experimental measurements are identical and make it possible to test seek nodes in opposite, the taking into account of a local orientation and the treatment of one sampling in constant time or not, for measurements in displacement.

In both cases, the reference solution is analytically given (by Maple); projection is realized in the favorable configuration where the number of modes is equal to the number of measurements.
The answers in displacement obtained after projection are identical to displacements of reference provided in data.

The values speeds and the accelerations deduced from the displacements obtained after projection are close relations of those obtained analytically. The weak noted variations are due to the errors of approximation
generated by the determination via a linear diagram in time of speeds and accelerations.

1
Problem of reference

1.1
Description of the system

We consider the system represented by the diagram below:

K

K
K

m
m

X1
X2

1.2
Masses and rigidity

The three springs are of identical rigidity: K = 1000 N/m.
The two masses are equal to m = 10 kg.

1.3
Boundary conditions and loading

The two ends are embedded.
The loading is a thrust load in traction applied to the mass m1, sinusoidal according to time, of pulsation.

2
Reference solutions

2.1
Method of calculation used for the reference solution

The analytical solution of this problem is presented below.

.

Modes and frequencies of vibration:
The following system characterizes the dynamics of the masses:

mx& + 2kx - kx
1
1
2 = 0

éq 2.1-1
MX
& + 2kx - kx
2
2
1 = 0

What is equivalent to the following system:

(
m x& + X
1
&2) + K (X + X
1
2) = 0

éq 2.1-2

(
m x& - X
1
&2) + K
3 (X - X
1
2) = 0

The 2 Eigen frequencies of the system are thus given by:

K
K
=
and
3
1
2 =

éq
2.1-3
m
m

and the associated modal deformations are:

1
1

= and
1
2 =

éq
2.1-4
1
- *1*

The generalized matrices are:

1
1m 01
1 2m
0
M *= TM =*

=

1 **-**
1 0

m 1 **-**
1
0
2
m

éq
2.1-5
1
1 2k **-** *k1*
1 2k
0
K *= TK =*

=

1 **-**
1 **-** *K*
2k 1 **-**

1
0 6k

.
Transitory answer:
1
*The sinusoidal effort is applied to the first mass: **F** =*
(
sin T)

0

The checked dynamic system is as follows:

MX
*& + **KX** = **F***

éq 2.1-6

While projecting on the basis of clean mode, we obtain:

T & + T = T
M
K
F
éq
2.1-7

That is to say:

2m
0 & 2k
0 1 1 1
1
1

+
=

(
sin T
)

éq
2.1-8
0
2m & 0 6k 1 - 10
2
2

We thus end to the following uncoupled system:

1
m
& + K = if (
N T
)
1
1

2

éq
2.1-9
1
m

& + K
3 =
(
sin T
)
2
2

2

The solution of this system is given by:

sin T
(T)
1
= 1
With
(
cos 1t) + 1
B if (
N 1t)
( )
+ 2

(m2 -2
1
)

éq
2.1-10
sin

(
T
T)
2
= 2
With

(
cos 2t) + 2
B S (
in 2t)
( )
+

2

(m2 -2
2
)

Displacements in physical space are obtained by the formula of Ritz:

x1
1

1 1
+
1
2

X = = =
=

éq
2.1-11
x2
1 **-**
1 2
-
1
2

One deduces the expressions from them from:

X (T) and X (T)
1
2

éq

2.1-12

sin T

1
1

X (T) = A cos
sin
cos
sin

1
1
(T1) + B1 (T1) + A2 (t2) + B2 (t2)
( )
+
+
2m 2
2
2
2

1
-
2 -

sin T

1
1

X (T) = A cos
sin
cos
sin

2
1
(T1) + B1 (T1) - A2 (t2) + B2 (t2)

( )
+
-
2m 2
2
2
2

1
-
2 -

At the initial moment, the system is at rest, from where final expressions of X (T)
1
and X (T)
2
:

(
sin T
) -
S (
in T
1)
(
sin T
) -
S (
in T
2)
1

X (T)
1
2

1
=
+

2m
2
2
2
2

1 -
2 -

éq
2.1-13

(
sin T
) -
S (
in T
1)
(
sin T
) -
S (
in T
2)

1

X (T)
1
2

2
=
-
2m
2
2
2
2

1 -

2 -

Speeds of the two masses are calculated by deriving displacements compared to time:

(
cos T
) - C (
bone T

1)
(
cos T) - C (
bone
T
2)
X (T)
&

1
=
+

2m
2
2
2
2

1
-
2 -

éq

2.1-14

(
cos T
) - C (
bone T

1)
Co (
S T) - C (
bone
T
2)
X (T)
&

2
=
-
2m
2
2
2
2

1
-
2 -

Accelerations of the two masses are calculated by deriving speeds compared to time:

(
sin T
) - S

1
(
in
T
1)
if (
N T) -
S
2
(
in
T
2)
&x (T)

1
=
+

2m
2
2
2
2

1
-
2 -

éq 2.1-15

(
sin T
) - S

1

(
in
T
1)
(
sin T) -
S
2
(
in
T
2)
&x (T)

2
=
-
2m
2
2
2
2

1
-
2 -

2.2
Results of reference

The comparison of the results relates to displacements, speeds and accelerations along the axis of two masses, at five different moments.

2.3
Uncertainty on the solution

The reference solution is exact.
The discrete model represents perfectly the problem arising (the modal base is complete; there is not thus not of approximation related to a possible modal truncation). The number of modes of the base of modal projection is equal to the number of measurements, therefore the solution of the inversion is exact (by

opposition to an approximate solution of a generalized opposite problem). If the research of the nodes in opposite is good, the displacements obtained after projection must be in perfect adequacy with the experimental values. Speeds and accelerations are determined by derivation of modal contributions identified via a diagram of linear approximation in time, thus being able to generate some errors.

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---

3 Modeling
With

3.1
Characteristics of modeling and the grids

.
Numerical grid:
The numerical grid is carried out directly with the format ASTER. It comprises 4 nodes and 3 discrete meshs.

K
m K
m
K
X

N1
N2
N3
N4

(x=0.) (x=0.1) (x=0.2) (x=0.3)

.
Experimental grid:
The grid of measurement includes/understands only 2 specific elements and 2 nodes:

X

N2 N3

(x=0.12) (x=0.18)

3.2
Characteristics of measurements

Provided experimental measurements are:

.
With the N3 node:
The data are the displacements axial, multiplied by (2 /2), and applied in the direction X. the local orientation indicated in the command file is (45. 0. 0.)
The sampling of time is constant: initial time is 0 S, the step of times is 103 S and it a many moments are 1001 (i.e until a final time of 1 S).

.
With the node N2:
The data are the axial displacements, applied in direction X.
The sampling of time is variable: every moment is indicated of 0 S to 1 S, by step of 103 S (1001 moments on the whole).

The values result from the analytical calculation carried out with Maple.

3.3
Characteristics of the modal base

The two only modes are stored in a concept of the type [mode_meca] created by the order MODE_ITER_SIMULT. Their Eigen frequencies are identical to the analytical Eigen frequencies.

3.4 Functionalities tested

Orders

AFFE_CARA_ELEM
DISCRETE
CARA
'M_T_D_N

“K_T_D_L”
ORIENTATION
“ANGL_NAUT”

LOCATE
“LOCAL”
AFFE_CHAR_MECA
DDL_IMPO
ALL

NODE
AFFE_MODELE
ALL
“MECHANICAL” “DIST_T”

ASSE_MATRICE

CALC_MATR_ELEM OPTION

"MASS_MECA"

"RIGI_MECA"
MODE_ITER_SIMULT CALC_FREQ
OPTION
"BAND"

NUME_DDL

NUME_DDL_GENE

PROJ_MATR_BASE

PROJ_MESU_MODAL
MEASURE

REGULARIZATION
REST_BASE_PHYS TOUT_CHAM
"YES"

TEST_RESU NOM_CHAM
"DEPL"

CRITERION
"QUICKLY"
"ACCE"
"RELATIVE"

4
Results of modeling A

4.1 Values
tested

Identification Reference
***Code_Aster** difference*

with T = 0.1 S
1.745 10-4 1.745
10-4 0.01
%

with T = 0.3 S
6.797 10-4 6.797
10-4 0.01
%
DEPL_X
with the node N2
with T = 0.5 S
-1.217 10-3 -1.217
10-3 0.01
%
(m) (mass
1)
with T = 0.7 S
5.214 10-4 5.214
10-4 -0.01
%

with T = 0.9 S
9.031 10-4 9.031
10-4 0.00
%

with T = 0.1 S
9.154 10-6 9.154
10-6 0.00
%

with T = 0.3 S
6.414 10-4 6.414
10-4 0.00
%
DEPL_X
with the N3 node
with T = 0.5 S
-8.636 10-4 -8.636
10-4 0.00
%
(m) (mass
2)
with T = 0.7 S
-1.107 10-4 -1.107
10-4 0.03
%

with T = 0.9 S
1.633 10-3 1.633
10-3 0.02
%

with T = 0.1 S
4.586 10-3 4.616
10-3 0.65
%

with T = 0.3 S

-7.598 10-3 -7.663
10-3 0.85
%
VITE_X
with the node N2
with T = 0.5 S
-1.581 10-4 -8.000
10-5 7.81
105 m/s
(m/s) (mass
1)
with T = 0.7 S
9.382 10-3 9.354
10-3 -0.30
%

with T = 0.9 S
-7.481 10-3 -7.537
10-3 0.75
%

with T = 0.1 S
4.328 10-4 4.405
10-4 1.79
%

with T = 0.3 S
3.671 10-3 3.640
10-3 -0.84
%
VITE_X
with the N3 node
with T = 0.5 S
-1.539 10-2 -1.536
10-2 -0.20
%
(m/s) (mass
2)
with T = 0.7 S
2.453 10-2 2.457
10-2 0.15

%

with T = 0.9 S
-1.899 10-2 -1.912
10-2 0.68
%

with T = 0.1 S
6.112 10-2 6.100
10-2 -0.20
%

with T = 0.3 S
-1.306 10-1 -1.300
10-1 -0.46
%
ACCE_X
with the node N2
with T = 0.5 S
1.571 10-1 1.600
10-1 1.85
%
(m/s2) (mass
1) with T = 0.7 S
-5.657 10-2 -5.800
10-2 2.53
%

with T = 0.9 S
-1.124 10-1 -1.130
10-1 0.53
%

with T = 0.1 S
1.562 10-2 1.618
10-2 3.58
%

with T = 0.3 S

-6.031 10-2 -6.223
10-2 3.18
%
ACCE_X
with the N3 node
with T = 0.5 S
5.102 10-2 5.374
10-2 5.33
%
(m/s2) (mass
2) with T = 0.7 S
7.428 10-2 7.043
10-2 -5.19
%

with T = 0.9 S
-2.364 10-1 -2.263
10-1 -4.28
%

Note:

Speed with the node N2 at the moment T = 0.5 S being relatively close to zero, the comparison is realized for this case in absolute value.

4.2 Parameters of execution

Version: STA5 (5.05)

Machine: CLASTER

Obstruction memory: 100 Mo
Time CPU To use: 9.05 seconds
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
SDLD104 - Extrapolation of local measurements on a complete model

5 Modeling B

5.1 Characteristics of modeling and the grids

.

Numerical grid:
The numerical grid is carried out directly with the format ASTER. It comprises 4 nodes and 3 discrete meshs.

K
m K
m
K
X

N1
N2
N3
N4

(x=0.) (x=0.1) (x=0.2) (x=0.3)

.

Experimental grid:
The grid of measurement includes/understands only 2 specific elements and 2 nodes:

X

N2

N3

(x=0.12) (x=0.18)

5.2
Characteristic of measurements

Provided experimental measurements are:

.
With the N3 node:
The data are the displacements axial, multiplied by (2 /2), and applied in the direction X. The local orientation indicated in the command file is (45. 0. 0.)
The sampling of time is constant: initial time is 0 S, the step of times is 103 S and it a many moments are 1001 (i.e until a final time of 1 S).

.
With the node N2:
The data are the axial displacements, applied in direction X.
The sampling of time is variable: every moment is indicated of 0 S to 1 S, by step of 103 S (1001 moments on the whole).

The values result from the analytical calculation carried out with Maple.

5.3
Characteristics of the modal base

The two only modes are stored in a concept of the type [base_modale], created by the order DEFI_BASE_MODALE. The interface, of Craig-Bampton type, is placed on the degree of freedom in displacement following X of the node N2 (corresponding to the mass m 1). The modal base thus contains a dynamic mode (with blocked N2) and a static mode.

5.4 Functionalities tested

Orders

AFFE_CARA_ELEM
DISCRETE
CARA
'M_T_D_N

“K_T_D_L”

ORIENTATION
“ANGL_NAUT”

LOCATE
“LOCAL”

AFFE_CHAR_MECA
DDL_IMPO
ALL

NODE
AFFE_MODELE
ALL
“YES”

PHENOMENON
“MECHANICAL”
MODELING
“DIST_T”

ASSE_MATRICE

CALC_MATR_ELEM OPTION
“MASS_MECA”

“RIGI_MECA”
TRADITIONAL DEFI_BASE_MODALE

DEFI_INTERF_DYNA INTERFACES

MODE_ITER_SIMULT CALC_FREQ
OPTION
“BAND”

NUME_DDL

NUME_DDL_GENE

PROJ_MATR_BASE

PROJ_MESU_MODAL
MEASURE

REGULARIZATION
REST_BASE_PHYS TOUT_CHAM
“YES”

TEST_RESU NOM_CHAM

"DEPL"

CRITERION
"QUICKLY"
"ACCE"
"RELATIVE"
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
SDLD104 - Extrapolation of local measurements on a complete model
Date:
04/03/02
Author (S):
***S. AUDEBERT**, Key P. HERMAN*
:
V2.01.104-A Page:
11/12

6
Results of modeling B

6.1 Values
tested

Identification Reference
***Code_Aster** difference*

with T = 0.1 S
1.745 10-4 1.745
10-4 0.01
%

with T = 0.3 S
6.797 10-4 6.797
10-4 0.01

%
DEPL_X
with the node N2
with T = 0.5 S
-1.217 10-3 -1.217
10-3 0.01
%
(m) (mass
1)
with T = 0.7 S
5.214 10-4 5.214
10-4 -0.01
%

with T = 0.9 S
9.031 10-4 9.031
10-4 0.00
%

with T = 0.1 S
9.154 10-6 9.154
10-6 0.00
%

with T = 0.3 S
6.414 10-4 6.414
10-4 0.00
%
DEPL_X
with the N3 node
with T = 0.5 S
-8.636 10-4 -8.636
10-4 0.00
%
(m) (mass
2)
with T = 0.7 S
-1.107 10-4 -1.107
10-4 0.03
%

with T = 0.9 S
1.633 10-3 1.633
10-3 0.02
%

with T = 0.1 S
4.586 10-3 4.616
10-3 0.65
%

with T = 0.3 S
-7.598 10-3 -7.663
10-3 0.85
%
VITE_X
with the node N2
with T = 0.5 S
-1.581 10-4 -8.000
10-5 7.81
105 m/s
(m/s) (mass
1)
with T = 0.7 S
9.382 10-3 9.354
10-3 -0.30
%

with T = 0.9 S
-7.481 10-3 -7.537
10-3 0.75
%

with T = 0.1 S
4.328 10-4 4.405
10-4 1.79
%

with T = 0.3 S
3.671 10-3 3.640

10-3 -0.84
%
VITE_X
with the N3 node
with T = 0.5 S
-1.539 10-2 -1.536
10-2 -0.20
%
(m/s) (mass
2)
with T = 0.7 S
2.453 10-2 2.457
10-2 0.15
%

with T = 0.9 S
-1.899 10-2 -1.912
10-2 0.68
%

with T = 0.1 S
6.112 10-2 6.100
10-2 -0.20
%

with T = 0.3 S
-1.306 10-1 -1.300
10-1 -0.46
%
ACCE_X
with the node N2
with T = 0.5 S
1.571 10-1 1.600
10-1 1.85
%
(m/s2) (mass
1) with T = 0.7 S
-5.657 10-2 -5.800
10-2 2.53
%

with T = 0.9 S
-1.124 10-1 -1.130
10-1 0.53
%

with T = 0.1 S
1.562 10-2 1.618
10-2 3.58
%

with T = 0.3 S
-6.031 10-2 -6.223
10-2 3.18
%
ACCE_X
with the N3 node
with T = 0.5 S
5.102 10-2 5.374
10-2 5.33
%
(m/s2) (mass
2) with T = 0.7 S
7.428 10-2 7.043
10-2 -5.19
%

with T = 0.9 S
-2.364 10-1 -2.263
10-1 -4.28
%

Note:

Speed with the node N2 at the moment T = 0.5 S being relatively close to zero, the comparison is realized for this case in absolute value.

6.2 Parameters of execution

Version: STA5 (5.05)

Machine: CLASTER

Obstruction memory: 100 Mo
Time CPU To use: 9.24 seconds

7
Summary of the results

For two modelings, the answers in displacement obtained after projection are identical with the displacements of reference calculated analytically with Maple and provided in data.

Values speeds and the accelerations deduced from the displacements obtained after projection are close to those obtained analytically. The weak noted variations are due to the errors of approximation generated by the determination by a linear diagram in time speeds and accelerations.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
Document: V2.01.313

SDLD313 - System masses spring with 2 DDL with damping hysteretic

Summary:

This one-way problem consists in carrying out a harmonic analysis of a mechanical structure composed of a whole of mass-springs with damping hysteretic and subjected to an excitation sinusoidal. This test of mechanics of the structures corresponds to a dynamic analysis of a discrete model
having a linear behavior. It includes/understands three modelings.

Via modeling A, one tests the discrete elements in translation (mass, arises), them
options AMOR_HYST of AFFE_CARA_ELEM.

Via modeling B, one tests the elements of beam (POU_D_T), options AMOR_HYST of DEFI_MATERIAU,
Via modeling C, one tests calculation modal (MODE_ITER_SIMULT) complex.

On the first two modelings, one tests the definition of a force of specific excitation harmonic and the operator of harmonic calculation of answer (DYNA_LINE_HARM [U4.54.02]). In addition, several are tested
operators of postprocessing: RECU_FONCTION [U4.62.03], TEST_FONCTION [U4.72.02], RECU_CHAMP
[U4.62.01].

Results obtained for the first two modelings (field of displacement for different frequencies of excitation) are in concord with the results of guide VPCS. Results obtained for the third modeling are in concord with the semi-analytical results.

1
Problem of reference

1.1 Geometry
We consider the system represented by the diagram below:

*k1 (1+j*1)*
*k2 (1+j*2)*

m

m2

1

X1
X2
WITH B C

Specific masses:
m & m
1
2

Stiffnesses of connection:
k1 & k2

Damping hysteretic:
1 & 2

1.2
Properties of material

Comes out from linear elastic translation
K1 = 28000
N/m

K2 =
28000 N/m
Specific mass
M1 =
10 kg

M2 =
5 kg
Damping hysteretic
1 =
0.1

2 =
0.0

1.3
Boundary conditions and loadings

Boundary conditions:
Points A, B, C embedded out of DY and DZ
Embedded points a: (DX = 0).

Loading: Force concentrated sinusoidal of variable frequency at the point C

Not C

Fx = 0
F sint = 2 F 0 Hz

F
Hz

21.0543
4

0
F = constant =
NR

100

1.4 Conditions
initial

Without object for the study of the permanent harmonic mode.

2
Reference solution

2.1
Method of calculation

The system of differential equations of the second order coupled is form:

M u&+ Ku = F
0 0 0
1+ .
0 1 J
-1 - 0 1
. J
0

with M = 0 10 0
and
K = 28000-1-.
0 1 J
2 + 0 1
. J
-
1

0 0 5

0
-1
1

The solution with a harmonic excitation F = F0 E J T j2 = -1
(

) is form U =u0 ejt, it
who leads to: (
2
K - M) U = F
0
0

This system is solved for all.

2.2
Sizes and results of reference

Displacement according to X of the point C for certain frequencies.
Eigen frequencies and damping reduced.

2.3
Uncertainties on the solution

Semi-analytical solution.

2.4 References
bibliographical

[1]
J. PIRANDA: Note of use of the software of modal analysis MODAN - Version 0.2 (1990). Laboratory of Mechanics Applied - University of Frank County - Besancon (France).

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/03/008/A

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3 Modeling With

3.1 Characteristics of modeling

Discrete element of rigidity in translation

y
X
WITH B
C

Characteristics of the elements
DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity
K_T_D_L

Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: "YES" DY: 0. , DZ: 0.)
with the node end A

(GROUP_NO: WITH DX: 0.)

Names of the nodes:
Not A = N1
With = N1
Not B = N2
B = N2
Not C = N3
C = N3

3.2
Characteristics of the grid

A number of nodes: 3
A number of meshs and types: 2 SEG2

3.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA “K_T_D_L”

GROUP_MA
AMOR_HYST
“A_T_D_L”
“MECHANICAL” AFFE_MODELE VERY “DIS_T”

GROUP_NO
“DIS_T”
AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE
DEFI_LIST_REEL BEGINNING

INTERVAL
RECU_FONCTION LIST_FREQ

3.4
Sizes tested and results

Parts real and imaginary of component DX of the displacement of the point C.

Frequency Reference
Aster *%*
Difference
0.00
7.1075E-03
7.1074964639321E-03
1.08E-04
3.5360E-04
3.5360678925035E-04
3.36870E+00 9.388216E-03
9.3882649899583E-03
5.31E-04
7.31196E-04
7.3120610001073E-04
6.48480E+00 5.0269E-03
5.0349198344062E-03
0.012
7.07103E-02
7.0708581052416E-02

8.00060E+00 9.54931E-03
9.5490053525137E-03
0.003
2.2154E-03
2.2153458282190E-03
1.18746E+01 4.23259E-05
4.2266734408325E-05
0.016
3.57193E-04
3.5719325443817E-04
1.34747E+01 2.35524E-03
2.3552527130123E-03
5.34E-04
5.01765E-04
5.0176685846530E-04
1.55802E+01 1.6395374E-02
1.6420641488151E-02
0.039
6.871471E-02
6.8704047854161E-02
2.10543E+01 1.88977E-03
1.8897660707219E-03
2.08E-04
5.53314E-06
5.5328629109043E-06

3.5 Remarks

Contents of the file results:

Values of the displacement of component DX of the point C for all the frequencies of 0 with 2.10543E+01Hz by step of 3.3687.

---

4 Modeling
B

4.1
Characteristics of modeling

Continuous element of beam type in traction

y
X
WITH B
C

Characteristics of the elements
DISCRETE: masses
nodal
M_T_D_N
BEAM:
matrices of rigidity
POU_D_T

Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: “YES” DY: 0. , DZ: 0.)
with the node end A

(GROUP_NO: WITH DX: 0.)

Names of the nodes:
Not A = N1
With = N1

Not B = N2
B = N2
Not C = N3
C = N3

4.2
Characteristics of the grid

A number of nodes: 3
A number of meshs and types: 2 SEG2

4.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM
GROUP_MA "M_T_D_L"

DEFI_MATERIEU ELAS

AMOR_HYST

AFFE_MODELE ALL
"MECHANICAL" "POU_D_T"

GROUP_NO
"DIS_T"
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
NODE
CALC_MATR_ELEM RIGI_MECA_HYST

DEFI_LIST_REEL BEGINNING

INTERVAL

RECU_FONCTION LIST_FREQ

4.4
Sizes tested and results

Parts real and imaginary of component DX of the displacement of the point C.

Frequency Reference
Aster *%*
Difference
0.00
7.1075E-03
7.1074964639321E-03
1.08E-04
3.5360E-04
3.5360678925035E-04
3.36870E+00 9.388216E-03
9.3882649899583E-03
5.31E-04
7.31196E-04
7.3120610001073E-04
6.48480E+00 5.0269E-03
5.03491983440 64E-03
0.012
7.07103E-02

7.0708581052416E-02
8.00060E+00 9.54931E-03
9.5490053525137E-03
0.003
2.2154E-03
2.2153458282190E-03
1.18746E+01 4.23259E-05
4.2266734408325E-05
0.016
3.57193E-04
3.5719325443817E-04
1.34747E+01 2.35524E-03
2.3552527130123E-03
5.34E-04
5.01765E-04
5.0176685846530E-04
1.55802E+01 1.6395374E-02
1.6420641488152E-02
0.039
6.871471E-02
6.8704047854161E-02
2.10543E+01 1.88977E-03
1.8897660707219E-03
2.08E-04
5.53314E-06
5.5328629109043E-06

4.5 Remarks

Contents of the file results:

Values of the displacement of component DX of the point C for all the frequencies of 0 with 2.10543E+01Hz by step of 3.3687.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/03/008/A

Code_Aster ®
Version
7.0

Titrate:

5 Modeling C

5.1 Characteristics of modeling

Discrete element of rigidity in translation

y
X
WITH B
C

Characteristics of the elements
DISCRETE:
with nodal masses
M_T_D_N

and matrices of rigidity
K_T_D_L

Limiting conditions:
in all the nodes
DDL_IMPO:
(ALL: "YES" DY: 0. , DZ: 0.)
with the node end A

(GROUP_NO: WITH DX: 0.)

Names of the nodes:
Not A = N1
With = N1

Not B = N2
B = N2
Not C = N3
C = N3

5.2
Characteristics of the grid

A number of nodes: 3
A number of meshs and types: 2 SEG2

5.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM GROUP_MA "K_T_D_L"

GROUP_MA
AMOR_HYST
"A_T_D_L"
"MECHANICAL" AFFE_MODELE VERY "DIS_T"

GROUP_NO
"DIS_T"
AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FORCE_NODALE
NODE
MODE_ITER_SIMULT SORENSEN
"COMPLEX"

DEFI_LIST_REEL BEGINNING

INTERVAL
RECU_FONCTION LIST_FREQ

Handbook of Validation

5.4
Sizes tested and results

Eigen frequencies and reduced depreciation.

Eigen frequencies:

Sequence number
Reference
***Aster** %*
Difference
1
6.4537 6.44568
-0.124
2 15.5806 1.55612
-0.124

Reduced depreciation:

Sequence number
Reference
***Aster** %*
Difference

1
0.05 0.05
1.39E-14
2 0.05 0.05
2.78E-14

6
Summary of the results

The results obtained are excellent.

***E. BOYERE**, T. QUESNEL Key*
:
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Organization (S): EDF-R & D /AMA, IRCN

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.320 document

SDLD320 - Transitory response of a free system of 3 masses and 2 springs under excitation harmonic

Summary:

One considers the transitory analysis of a discrete system masses/arises linear with three degrees of freedom completely free. This system has a non-proportional damping. A sinewave excitation is applied at an end of the system.

In this problem, one tests, through a discrete model, the calculation of the transitory response of a system whose rigid modes are not fixed. One is interested only in the transient state. For that, one will seek the solution by an integration on the complete modal basis (DYNA_TRAN_MODAL [U4.53.21]).

The results obtained (displacement, speed and acceleration) are compared with an average of results coming from industrial codes and a method of integration numerical of type - Newmark improved.

1
Problem of reference

1.1 Geometry

k1
k2
m1
m
m
2
3
F0 sin (T)
P1
P
P
2
3
C1
C2

1.2
Properties of materials

Stiffnesses of connection: k1 = 4. 109 N.m1, k2 = 5.33 108 N.m1

Specific masses: m1 = 106 kg, m2 = m3 = 12.106 kg

One-way viscous damping: C1 = 1.2566 106 kg.s1, C2 = 9.0478 106 kg.s1

1.3
Boundary conditions and loadings

Completely free system.

Loading at the P3 point following axis X: F (T) 0=F0 sin (T) for T 0 with F0= 5.104 NR and =19 rad.s 1.

1.4 Conditions
initial

The system is at rest with t=0: (
U 0) = 0 and
( )
0 = 0 .
dt

2
Reference solution

2.1
Method of calculation used for the reference solution

The research of the transitory response of this problem to damping nonproportional, and where them rigid modes are not fixed, can be carried out by numerical integration in real space:

[M] {u&} + [C] {u&} + [K] {U} = {F
N
N
N
} .

For that, the answer was calculated with two industrial codes:

.
PERMAS: Diagram of integration of Newmark (=0,25, =0,5), t=104s,

Diagram of integration with cubic interpolation of Hermit [bib1], t=104s,

.
ABAQUS: Diagram of integration of Hilber-Hughes-Taylor [bib2] (=-0,05), t=104s,

and method of integration of - Newmark improved [bib3]:

[M] [C] [K]

+
+

+
+

+
+

{
F
F
F

2 M
K
U
N2
N 1
N
N + 2}
{
} {
} { }
[ ] [ ]
=
+
-

{un+}
t2
2t
3
3

t2
1
3

[M] [C] [K]
+ -
+
-

{a}
t2
2t
3

where N, n+1, n+2 respectively indicate the calculations carried out at times tn, tn+1=tn+t and tn+2=tn +2t where
T is the increment of appointed time.

To start, one takes:

.
u0 and U 1 = U

-
0 - T
u&0
.
F
2F
F
- =
-
1
0
1

The step of adopted time is t=10-5s.

2.2
Results of reference

Displacement, speed and acceleration of the P3 point.

Differential of displacement enters the points P3 and P1.

Relative displacement of the P3 point compared to the P1 point
1,00E-05
5,00E-06
(m) 1 *0,00E+00*
- U
0,0
0,5
1,0
1,5
2,0
2,5
3,0
3,5
4,0
4,5
5,0
U 3
-5,00E-06
-1,00E-05
time (S)

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2.3
Uncertainty on the solution

Average of numerical solutions.

2.4 References
bibliographical

[1]
J.H. ARGYRIS, PC DUNNE and T. ANGELOPOULOS "Non-linear oscillations using the finite technical element" comp. Meth. Appl. Mech. Engng., Vol.2, 1972, pp. 203-254
[2]
H.M. HILBER, T.J.R. HUGHES and R.L. TAYLOR "Improved numerical dissipation for time integration algorithms in structural dynamics" Earthquake Structural Engineering and Dynamics, Vol.5, 1977, pp. 283-292
[3]
Structural N.M. NEWMARK "A method of computation for dynamics" Proceeding ASCE J.Eng.Mech. Div E-3, July 1959, pp. 67-94

Code_Aster ®
Version
6.4

Titrate:
SDLD320 - Transitory response of a free system of 3 masses and 2 springs

3 Modeling With

3.1 Characteristics of modeling

Discrete elements of rigidity, damping and mass.

y
P
P2
P
1
3
.
.
.
X
N1
N2
N3
Z

Characteristics of the elements:

DISCRETE:
nodal masses
M_TR_D_N
rigidities
linear K_TR_D_L
depreciation
linear
A_TR_D_L

No boundary conditions, in all the nodes: DX, DY, DZ, DRX, DRY, DRZ free.

Names of the nodes: P1 = N1, P2 = N2, P3 = N3.

Method of calculation:

Integration on the modal basis supplements with Newmark (=0,25, =0,5),
No time: t=10-4s then modal recombination.

Duration of observation: 5s.

3.2
Characteristics of the grid

A number of nodes: 3

A number of meshs and type: 2 meshs SEG2

3.3
Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM
NET
“K_TR_D_L”

NET
“A_TR_D_L”

NODE
“M_TR_D_N”

MODE_ITER_SIMULT
CALC_FREQ
(Option: “CENTER”)
DYNA_TRAN_MODAL NEWMARK

REST_BASE_PHYS NOM_CHAM: “DEPL”

CALC_FONCTION COMB

4
Results of modeling A

4.1 Values
tested

.
Displacement of the P3 point

Time Displacement
Displacement
Difference
(S)
***Reference** (m)*
***Aster** (m)*
(%)
0,09

6,7395 E-6
6,73326 E-6
-0,093
0,32
1,1019 E-5
1,10002 E-6
-0,171
1,18
3,6683 E-5
3,66122 E-5
-0,193
4,92
1,6615 E-4
1,65849 E-4
-0,181

.

Speed of the P3 point

Time Speed Speed
Difference
(S)
Reference
-
-
(m.s 1)
Aster *(m.s 1)*
(%)
0,05
1,3425 E-4
1,34131 E-4
-0,088
0,32
-6,4111 E-5
-6,41097 E-4
-0,002
1,18
1,6104 E-5
1,60598 E-5
-0,274
3,55
4,4262 E-5
4,41720 E-5

-0,203

.

Acceleration of the P3 point

Time Acceleration
Acceleration Difference
(S)
Reference
-
-
(m.s 2)
***Aster** (m.s 2)*
(%)
0,09
-3,5694 E-3
-3,56634 E-3
-0,086
0,18
-4,3924 E-3
-4,38933 E-3
-0,070
0,55
4,3766 E-3
4,37283 E-3
-0,086
1,18
4,2459 E-3
4,24264 E-3
-0,077
4,92
-4,2233 E-3
-4,21962 E-3
-0,087

.

Relative displacement of the P3 point compared to the P1 point

Time u3-u1
u3-u1 Difference
(S)
***Reference** (m)*
***Aster** (m)*
(%)

0,18
8,0987 E-6
8,04800 E-6
-0,626
0,55
-6,2246 E-6
-6,21194 E-6
-0,203
0,82
5,3064 E-6
5,34121 E-6
0,656
1,18
-4,5552 E-6
-4,52071 E-6
-0,757
1,92
-3,0416 E-6
-3,04417 E-6
0,085
3,55
1,8448 E-6
1,82742 E-6
-0,942
4,92
1,4832 E-6
1,47526 E-6
-0,535

4.2 Remarks

In addition to the comparison for the values tested, one checks that the variables different kinematics that those related to the translation according to X remain null.

5
Summary of the results

.
To obtain a good precision of the results, it is initially necessary to obtain a base modal precise and perfectly orthogonal (MODE_ITER_SIMULT):

by avoiding the multiple modes (different rigidity on the nonexcited ddl),

by calculating the rigid modes of body correctly (to prefer the option "Centers" in MODE_ITER_SIMULT with the other options),

by specifying method "JACOBI" for a modal complete extraction.

.
The precision of the results is good as well for displacements for speeds and accelerations.

For the elastic response of the system (relative displacements u3-u1), the numerical precision is one little worse because of the numerical office plurality of the errors on the absolute values.

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Code_Aster ®
Version
6.4

Titrate:
SDLD321 - Transitory dynamic response of a harmonic oscillator
Date:
17/02/04
Author (S):
E. BOYERE, T. QUESNEL Key
:
V2.01.321-A Page:
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Organization (S): EDF-R & D /AMA, IRCN

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.321 document

SDLD321 - Transitory dynamic response of one harmonic oscillator with damping variable

Summary:

The system considered is a harmonic oscillator with 1 d.d.l under harmonic excitation with resonance.
Various depreciation will be considered:

- ***critical damping,***
- ***average damping,***
- ***very weak damping.***

Via this problem, one tests the various algorithms of order DYNA_TRAN_MODAL [U4.54.03] and their capacities to deal with problems with extreme damping. The results are compared with the exact analytical solutions.

---

1 Problem of reference

1.1 Geometry

The system is composed of a mass, a spring and a shock absorber. It admits a single degree of freedom in translation.

y, v
With
K
B
X, U
m
F0 sin (T)
C
: pulsation of excitation corresponding
with the resonance of the system not deadened
= km

1.2 Material properties

Stiffness of connection: K = 25.103 N.m-1

Specific mass: m = 10 kg

Viscous damping:

C = ccritic; C = 0,01 ccritique; C = 10-5 ccritique
with ccritic = 1.000 kg.s-1

1.3
Boundary conditions and loadings

Embedded end A.

Force harmonic according to X at the frequency of resonance at point b:

F (T) = F0 sin (T) for T 0 with F0 = 5 NR and =
K = 50 rad.s-1.
m

1.4 Conditions
initial

The system is at rest with T = 0: (
U 0) = 0 and
( )
0 = 0 .
dt

2
Reference solution

2.1
Method of calculation used for the reference solution

The simple oscillator checks the following equation:

m u& + C u& + K U = F sin
0
(T
)

with U (0) = 0 and u& (0) = 0
: own pulsation of the oscillator =
K
m

Critical damping is ccritic = 2m.

The solution for C = ccritic is:

(
F
U T)
0 [and
=
(1+ T
) - cos (T
)]
2k

C
The solution for a subcritical damping such as
= is:
ccritic
(
- T

F
F

F
U T) = E

0
(
cos

T
0
0
D) +
sin (T
D) -
(
cos T
)

2 K
2k

2 K
D

with
1 2
D =
-

2.2 Results of reference

Displacement and speed of the point B.

Displacement for critical damping
1,50E-04
1,00E-04
5,00E-05
)
(m 0,00E+00
U B
0
0,1
0,2
0,3
0,4

0,5
-5,00E-05
-1,00E-04
-1,50E-04
time (S)

Displacement for the damping of 1%
1,00E-02
5,00E-03
(m) 0,00E+00
U B
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
5
-5,00E-03
-1,00E-02
time (S)

Displacement for the damping of 0,001%
2,50E-02
2,00E-02
1,50E-02
1,00E-02
5,00E-03
(m) 0,00E+00
U B
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
5
-5,00E-03
-1,00E-02
-1,50E-02
-2,00E-02
-2,50E-02
time (S)

2.3
Uncertainty on the solution

Exact analytical solution.
Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

Code_Aster ®
Version
6.4

Titrate:
SDLD321 - Transitory dynamic response of a harmonic oscillator

3 Modeling
With

3.1
Characteristics of modeling

Discrete elements of rigidity, damping and mass.
y
. B
A.
X
N1
N2

Characteristics of the elements:

DISCRETE: nodal mass
M_T_D_N
rigidity
linear
K_T_D_L
damping
linear
A_T_D_L (c=ccritic)

Boundary conditions: with the node N1 DDL_IMPO DX = DY = DZ = 0.

Names of the nodes: P1 = N1, P2 = N2.

Methods of calculation:

.
Integration on the modal basis with Newmark (= 0,25, = 0,5)
No time T = 10-3 S

.

Integration on the modal basis with Euler
No time T = 10-3 S

Duration of observation: 0,5 S.

3.2
Characteristics of the grid

A number of nodes: 2

A number of meshs and type: 1 mesh SEG2

3.3
Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM
NET “K_T_D_L”

NET
“A_T_D_L”

NODE
“M_T_D_N”

MODE_ITER_SIMULT
OPTION: “CENTER”

! FORMULATE REAL

CALC_FONC_INTERP FUNCTION

DYNA_TRAN_MODAL NEWMARK
AMOR_GENE

EULER

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

---

4 Results of modeling A

4.1 Values tested

.
Displacement of the point B

Displacement displacement

Displacement

Time
Reference
NEWMARK
Difference
EULER
Difference
(S)
(m)
***Aster** (m)*
(%)
***Aster** (m)*
(%)
0,06
1,18914 E4
1,18886 E4 0,023 1,18886
E4

-0,024
0,12
9,42819 E5
9,42574 E5 0,026 9,47822
E5 0,531
0,19
9,97958 E5
9,97765 E5 0,019 9,96206
E5
-0,176
0,25
9,97748 E5
9,97526 E5 0,022 9,99152
E5
-0,141
0,31
9,78457 E5
9,78210 E5 0,025 9,83436
E5
0,509
0,38
9,88705 E5
9,88530 E5 0,018 9,84730
E5
-0,402
0,44
9,99961 E5
9,99754 E5 0,021 9,99525
E5
-0,044

.

Speed of the point B

Speed Speed
Speed

Time
Reference NEWMARK
Difference
EULER
Difference
(S)

(m.s-1)
***Aster** (m.s-1)*
(%)
***Aster** (m.s-1)*
(%)
0,03
3,31400 E3
3,31363 E3 0,011 3,32568
E3
0,353
0,09
5,13760 E3
5,13729 E3 0,006 5,13627
E3
-0,026
0,16
4,93337 E3
4,93354 E3 0,003
4,93088
E3
-0,050
0,22
5,00087 E3
5,00087 E3 0,000
-5,00133
E3
0,009
0,28
4,95298 E3
4,95284 E3 0,003 4,95297
E3
0,000
0,35
4,87813 E3
4,87836 E3 0,005
-4,87801
E3
-0,002
0,41
4,98415 E3
4,98423 E3 0,002
4,98409
E3

-0,001
0,47
4,99041 E3
4,99035 E3 0,001 4,99043
E3 0,000

4.2 Remarks

The results are tested on the level of the peaks for the grain of observation selected (10-2s) where values
are most significant.

The mode becomes quasi-permanent after the first period, it is what one must observe in carrying out a transitory analysis.

---

5 Modeling
B

5.1
Characteristics of modeling

Discrete elements of rigidity, damping and mass.
y
. B
A.

X
N1
N2

Characteristics of the elements:

DISCRETE: nodal mass
M_T_D_N
rigidity
linear K_T_D_L
damping
linear
A_T_D_L (C = 0,01 ccritic)

Boundary conditions: with the node N1 DDL_IMPO DX = DY = DZ = 0.

Names of the nodes: P1 = N1, P2 = N2.

Methods of calculation:

.
Integration on the modal basis with Fu-Devogelaere
No time T = 10-3s

.
Integration on the modal basis with T adaptive
No initial time T = 10-3s

Duration of observation: 5 S.

5.2 Characteristics of the grid

A number of nodes: 2

A number of meshs and type: 1 mesh SEG2

5.3
Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM
NET
“K_T_D_L”

NET
“A_T_D_L”

NODE
“M_T_D_N”

MODE_ITER_SIMULT
OPTION: “CENTER”

! FORMULATE REAL

CALC_FONC_INTERP FUNCTION

DYNA_TRAN_MODAL DEVOGE
AMOR_REDUIT

ADAPT
AMOR_GENE

8/12

6
Results of modeling B

6.1 Values
tested

.
Displacement of the point B

Displacement displacement

Displacement

Time
Reference DEVOG Difference
ADAPT
Difference
(S)
(m)
Aster *(m)*
(%)
Aster *(m)*
(%)
0,06
3,06503 E4
3,06503 E4 0,000 3,06481
E4
-0,007
0,13
5,93807 E4
5,93807 E4 0,000 5,93696
E4
-0,019
0,25
1,17872 E3
1,17872 E3 0,000 1,17862
E3
-0,009
0,69
2,91788 E3

2,91788 E3 0,000 2,91748
E3
-0,014
1,01
3,83901 E3
3,83901 E3 0,000 3,83548
E3
-0,092
2,32
6,68206 E3
6,68206 E3 0,000 6,68614
E3 0,061
3,64
8,19821 E3
8,19821 E3 0,000 8,20355
E3 0,065
4,96
9,00847 E3
9,00847 E3 0,000 9,01348
E3 0,056

.

Speed of the point B

Speed Speed

Speed

Time
Reference DEVOG Difference
ADAPT
Difference
(S)
(m.s-1)
***Aster** (m.s-1)*
(%)
***Aster** (m.s-1)*
(%)
0,04
8,95997 E3
8,95997 E3 0,000
8,97145
E3 0,128

0,10
2,33271 E2
2,33271 E2
0,000 -2,33492
E2
0,095
0,22
5,20590 E2
5,20590 E2
0,000 -5,21002
E2
0,079
0,66
1,40500 E1
1,40500 E1 0,000
1,40593
E1 0,066
1,04
1,99889 E1
1,99889 E1 0,000
1,99923
E1 0,017
2,36
3,39933 E1
3,39933 E1
0,000 -3,39703
E1
-0,068
3,68
4,10585 E1
4,10585 E1 0,000
4,09991
E1
-0,145
5,00
4,45309 E1
4,45309 E1
0,000 -4,42239
E1
-0,689

6.2 Remarks

The results are tested on the level of the peaks where the values are most significant.

The duration of selected observation makes it possible to see the effect of damping. However, in this interval, the response of the point B remains always transitory but one is close to steady operation whose scale of displacement is 10-2m.

---

7 Modeling
C

7.1
Characteristics of modeling

Discrete elements of rigidity, damping and mass.
y
. B
A.
X
N1
N2

Characteristics of the elements:

DISCRETE:
nodal mass

M_T_D_N
rigidity
linear K_T_D_L
damping
linear
A_T_D_L (C = 10-5 ccritic)

Boundary conditions: with the node N1 DDL_IMPO DX = DY = DZ = 0.

Names of the nodes: P1 = N1, P2 = N2.

Methods of calculation:

.
Integration on the modal basis with Newmark (= 0,25, = 0,5)
No time T = 10-3s

.
Integration on the modal basis with Euler
No time T = 10-3s

Duration of observation: 5 S.

7.2
Characteristics of the grid

A number of nodes: 2

A number of meshs and type: 1 mesh SEG2

7.3
Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM
NET “K_T_D_L”

NET
“A_T_D_L”

NODE

“M_T_D_N”

MODE_ITER_SIMULT
OPTION: “CENTER”

! FORMULATE REAL

CALC_FONC_INTERP FUNCTION

DYNA_TRAN_MODAL NEWMARK
AMOR_GENE

EULER

8
Results of modeling C

8.1 Values
tested

.

Displacement of the point B

Displacement displacement

Displacement

Time
Reference NEWMARK Difference
EULER
Difference
(S)
(m)
Aster (m)
(%)
Aster (m)
(%)
0,06
3,11105 E4
3,10936 E4 0,054 3,11181
E4
0,024
0,13
6,13250 E4
6,13016 E4 0,038 6,13380
E4
0,021
0,25
1,25380 E3
1,25304 E3 0,060 1,25418
E3
0,030
0,69
3,44945 E3
3,44691 E3 0,074 3,45069
E3
0,036
1,01
4,88729 E3
4,89081 E3 0,072 4,88547
E3
-0,037
2,32

1,12876 E2
1,12475 E2 0,355 1,13069
E2
0,171
3,64
1,77960 E2
1,77100 E2 0,484 1,78360
E2
0,225
4,96
2,43613 E2
2,42198 E2 0,581 2,44242
E2
0,258

.
Speed of the point B

Speed Speed

Speed

Time
Reference NEWMARK Difference
EULER
Difference
(S)
(m.s-1)
Aster (m.s-1)
(%)
Aster (m.s-1)
(%)
0,04
9,09284 E3
9,08897 E3 0,043 9,08230
E3
-0,116
0,10
2,39724 E2
2,39637 E2 0,036 2,40269
E2 0,227
0,22
5,49964 E2

5,49680 E2 0,052 5,48752
E2
-0,220
0,66
1,64958 E1
1,64879 E1 0,048 1,64882
E1
-0,046
1,04
2,56456 E1
2,56547 E1 0,035
2,57280
E1
0,321
2,36
5,79010 E1
5,80019 E1 0,174
-5,81033
E1
0,349
3,68
8,97631 E1
9,00729 E1 0,345
9,00668
E1
0,338
5,00 -1,21164 -1,21829
0,549 -1,21531
0,303

8.2 Remarks

The results are tested on the level of the peaks where the values are most significant.

In the interval of observation, one remains very in lower part of steady operation in resonance of which
the scale of displacement is 10 Mr.

Version
6.4

Titrate:
SDLD321 - Transitory dynamic response of a harmonic oscillator
Date:
17/02/04
Author (S):
E. BOYERE, T. QUESNEL Key
:
V2.01.321-A Page:
11/12

9
Summary of the results

As modeling A, as result obtained as well in displacement of speed have an error absolute largely lower than 1% compared to the analytical solution.

The diagram of integration of Newmark is shown more precise than the diagram of Euler.

To 1% of damping criticizes (modeling B), the diagram of Fu-Devogelaere integration is of one frightening precision (not of error compared to the reference solution).

The diagram with step of adaptive time also gives results to very small percentage of error.

For very weak depreciation (modeling C), one will note a better precision for diagram of integration of the Euler type that for a diagram of the Newmark type. For this last, the error increase according to time but remains lower than 1% all the same.

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

Code_Aster ®
Version
6.4

Titrate:
SDLD321 - Transitory dynamic response of a harmonic oscillator
Date:
17/02/04
Author (S):

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Titrate:
SDLD325 - Transitory dynamic response of a system mass-arises
Date:
16/02/04
Author (S):
E. BOYERE, T. QUESNEL Key
:
V2.01.325-A Page:
1/10

Organization (S): EDF-R & D /AMA, IRCN

Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
V2.01.325 document

SDLD325 - Transitory dynamic response of one
system mass-arises deadened to 2 ddl

Summary:

This problem consists in analyzing the dynamic response of a system made up of a unit of mass-spring-shock absorbers with 2 ddl from which the stiffnesses of the springs are very different under excitation from crenel type in 1 ddl.

Via this problem, one tests the sensitivity of diagrams of integration on physical space (DYNA_LINE_TRAN [U4.53.02]) or modal space (DYNA_TRAN_MODAL [U4.53.21]) with respect to the report/ratio of rigidities.

The results in displacement and speed are compared with an average of results coming from codes industrialists and of a method of integration numerical of type - Newmark improved.

1
Problem of reference

1.1 Geometry

y, v
K
C
K
B
1
2
With
m
m
F
X, U
0 (T)
C
C

T (S)
0
1

1.2
Material properties

Stiffnesses of connection: K = 28.103 N.m1

2 cases:

.

k1 = k/10, k2 = 10k

.

k1 = 10k, k2 = k/10

Specific mass: m = 10 kg

One-way viscous damping: C = 50 kg.s1

1.3
Boundary conditions and loadings

Embedded end A.

(T) = 1 if 0 T S

1
Force applied at end b: F (T) = F0 (T) with
and F0 = 5N.

(T) = 0 if not

1.4 Conditions
initial

The system is at rest with T = 0: (
U)
0 = 0 and
( )
0 = 0 .
dt

2
Reference solution

2.1
Method of calculation used for the reference solution

The research of the transitory response of this problem to damping nonproportional can be carried out by numerical integration in real space:

[M] {u&} + [C] {u&} + [K] {U} = {F
N
N
N
}.

For that, the answer was calculated with two industrial codes:

.
PERMAS: Diagram of integration of Newmark (= 0,25 and = 0,5) T = 104s;
.
ABAQUS: Diagram of integration of Hilbert-Hugues-Taylor [bib1] (= 0,05) T = 104s;

and method of integration of - Newmark improved [bib2]:

[M] [C] [K]

+
+

+

+

+
+

{
F
F
F
2 M
K
U
N2
N 1
N
n+2}
{
} {
} { }
[ ] [ ]
=
+
-

{U
n+}
t2
2t
3
3

t2
1
3

[M] [C] [K]
+ -
+
-

{U
N}

t2
2t
3

where N, n+1, n+2 respectively indicate the calculations carried out at times tn, tn+1 = tn+t and tn+2 = tn+2t
where T is the increment of appointed time.

To start, one takes:

.
u0 and U 1 = U
-
0 - T
u&0
.
F
2F
F
- =
-
1
0
1

The step of adopted time is T = 105s.

2.2
Results of reference

Displacement and speed of the point end B.

Displacement of the point B for k2/k1=100
3,20E-03
2,40E-03
1,60E-03
(m) 8,00E-04
U B
0,00E+00
0,00
0,50
1,00
1,50

2,00
2,50
3,00
-8,00E-04
-1,60E-03
time (S)

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V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

Displacement of the point B for k2/k1=0,01
3,00E-03
2,50E-03
2,00E-03
1,50E-03
1,00E-03
(m)
***U B** 5,00E-04*
0,00E+00
0,00
0,50
1,00
1,50
2,00
2,50
-5,00E-04
-1,00E-03
-1,50E-03
time (S)

2.3 Uncertainty on the solution

Average of numerical solutions.

2.4 References bibliographical

[1]
H.M. HILBERT, T.J.R HUGUES and R.L. TAYLOR "Improved numerical dissipation for time integration algorithms in structural dynamics" Earthquake Structural Engineering and Dynamics, Vol.5, 1977, pp. 283-292
[2]
Structural N.M. NEWMARK "A method of computation for dynamics" Proceeding ASCE J.Eng.Mech. DIV E-3, July 1959, pp. 67-94

---

3 Modeling With

3.1 Characteristics of modeling

Discrete elements of rigidity, damping and mass.

y
B
C
A.
.
.
X
N1

N2
N3

Characteristics of the elements:

DISCRETE: nodal mass
M_T_D_N
rigidity
linear
K_T_D_L (kN1N2 = k/10, kN2N3 = 10k)
damping
linear
A_T_D_L

Boundary conditions: with the node N1 DDL_IMPO DX = DY = DZ = 0.

Names of the nodes: With = N1, C = N2, B = N3.

Methods of calculation:

.
Integration on physical space with Newmark (= 0,25, = 0,5)
No time T = 103s

.
Integration on the modal basis supplements with Euler
No time T = 103s then modal recombination

.
Integration on the modal basis supplements with T adaptive
No initial time T = 103s then modal recombination

Duration of observation: 3 S.

3.2
Characteristics of the grid

A number of nodes: 3

A number of meshs and type: 2 meshs SEG2

3.3
Functionalities tested

Orders

DISCRETE AFFE_CARA_ELEM
NET "K_T_D_L"

NET
"A_T_D_L"

NODE
"M_T_D_N"

MODE_ITER_SIMULT
OPTION: "CENTER"

DYNA_LINE_TRAN NEWMARK

MATR_AMOR

DYNA_TRAN_MODAL EULER

AMOR_GENE

ADAPT

REST_BASE_PHYS

4
Results of modeling A

4.1 Values
tested

.
Displacement (m) of the point B

Displacement displacement
Displacement
Time Reference
***Aster** Difference*
***Aster** Difference*
***Aster** Difference*
(S)
NEWMARK
(%)
EULER
(%)
ADAPT
(%)
0,27 3,0927 E-3 3,09263 E-3
-0,002
3,09254 E-3
-0,005
3,09278 E-3
0,003
0,53 8,7953 E-4 8,79902 E-4
0,042
8,79515 E-4
-0,002
8,79583 E-4
0,006
0,80 2,4669 E-3 2,46677 E-3
-0,005
2,46666 E-4

-0,010
2,46688 E-4
-0,001
1,25 -1,0980 E-3 -1,09829 E-3
0,026
-1,09248 E-4
-0,502
-1,09844 E-4
0,040
1,51 7,8754 E-4 7,87625 E-4
0,011
7,82702 E-4
-0,614
7,87760 E-4
0,028
1,78 -5,6508 E-4 -5,65131 E-4
0,009
-5,61709 E-4
-0,597
-5,65265 E-4
0,033
2,05 4,0502 E-4 4,05155 E-4
0,033
4,02581 E-4
-0,602
4,05168 E-4
0,037
2,31 -2,9012 E-4 -2,90070 E-4
-0,017
-2,88252 E-4
-0,644
-2,90192 E-4
0,025
2,58 2,0831 E-4 2,08323 E-4
0,006
2,06960 E-4
-0,648
2,08376 E-4
0,032
2,85 -1,4943 E-4 -1,49462 E-4
0,022
-1,48425 E-4
-0,672

-1,49477 E-4
0,032

.
Speed (m.s1) of the point B

Speed Speed Speed
Time Reference
***Aster** Difference*
***Aster** Difference*
***Aster** Difference*
(S)
NEWMARK
(%)
EULER
(%)
ADAPT
(%)
0,11 1,8347 E-2 1,82400 E-2
-0,583
1,84067 E-2
0,326
1,83510 E-2
0,022
0,39 -1,3140 E-2 -1,31120 E-2
-0,213
1,31472 E-2
0,055
-1,31407 E-2
0,006
0,66 9,3509 E-3 9,34550 E-3
-0,058
9,36556 E-3
0,157
9,35335 E-2
0,026
0,93 -6,7080 E-3 -6,71303 E-3
0,075
-6,70399 E-3
-0,060
-6,70788 E-3
-0,002
1,11 -1,5863 E-2 -1,57872 E-2

-0,478
-1,57871 E-2
-0,478
-1,58789 E-2
0,100
1,37 1,1157 E-2 1,12034 E-2
0,416
1,10701 E-2
-0,779
1,11521 E-2
-0,044
1,64 -7,9838 E-3 -7,97210 E-3
-0,147
-7,94957 E-3
-0,429
-7,98789 E-3
0,051
1,90 5,7108 E-3 5,71217 E-3
0,024
5,67244 E-3
-0,672
5,71139 E-3
0,010
2,17 -4,0998 E-3 -4,09898 E-3
-0,020
-4,07584 E-3
-0,584
-4,10120 E-3
0,034
2,44 2,9405 E-3 2,94126 E-3
0,026
2,92375 E-3
-0,576
2,94154 E-3
0,035
2,71 -2,1073 E-3 -2,10817 E-3
0,041
-2,09494 E-3
-0,586
-2,10808 E-3
0,037
2,97 1,5105 E-3 1,51036 E-3
-0,009

1,50087 E-3
-0,638
1,51084 E-3
0,022

4.2 Remarks

The results are tested on the level of the respective peaks of displacement and speed where values are most significant.

---

5 Modeling
B

5.1
Characteristics of modeling

Discrete elements of rigidity, damping and mass.

y
B
C
A.
.
.
X
N1

N2
N3

Characteristics of the elements:

DISCRETE: nodal mass
M_T_D_N
rigidity
linear
K_T_D_L (kN1N2 = 10k, kN2N3 = k/10)
damping
linear
A_T_D_L

Boundary conditions: with the node N1 DDL_IMPO DX=DY=DZ=0.

Names of the nodes: With = N1, C = N2, B = N3.

Methods of calculation:

.
Integration on physical space with Newmark (= 0,25, = 0,5)
No time T = 103s

.
Integration on the modal basis supplements with Euler
No time T = 103s then modal recombination

.
Integration on the modal basis supplements with T adaptive
No initial time T = 103s then modal recombination

Duration of observation: 2,5 S.

5.2
Characteristics of the grid

A number of nodes: 3

A number of meshs and type: 2 meshs SEG2

5.3 Functionalities
tested

Orders

DISCRETE AFFE_CARA_ELEM
NET “K_T_D_L”

NET
“A_T_D_L”

NODE
“M_T_D_N”

MODE_ITER_SIMULT
OPTION: “CENTER”

DYNA_LINE_TRAN NEWMARK

MATR_AMOR

DYNA_TRAN_MODAL EULER

AMOR_GENE

ADAPT

REST_BASE_PHYS

6
Results of modeling B

6.1 Values
tested

.
Displacement (m) of the point B

Displacement displacement
Displacement
Time Reference
Aster Difference
Aster Difference
Aster Difference
(S)
NEWMARK
(%)
EULER
(%)
ADAPT
(%)
0,19 2,9334 E-3 2,93325 E-3
-0,005
2,93308 E-3
-0,011
2,93355 E-3
0,005
0,38 1,0959 E-3 1,09605 E-3
0,014
1,09625 E-3
0,032
1,09573 E-3
-0,015
0,57 2,2468 E-3 2,24664 E-3
-0,007
2,24647 E-3

-0,015
2,24690 E-3
0,005
0,76 1,5260 E-3 1,52615 E-3
0,010
1,52627 E-3
0,017
1,52595 E-3
-0,003
0,95 1,9773 E-3 1,97725 E-3
-0,002
1,97718 E-3
-0,006
1,97739 E-3
0,005
1,19 -1,2107 E-3 -1,21113 E-3
0,036
-1,20839 E-3
-0,191
-1,21142 E-3
0,060
1,38 7,5880 E-4 7,59030 E-4
0,030
7,56994 E-4
-0,238
7,59422 E-4
0,082
1,57 -4,7553 E-4 -4,75637 E-4
0,023
-4,74180 E-4
-0,284
-4,75974 E-4
0,093
1,76 2,9796 E-4 2,98011 E-4
0,017
2,97002 E-4
-0,322
2,98273 E-4
0,105
1,95 -1,8668 E-4 -1,86695 E-4
0,008
-1,86012 E-4
-0,358

-1,86890 E-4
0,113
2,14 1,1694 E-4 1,16943 E-4
0,002
1,16489 E-4
-0,385
1,17076 E-4
0,116
2,33 -7,3246 E-5 -7,32415 E-5
-0,006
-7,29453 E-5
-0,411
-7,33309 E-5
0,116

.

Speed (m.s1) of the point B

Speed Speed Speed
Time Reference
Aster Difference
Aster Difference
Aster Difference
(S)
NEWMARK
(%)
EULER
(%)
ADAPT
(%)
0,09 2,4261 E-2 2,42719 E-2
0,045
2,42772 E-2
0,067
2,42563 E-2
-0,019
0,28 -1,5210 E-2 -1,52159 E-2
0,039
-1,52111 E-2
0,007
-1,52087 E-2
-0,009
0,47 9,5332 E-3 9,53598 E-3

0,029
9,52994 E-3
-0,034
9,53446 E-3
0,013
0,66 -5,9745 E-3 -5,97590 E-3
0,023
-5,97018 E-3
-0,072
-5,97614 E-3
0,028
0,85 3,7438 E-3 3,74438 E-3
0,015
3,73979 E-3
-0,107
3,74519 E-3
0,037
1,08 -2,6037 E-2 -2,60274 E-2
-0,037
-2,59908 E-2
-0,177
-2,60402 E-2
0,012
1,27 1,6302 E-2 1,62945 E-2
-0,046
1,62664 E-2
-0,218
1,63040 E-2
0,013
1,46 -1,0204 E-2 -1,01990 E-2
-0,049
-1,01797 E-2
-0,238
-1,02065 E-2
0,024
1,66 6,3887 E-3 6,39331 E-3
0,072
6,37778 E-3
-0,171
6,39477 E-3
0,095
1,85 -4,0059 E-3 -4,00851 E-3
0,065

3,99659 E-3
-0,232
-4,01048 E-3
0,114
2,04 2,5114 E-3 2,51292 E-3
0,061
2,50425 E-3
-0,285
2,51465 E-3
0,130
2,23 -1,5743 E-3 -1,57516 E-3
0,055
-1,56902 E-3
-0,355
-1,57652 E-3
0,141
2,42 9,8676 E-4 9,87206 E-4
0,045
9,82986 E-4
-0,382
9,88220 E-4
0,148

6.2 Remarks

The results are tested on the level of the respective peaks of displacement and speed where values are most significant.

7
Summary of the results

For two modelings, the results are precise with an error lower than 1%.

Integration on modal basis with a diagram with adaptive step gives the best results for one restricted computing time.

For information, here various times CPU To use used for the resolution of modelings A and B.

CPU To use
DYNA_LINE_TRAN DYNA_TRAN_MODAL DYNA_TRAN_MODAL
(dryness) (NEWMARK) (EULER) (Adaptive)
Modeling A
69,82
0,50 *
0,81 *
Modeling B
57,29
0,42 *
0,50 *

(*): MODE_ITER_SIMULT = 0,23 S: computing time of the modal base to add.

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Handbook of Validation
V2.01 booklet: Linear dynamics of the discrete systems
HT-66/04/005/A

Code_Aster ®
Version
4.0
Titrate:
SDLL01 short Beam on simple supports
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.001-C Page:
1/8
Organization (S): EDF/IMA/MMN
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.001 document
SDLL01 - Short beam on simple supports

Summary:
This two-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure
composed of a beam in simple supports at its two ends. This case test of Mechanics of the Structures corresponds to a dynamic analysis of a linear model having a linear behavior. One studies
the influence of the position of the points considered as points of supports (points on neutral fibre or points
offset at the base of the beam) compared to neutral fibre of a thick beam.
This test which comprises only one modeling, makes it possible to test part of the functionalities which concern the beams of Timoshenko, the connections rigid and the search for Eigen frequencies by iterations
opposite.
Results obtained, either with the points of supports on neutral fibre, or with the points of offset supports
are compared with results VPCS. In the second configuration, the reference solution is an average results of several software packages.
When the points of supports are offset, one observes a coupling between the various modes of traction and compression and of inflection.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

1
Problem of reference

1.1 Geometry

y
y
y
With
With
B

B

H
X
Z
X
C
D
X, U
B
L
L
Rectangular cross-section:
height:
H = 0.2 m
width:
B = 0.1 m
surface:
To = 2.102 m2
inertia:
lz = 6.667 105
shearing:
Ay = Az = 1.17692
torsion:
Jx = 0.45776042 104
Length of the beam
L: 1. m
Co-ordinates of the points (m):
With
B
C
D
X
0.
1.
0.
1.
y
0.
0.
0.1
0.1
1.2

Material properties
E = 2.1011 Pa
= 0.3
= 7.800. kg/m3
1.3
Boundary conditions and loadings
Problem 1:
Not A
U = v = 0.
Not B
v = 0.
Problem 2:
Not C
U = v = 0.
Not D
v = 0.
1.4 Conditions
initial
Without object for the modal analysis.

2
Reference solution
2.1
Method of calculation used for the reference solution
The reference solution is that given in card SDLL01/89 of the guide VPCS which presents method of calculation in the following way:
Problem 1: Analytical calculation
The equation of inflection of the nonslim beams gives the formulation of Timoshenko, in

superimposing the effects of the pure bending, deformations of shearing action and the inertia of rotation.
The Eigen frequencies of reference are determined by a digital simulation of this equation, independent of any software package.
The Eigen frequencies in traction and compression are given by:

E
2 -
I
(I) 1
F =
with
=

I = 1 2
, ,...
I
2 L
I

2
Problem 2:
The problem not having an analytical solution, the solution is established by average of several software package: model of Timoshenko with effect of the deformations of shearing action and inertia of
rotation.
The modes of inflection and traction and compression are coupled.
2.2
Results of reference
Problem 1: the first 6 clean modes.
Problem 2: the first 5 clean modes.
2.3
Uncertainty on the solution
Problem 1: analytical solution. `
Problem 2: ± 0.1%
2.4 References
bibliographical
[1]
S.P. TIMOSHENKO, D.H. YOUNG, W. WEAVER. Problems vibrations in Engineering. New York: Wiley & Sounds, 4° edition, p. 415 (1974).

3 Modeling With

3.1 Characteristics of modeling

One uses the element of right beam of Timoshenko: POU_D_T

y
y
B
B
With
With
X
X
C
D

Problem 1:

Cutting:
beam AB: 40 meshs SEG2
Limiting conditions:
in all the nodes
DDL_IMPO: (GROUP_NO: AB DZ: 0. , DRX: 0, DRY: 0.)
in a:
(NODE: WITH DX: 0. , DY: 0.)
in b:
(NODE: B DY: 0.)

Problem 2:

Cutting:
beam AB: 40 meshs SEG2
2 rigid elements AC, BC: 2 meshs SEG2
Limiting conditions:
in all the nodes

DDL_IMPO: (ALL: “YES” DZ: 0. , DRX: 0, DRY: 0.)
out of C:
(NODE: C DX: 0. , DY: 0.)
in D:
(NODE: D DY: 0.)
Names of the nodes:
Not A = N100
Not C = N300
Not B = N200
Not D = N400

3.2
Characteristics of the grid

A number of nodes:
43
A number of meshs and types:
42 SEG2

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
BEAM
“GENERAL”
ALL
[U4.24.01]
GROUP_MA
“RIGHT-ANGLED”
GROUP_MA
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
GROUP_NO
NODE
AFFE_MATERIAU
GROUP_MA
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_T”
ALL
[U4.22.01]
GROUP_MA

DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
CALC_FREQ
OPTION
“ADJUSTS”
[U5.23.01]
FREQ

3.4 Remarks

Definition of the rigid beams AC and data base:
· Section: Hy = 0.2, Hz = 0.2.
· Matériau: E = 2.1016, = 0.

4
Results of modeling A

4.1 Values
tested

Frequency (Hz)
Clean mode
Reference
Aster
% difference
Problem 1
inflection 1
431.555
431.8916
0.078

traction 1
1265.924
1266.0056
0.006
inflection 2
1498.295
1500.7635
0.165
inflection 3
2870.661
2873.5344
0.100
traction 2
3797.773
3799.9692
0.058
inflection 4
4377.837
4370.8206
0.160

Problem 2

1
392.8 ±2.7%
394.4774
0.427
coupling 2
922.2 ±5.7%
922.6072
0.044
inflection 3
1592.0 ±2.9%
1638.2311
2.903
traction 4
2629.2 ±5.7%
2778.7000
5.686
compression 5
3126.2 ±4.3%
3261.6699
4.333

4.2 Remarks

Calculations carried out by:

Problem 1:
MODE_ITER_INV OPTION: LIST_FREQ “ADJUSTS”: (430. , 4500.)
Problem 2:
MODE_ITER_INV OPTION: LIST_FREQ “ADJUSTS”: (380. , 3300.)

Contents of the file results:

Problem 1:
the first 6 Eigen frequencies, clean vectors and modal parameters.
Problem 1:
the first 5 Eigen frequencies, clean vectors and modal parameters.

4.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 Megawords
Time CPU To use:
9.7 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

POU_D_TG
y
y
B

B
With
With
X
X
C
D

Problem 1:

Cutting:
beam AB: 40 meshs SEG2
Limiting conditions:
in all the nodes
DDL_IMPO: (GROUP_NO: AB DZ: 0. , DRX: 0, DRY: 0.)
in a:
(NODE: WITH DX: 0. , DY: 0.)
in b:
(NODE: B DY: 0.)

Problem 2:

Cutting:
beam AB: 40 meshs SEG2
2 rigid elements AC, data base: 2 meshs SEG2
Limiting conditions:
in all the nodes
DDL_IMPO: (ALL: “YES” DZ: 0. , DRX: 0, DRY: 0.)
out of C:
(NODE: C DX: 0. , DY: 0.)
in D:
(NODE: D DY: 0.)
Names of the nodes:
Not A = N100
Not C = N300
Not B = N200
Not D = N400

5.2

Characteristics of the grid

A number of nodes:
43
A number of meshs and types:
42 SEG2

5.3 Functionalities
tested
Orders
Keys

AFFE_CARA_ELEM
BEAM
“GENERAL”
ALL
[U4.24.01]
GROUP_MA
“RIGHT-ANGLED”
GROUP_MA
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
GROUP_MA
NODE
AFFE_MATERIAU
GROUP_MA
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_TG”
ALL
[U4.22.01]
GROUP_MA
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
“ADJUSTS”
[U4.52.01]

5.4 Remarks

Definition of the rigid beams AC and data base:
· Section: Hy = 0.2, Hz = 0.2.
· Matériau: E = 2.1016, = 0.

07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.001-C Page:
7/8
6
Results of modeling B
6.1 Values
tested
Frequency (Hz)
Clean mode
Reference
Aster
% difference
Problem 1
inflection 1
431.555
431.8916
0.078
traction 1
1265.924
1266.0056
0.006
inflection 2
1498.295
1500.7635
0.165
inflection 3
2870.661
2873.5344
0.100
traction 2
3797.773
3799.9692
0.058
inflection 4
4377.837
4370.8206
0.160
Problem 2
1
392.8 ±2.7%

394.4774
0.427
coupling 2
922.2 ±5.7%
922.6072
0.044
inflection 3
1592.0 ±2.9%
1638.2311
2.903
traction 4
2629.2 ±5.7%
2778.7000
5.686
compression 5
3126.2 ±4.3%
3261.6699
4.333

6.2 Remarks

Calculations carried out by:
Problem 1:
ITERATIONS_INVERSES OPTION: LIST_FREQ “ADJUSTS”: (430. , 4500.)
Problem 2:
ITERATIONS_INVERSES OPTION: LIST_FREQ “ADJUSTS”: (380. , 3300.)

Contents of the file results:

Problem 1:
the first 6 Eigen frequencies, clean vectors and modal parameters.
Problem 1:
the first 5 Eigen frequencies, clean vectors and modal parameters.

6.3 Parameters
of execution

Version: 3.06
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 Megawords
Time CPU To use:
1.1875E+1 seconds

---

7 Summary of the results

The problem without eccentricity is correctly dealt with.
With eccentricity, the problem is dealt with with a dispersion from 3 to 6% by various software packages. Aster
remain in this fork.

Organization (S): EDF/AMA, DeltaCAD

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.002 document

SDLL02 - Beam hurled, embed-free,
folded up on it even

Summary:

This two-dimensional problem consists in seeking the frequencies and the modes of vibration of a structure
mechanics, made up of a hurled, embedded beam free and folded up on itself.

The problem arising does not have physical significance. It on the other hand makes it possible to validate the research of
Eigen frequencies of inflection multiples and the research of the modes double in a subspace of order 2.

In this test, one carries out three different modelings:

· in the first modeling, the boundary conditions are imposed using parameters of
Lagrange (order AFFE_CHAR_MECA) and the clean values and vectors are calculated by
method of Lanczos (order MODE_ITER_SIMULT, method: "TRI_DIAG"),
· in the second modeling, the boundary conditions are imposed by removing degrees
of freedom in the matrices of mass and stiffness (order AFFE_CHAR_CINE) and the values and
clean vectors are calculated by the method of Bathe and Wilson (order MODE_ITER_SIMULT,
method: "JACOBI"),
· in the third modeling, one checks the behavior of modeling COQUE_C_PLAN in
dynamics. The eigenvalues and the clean modes are calculated with the order
MODE_ITER_SIMULT and with the method of SORENSEN.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams

HT-66/02/001/A

1
Problem of reference

1.1 Geometry

y
y, v
y
With
B
H

C
X
Z
X, U
B
L

The geometrical characteristics of the beam constituting the mechanical model are as follows:

Length: L = 0.5 m

Rectangular cross-section:

Height:
H = 0.005 m
Width:
B = 0.050 m
Surface:
To = 2.5 104 m2
Moment of inertia:
Iz = 5.208 1010 m4

The co-ordinates (in meters) of the points characteristic of the whole of the beams are:

WITH B
C
X 0.
0.5
0.
y 0.
0. 0.

1.2
Material properties

The properties of material constituting the beam are:

E = 2.1 1011 Pa

= 0.3

= 7.800. kg/m3

1.3
Boundary conditions and loadings

The boundary condition which characterizes this problem is the embedding of point A and is written:

U = v = 0. , = 0.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLL02/89 of the guide VPCS which presents method of calculation in the following way:

By the method of stiffness dynamic, one shows that the folded up beam admits frequencies double, solution of:
cos
() = 0

I = 2
(I -1) 2
2

E I
F
I
Z
I = 1
I =1, 2,…
2 L2
With

For a rectangular section, one obtains:

E
F

(
) 2
I = 2 I - 1 R
I = 1, 2,…
8 L2
12

This formulation neglects the deformations of shearing action and inertia of rotation (beam of Euler-Bernoulli).

For the clean modes, the forms are given in guide VPCS. They are normalized to 1 or 1 with not greater amplitude. There are results only for modes 1, 2, 3, 4, 7 and 8. By example, the forms of the first two clean modes are as follows:

1
1
0.707
0.707
mode 1
F
mode 2
1 = 11.76 Hz

2.2
Results of reference

The results of reference are the first eight Eigen frequencies and displacements of the points B, C for the clean modes 1, 2, 3, 4, 7 and 8. In Code_Aster, the modes are normalized to 1 with not greater amplitude (order NORM_MODE). To be able to make comparisons with the results of reference, the latter were corrected (multiplication by 1 if necessary).

2.3
Uncertainty on the solution

There is no uncertainty on the solution because it is analytical.

2.4 References
bibliographical

[1]
PIRANDA J.: Run and Directed Work of Vibrations of the Structures - Mechanical Option - École Nationale Supérieure of Mechanics and Micromechanics - Laboratory of Mechanics Applied - Besancon (France (1983).)

---

3 Modeling
With

3.1
Characteristics of modeling

y
B
With
X
C

The beam in 20 meshs SEG2 was cut out (10 for part AB and 10 for part BC).

The modeling used for the beams is that of Euler Bernoulli (POU_D_E).

Two-dimensional solutions are sought. One can thus block for all the nodes it displacement DZ and rotations DRX and DRY.

The end of the beam (not A) is embedded from where in this point:

DX = DY = 0. DRZ = 0.

3.2
Characteristics of the grid

The grid contains 21 nodes and 20 meshs of the type SEG2.

The points characteristic of the grid are as follows:

Not A = A
Not B = B
Not C = C

3.3 Functionalities
tested

The functionalities tested are summarized in this table:

Orders

AFFE_CARA_ELEM
BEAM
“RIGHT-ANGLED”
ALL

AFFE_CHAR_MECA
DDL_IMPO
ALL

NODE

AFFE_MATERIAU
ALL

AFFE_MODELE
“MECHANICAL”
“POU_D_E”
ALL

RECU_CHAMP
“NUMERO_ORDRE”
“DEPL”

DEFI_MATERIAU
ELAS

MODE_ITER_SIMULT
METHOD
“TRI_DIAG”

CALC_FREQ
OPTION
“PLUS_PETITE”

NORM_MODE
“TRAN”

One insists on orders MODE_ITER_SIMULT (method of Lanczos) for the calculation of the modes clean and AFFE_CHAR_MECA for the imposition of the boundary conditions.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SDLL02 - Beam hurled, embed-free, folded up on it even
Date:
19/08/02
Author (S):
P. MASSIN, F. LEBOUVIER Key
:
V2.02.002-B Page:
5/10

4
Results of modeling A

4.1 Values
tested

For the frequencies of vibration of the structure, there are the following results:

Identification Reference Aster %

difference
Frequency 1
11.76
11.7642
0.04
Frequency 2
11.76
11.7642
0.04
Frequency 3
105.88
105.8811
0.00
Frequency 4
105.88
105.8812
0.00
Frequency 5
294.10
294.1780
0.03
Frequency 6
294.10
294.1806
0.03
Frequency 7
576.44
576.9802
0.09
Frequency 8
576.44
577.0079
0.10

For the modes of vibration of the structure, there are the following results:

Identification Points
Size Reference
Aster %
difference
Frequency 1
B

DY
-0.707
-0.69845
-1.2
C
DY
1.
1.
Frequency 2
B
DY
0.707
0.72615
2.7
C
DY
1.
1.
Frequency 3
B
DY
0.707
0.70711
0.01
C
DY
1.
1.
Frequency 4
B
DY
-0.370
-0.37015
0.04
C
DY
0.523
0.52347
0.09
Frequency 7
B
DY
0.707

0.70711
0.02
C
DY
1.
1.
Frequency 8
B
DY
-0.388
-0.38847
0.12
C
DY
0.549
0.54937
0.07

4.2 Remarks

For the Eigen frequencies, the results obtained are correct. It is the same for the results obtained concerning the clean modes. The tolerance is lower than 2% for the whole of the modes except for the mode 2 where the tolerance lies between 2 and 3%.

4.3 Parameters of execution

Version: NEW 3.03.09
Machine: CRAY C90

Obstruction memory:
8 MW
Time CPU To use:
5 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

---

5 Modeling B

5.1 Characteristics of modeling

y
B
With
X
C

The beam in 20 meshs SEG2 was cut out (10 for part AB and 10 for part BC).

The modeling used for the beams is that of Euler Bernouilli (POU_D_E).

Two-dimensional solutions are sought. One can thus block for all the nodes it displacement DZ and rotations DRX and DRY.

The end of the beam (not A) is embedded from where in this point:

DX = DY = 0. DRZ = 0.

5.2 Characteristics of the grid

The grid contains 21 nodes and 20 meshs of the type SEG2.

The points characteristic of the grid are as follows:

Not A = A
Not B = B
Not C = C

5.3 Functionalities tested

The functionalities tested are summarized in this table:

Orders

AFFE_CARA_ELEM
BEAM
“RIGHT-ANGLED”
ALL

AFFE_CHAR_CINE
MECA_IMPO
ALL

NODE

AFFE_MATERIAU
ALL

AFFE_MODELE
“MECHANICAL”
“POU_D_E”
ALL

RECU_CHAMP
“NUMERO_ORDRE”
“DEPL”

DEFI_MATERIAU
ELAS

MODE_ITER_SIMULT
METHOD
“JACOBI”

CALC_FREQ
OPTION
“PLUS_PETITE”

NORM_MODE
“TRAN”

One insists on orders MODE_ITER_SIMULT (method of Bathe and Wilson) for the calculation of clean modes and AFFE_CHAR_CINE for the imposition of the boundary conditions.

6
Results of modeling B

6.1 Values tested

For the frequencies of vibration of the structure, there are the following results:

Identification Reference Aster % difference
Frequency 1
11.76

11.7642
0.04
Frequency 2
11.76
11.7642
0.04
Frequency 3
105.88
105.8811
0.00
Frequency 4
105.88
105.8812
0.00
Frequency 5
294.10
294.1780
0.03
Frequency 6
294.10
294.1806
0.03
Frequency 7
576.44
576.9802
0.09
Frequency 8
576.44
577.0079
0.1

For the modes of vibration of the structure, there are the following results:

Identification Points
Size Reference
***Aster** %*
difference
Frequency 1
B
DY
-0.707
-0.69658

-1.47
C
DY
1.
1.
Frequency 2
B
DY
0.707
0.73038
3.31
C
DY
1.
1.
Frequency 3
B
DY
0.707
0.70711
0.02
C
DY
1.
1.
Frequency 4
B
DY
-0.370
-0.37014
0.04
C
DY
0.523
0.52347
0.09
Frequency 7
B
DY
0.707
0.70711
0.02
C

DY
1.
1.
Frequency 8
B
DY
-0.388
-0.38846
0.12
C
DY
0.549
0.54937
0.07

6.2 Remarks

For the Eigen frequencies, the results obtained are correct. It is the same for the results obtained concerning the clean modes. The tolerance is lower than 2% for the whole of the modes except for the mode 2 where the tolerance lies between 3 and 4%.

6.3 Parameters of execution

Version: NEW 3.03.09
Machine: CRAY C90

Obstruction memory:
8 MW
Time CPU To use:
5 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SDLL02 - Beam hurled, embed-free, folded up on it even

7 Modeling C

7.1 Characteristics of modeling

y
B
With
X
C

The beam in 20 meshs SEG3 was cut out (10 for part AB and 10 for part BC).

Modeling used is COQUE_C_PLAN.

The end of the beam (not A) is embedded from where in this point:

DX = DY = DRZ = 0.

7.2 Characteristics of the grid

The grid contains 41 nodes and 20 meshs of the type SEG3.

The points characteristic of the grid are as follows:

Not A = A
Not B = B
Not C = C

7.3 Functionalities

tested

The functionalities tested are summarized in this table:

Orders

AFFE_CARA_ELEM
HULL
THICK
AFFE_MODELE
"MODELING"
"COQUE_C_PLAN"
MODE_ITER_SIMULT
METHOD
"SORENSEN"
CALC_FREQ
OPTION
"PLUS_PETITE"
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

8
Results of modeling C

8.1 Values
tested

For the frequencies of vibration of the structure, there are the following results:

Identification	***Reference***	***Aster***	***% difference***
Frequency 1	*11.76*	*11.767*	*0.063*
Frequency 2	*11.76*	*11.804*	*0.377*
Frequency 3	*105.88*	*106.533*	*0.616*
Frequency 4	*105.88*	*107.556*	*1.583*
Frequency 5	*294.10*	*299.685*	*1.899*
Frequency 6	*294.10*	*304.643*	*3.585*
Frequency 7	*576.44*	*599.025*	*3.918*
Frequency 8	*576.44*	*613.506*	*6.430*

For the modes of vibration of the structure, there are the following results:

Identification Points

Size Reference
***Aster** %*
difference
Frequency 1
B
DY
-0.707
-0.707
0.015
C
DY
1.
1.
0.
Frequency 2
B
DY
0.707
0.707
0.015
C
DY
1.
1.
0.
Frequency 3
B
DY
0.707
0.707
0.015
C
DY
1.
1.
0.
Frequency 4
B
DY
-0.370
-0.373
0.713
C

DY
0.523
0.527
0.763
Frequency 7
B
DY
0.707
0.707
0.015
C
DY
1.
1.
0.
Frequency 8
B
DY
-0.388
-0.403
3.990
C
DY
0.549
0.571
3.936

8.2 Remarks

In this case-test, where the results are independent of the Young modulus, it is not necessary of to modify the Young modulus retained for modeling, as in the case of the static analysis linear, to take account of the real width of the beam.

8.3 Parameters of execution

Version: NEW 5.04.17
Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use:
2.49 seconds
Handbook of Validation

9
Summary of the results

· Modélisations A and B of the Beam type:
The problem is dealt with with very good precision on the first eight frequencies (tolerance < 0.1%) for two modelings tested. The components of modes 3, 4, 7 and 8 are also obtained with a good precision of about 0.1%. The precision on mode 1 is of the order of 1% for the method of Lanczos and 0.5% for the method of Bathe and Wilson. In it who relates to mode 2, the precision degrades himself: it is about 2.7% for the method of Lanczos and about 3.3% for the method of Bathe and Wilson. Complementary tests (use of the method of Lanczos by imposing boundary conditions by the order AFFE_CHAR_CINE) make it possible to think that these differences come from the method of seek eigenvalues used.

· Modélisation COQUE_C_PLAN
The precision on the results is good for the first three frequencies, the error is of the order from 0.6%. It is degraded as the frequency increases, the error passes from 4th frequency with 8th of 1.5% to 6.4%. More the frequency is high plus the difference between the frequencies double is important. The error on the modes is satisfactory for the first 7 modes (<0.7%), it is higher for 8th (<4%). A finer grid should allow best to represent the modal deformations associated with the high frequencies.

***Code_Aster* ®**
Version
4.0
Titrate:
SDLL04 Beam hurled on two supports
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.004-C Page:
1/6
Organization (S): EFD/IMA/MMN

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.004 document
SDLL04 - Beam hurled on two supports,
coupled to a system mass-arises

Summary:
This plane problem consists in seeking the frequencies of vibration of a mechanical structure made up of one
beam embed-slide and of a mass connected to the beam by a spring. Stiffness of the spring and mass
depend on a variable parameter, which will make it possible to highlight the displacement of the frequencies
clean for a small disturbance of the model. This test of Mechanics of the Structures corresponds to an analysis
dynamics of a linear model having a linear behavior. It includes/understands only one modeling.
This problem makes it possible to test the element of beam of Timoshenko in inflection, the calculation of the Eigen frequencies
by the method of the iterations opposite and the method of Lanczos, the discrete elastic connection between one
specific mass and a node of a beam.
The results obtained are in concord with the results given in guide VPCS. It well is observed
unfolding of the Eigen frequencies induced by the disturbance of the initial model (beam hurled on two supports).

SDLL04 Beam hurled on two supports
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.004-C Page:
2/6

1
Problem of reference
1.1 Geometry

C
y, v

With
D
B
X, U
L/4
L
Length: L = 10
has
(= AD B = dB)
m =
E
WITH L = 780 kg
K = 4
=
E
me
780 4 N m
Cross-section:
surface
A=1.102 m2
moment of inertia
Iz = 3.9 106 m4

3 cases studied:
= 0.
= 0.001
= 0.01
Co-ordinates of the points (meters):
With
B

C
D
X
0.
10.
2.5
2.5
y
0.
0.
qcq_0
0.

1.2
Material properties

E = 2.1011 Pa
= 7.800. kg/m3

1.3
Boundary conditions and loadings

Not a:
U = v = 0.
Not b:
v = 0.
Not C:
U = 0. = 0. vertical slide

1.4 Conditions
initial

Without object for the modal analysis.

2

Reference solution

2.1

Method of calculation used for the reference solution

The reference solution is that given in card SDLL04/89 of the guide VPCS which presents method of calculation in the following way:

The equation with the own pulsations of the complete system is written:

(
sin R has

I
) S (
in R B
I
) (
HS R has
I
) (
HS R B
I
)
R L
-
= 2 2 - 2
2
I

(
I
C
/C
sin R L

I
)
(
HS R L
I
)
( )

with:

= m
With
E
R 4 = 2
= ke
+ B has = L
WITH L
I
I E I
C
me
In absence of system secondary, K
=
E, me
0, one find well the Eigen frequencies of the beam
hurled on two supports.
1
I.E.(internal excitation)

F = i2
= i2
I
2 L2
With
2
When the secondary system is granted exactly on the first mode of this beam, them
new Eigen frequencies of the system can be obtained by the approximate formulas:

m
*
E
F
= 1± 05
.
F
*
= ±

1 2
1
(1 05
,
.

) F
F
F

M
1
3
2
1
with M1 modal beam without secondary system for a normalized clean mode with 1 masses at point D.

2.2
Results of reference

The first two Eigen frequencies for = 0.
The first three Eigen frequencies for = 0.001 and = 0.01.

2.3
Uncertainty on the solution

< 4% for the first modes if the system is granted to the first mode.

2.4 References
bibliographical

[1]
NOUR-OMID, SACKMAN, KIUREGHIAN. Modal characterisation of equipment continous structure system. Newspaper of Sound and Vibration, V.88 n°4, p. 459, 472 (1983).

---

3 Modeling
With

3.1
Characteristics of modeling

One uses right beams of Timoshenko POU_D_T and discrete elements DIS_T.
y
C
With
D
X
B
Cutting:
AD: 5 meshs SEG2
DB: 15 meshs SEG2
CD: 1 mesh SEG2
Modeling:
POU_D_T for all the meshs of beam AB
DIS_T for the mesh CD and the point C
For all the structure DZ = DRX = DRY = 0
Limiting conditions:
in all the nodes of
beam AB:
DDL_IMPO: (GROUP_NO: NPOUTRE DZ: 0. , DRX: 0, DRY: 0.)
with the nodes
ends:
(GROUP_NO: WITH DX: 0. , DY: 0.) (GROUP_NO: B DY: 0.)
out of C:
(GROUP_NO: C DX: 0. , DZ: 0.)
Names of the nodes:
Not A = N1
Not C = N22
Not B = N21
Not D = N6

3.2
Characteristics of the grid

A number of nodes:
22
A number of meshs and types:
21 meshs SEG2
1 mesh P0I1

3.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
BEAM
“GENERAL”

ALL
[U4.24.01]
GROUP_MA
DISCRETE
“K_T_D_L”
“M_T_D_N”
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
GROUP_NO
AFFE_MATERIAU
GROUP_MA
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_T”
GROUP_MA
[U4.22.01]
“DIS_T”
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“PLUS_PETITE”
NMAX_FREQ
MODE_ITER_INV
CALC_FREQ
OPTION
“NEAR”
[U5.52.01]
FREQ

4.0
Titrate:
SDLL04 Beam hurled on two supports
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.004-C Page:
5/6

4
Results of modeling A
4.1 Values
tested
Frequency (Hz)

Order of the clean mode
Reference
Aster
% difference
0.
inflection 1
1.5707
1.5707
0.
inflection 2
6.2831
6.2812
0.03
0.001
1 inflection
1.5460
1.5460
0.
2 inflection
1.5958
1.5957
0.
3 inflection 2
6.2336
6.2817
0.77
0.01

1 inflection
1.4937
1.4936
0.
2 inflection
1.6506
1.6506
0.
3 inflection 2
6.2874
6.2854
0.03

4.2 Remarks

For
= 0, one carried out:
MODE_ITER_SIMULT METHOD: "TRI_DIAG"
OPTION: "PLUS_PETITE"
NMAX_FREQ: 2
For = 0.001, one carried out:
MODE_ITER_INV
OPTION: "NEAR"
LIST_FREQ: (1.5, 1.6, 6.5)
For = 0.01, one carried out:
MODE_ITER_INV
OPTION: "ADJUSTS"
LIST_FREQ: (1. , 7.)

Contents of the file results:

Case 1: the first 2 Eigen frequencies, clean vectors and modal parameters.
Case 2: the first 3 Eigen frequencies and modal parameters.
Case 3: the first 3 Eigen frequencies, clean vectors and modal parameters.

4.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8 seconds

5
Summary of the results

The unfolding of the Eigen frequencies induced by the disturbance of the initial model is perfectly represented.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.006 document

SDLL06 - Transitory response of a post
embed-free

Summary

In this case test, one analyzes the transitory response of a not deadened embed-free beam, modelled by one
system masses - arises and subjected to an unspecified dynamic loading.

One tests the discrete element in inflection, the calculation of the clean modes by the method of Lanczos and calculation of
transitory response by modal recombination of the subjected structure is with a accélérogramme (modeling
With) is with an equivalent imposed force (modeling B).

The diagram of Euler is used.

The results obtained are in concord with the results of reference (analytical results).

1

Problem of reference

1.1 Geometry

It is a problem suggested initially in the reference [bib1] and contained in [bib2].

xr (T)
Co-ordinates
Fx (T)
B
m
points (m)
0
0
To 0
B 10
Iz
0
0
I
y
y
X
With
X
(T)
(T)

· beam AB: beam hurled without mass length AB, L = 10 m and of moment of inertia IZ = 0,3285 m4.
·
3
specific mass in b: m = 43,8 10 kg

1.2
Properties of materials

Young modulus:
10
E = 4. 10 Pa
Density:
= 0 kg/m3

1.3
Boundary conditions and loadings

Boundary conditions:
Only authorized displacements are the translations according to axis X.
Point A is embedded: dx = Dy = dz = drx = dry = drz = 0.

Loadings:
· modeling a: transverse acceleration at point a: (T)

Time (S)

0 0.025 0.05
(T)
(m/s2)

Acceleration according to X (ms2)
0 9.81 0
P0 = 9,81
T (S)
0
t0 = 0.025 0.05

· modeling b: forces transverse at point b: Fx (T) with Fx (T) = Mr. (T)

1.4 Conditions
initial

The system is at rest: with T = 0, dx (0) =0, dx/dt (0) = 0 in any point.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
Transitory SDLL06 Response of a embed-free post

Date: 14/09/01
Author (S): Fe WAECKEL

Key: V2.02.006-C Page: 3/8

2
Reference solution

2.1
Method of calculation used for the reference solution

The problem is dealt with by model with degree of freedom. The post is regarded as one slim not deadened and nonheavy beam of rigidity k= 3EIZ/l3 = 3,942.107 N/m. the superstructure
3
located at the top of the post by a specific mass m = 43,8 10 kg are modelled.

The two loading cases lead to the calculation of the response of a system to a degree of subjected freedom
with an acceleration (T) of an unspecified form:

K
3E.I
&
X + 2 X = - (T
Z
R
R
) with =
=
the Eigen frequency of the system and X
m
m.l3
R it
relative displacement of the point B compared to point A. the solution is obtained by integration of the integral of Duhamel [bib3]:

T
m
X (T) = -
(T) sin (T -) D
R

0

2.2

Results of reference

Displacement relating to the point B.

For a triangular imposed acceleration, one can calculate the integral of Duhamel analytically [bib3]:

P0
sin T

T
< T
: X
0
= -
T
R
-
2
T

0

P
2 sin
0
(T - t0) sin T

T
0 < T < 2t: X
0
= -
2t0 - T
R
-
-

2
T

0

P
T
> 2t
: X
0
0
R = -
2 sin
sin
2
sin
3
[
(T - t0) -
(T - t0) -
T]

T

0

2.3 Uncertainty on the solution

No if one calculates the integral of Duhamel analytically [bib3]. About the precision of method of integration numerical employed to calculate the integral of Duhamel ([bib1], [bib2]): method of Simpson with 40 points per period.

2.4 References bibliographical

[1]
R.W. Clough and J. Penzien: Dynamics of New York structures, Mac Graw-Hill, 1975, p. 102-105
[2]
Guide Technical VPCS AFNOR - 1990
[3]
J.S. Przemieniecki: Theory of matrix structural analysis New York, Mac Graw-Hill, 1968,

---

3 Modeling
With

3.1
Characteristics of modeling

The elements are modelled by discrete elements with 6 degrees of freedom "DIS_TR".

y
y
NO2
m
K
NO1
X
X
(T)
(T)

Node NO1 is subjected to an imposed acceleration (T). One calculates the relative displacement of the node
NO2 compared to the displacement of node NO1 and one compares it with calculated displacement analytically.
Temporal integration is carried out with the algorithm of Euler (not of time: 5. 104 S).

3.2
Characteristics of the grid

The grid consists of 2 nodes and a discrete element (DIS_TR).

3.3 Functionalities
tested

Orders

AFFE_MODELE
GROUP_MA
“MECHANICAL”
“DIS_TR”
AFFE_CARA_ELEM
DISCRETE
NODE
M_TR_D_N
NET
K_TR_D_L
AFFE_CHAR_MECA
DDL_IMPO
MODE_ITER_INV
CALC_FREQ
NEAR
CALC_CHAR_SEISME
MONO_APPUI
MACRO_PROJ_BASE
DYNA_TRAN_MODAL
METHOD
EULER
REST_BASE_PHYS
RECU_FONCTION
RESU_GENE
FORMULATE
CALC_FONC_INTERP

Version
5.0

Titrate:
Transitory SDLL06 Response of a embed-free post

Date: 14/09/01
Author (S): Fe WAECKEL
Key: V2.02.006-C Page: 5/8

4
Results of modeling A

4.1 Values
tested

Relative displacement of node NO1 (in meters).

Time (S)
Analytical calculation
Code_Aster Error
(%)
0,010 6,511E05
6,495E05
0
0,015 2,185E04
2,183E04
0
0,020 5,139E04
5,136E04
-0,058
0,024 8,809E04
8,806E04
-0,039
0,026 1,115E03
1,115E03
-0,041
0,030 1,679E03
1,679E03
-0,014
0,035 2,523E03
2,523E03
-0,004
0,040 3,457E03

3,457E03
0
0,045 4,412E03
4,412E03
0,004
0,049 5,143E03
5,143E03
0,005
0,051 5,485E03
5,485E03
0,005
0,055 6,109E03
6,109E03
0,005
0,060 6,765E03
6,765E03
0,005
0,065 7,269E03
7,269E03
0,005
0,070 7,610E03
7,610E03
0,005
0,075 7,779E03
7,780E03
0,005
0,080 7,774E03
7,775E03
0,004
0,085 7,595E03
7,595E03
0,004

4.2 Parameters of execution

Version:
STA 5.02

Machine:
SGI ORIGIN 2000

Time CPU To use:
3,16 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

The elements are modelled by discrete elements with 6 degrees of freedom "DIS_TR".

y
y
Fx (T)
Fx (T)
m
NO2
K
NO1
X
X

Node NO2 is subjected to an imposed force Fx (T). One calculates the relative displacement of node NO2
compared to the displacement of node NO1 and one compares it with the displacement calculated in

references [bib1] and [bib2].
Temporal integration is carried out with the algorithm of Euler (not of time: 103 S).

5.2 Functionalities tested

Orders

AFFE_MODELE
GROUP_MA
“MECHANICAL”
“DIS_TR”
AFFE_CARA_ELEM
DISCRETE
NODE
M_TR_D_N

NET
K_TR_D_L
AFFE_CHAR_MECA
DDL_IMPO
FORCE_NODALE
MODE_ITER_INV
CALC_FREQ
NEAR
CALC_CHAR_SEISME
MONO_APPUI
MACRO_PROJ_BASE
DYNA_TRAN_MODAL
METHOD
EULER
REST_BASE_PHYS
RECU_FONCTION
RESULT

5.3 Characteristics of the grid

It is the same grid as for modeling A.

Handbook of Validation

6
Results of modeling B

6.1 Values
tested

Relative displacement of node NO1 (in meters).

Time (S)
References
Code_Aster Error
(%)
[bib1], [bib2]
0,01
6,500E05 6,447E05 0,82
0,02
5,130E04 5,127E04 0,064
0,03
1,679E03 1,678E03 0,037
0,04 3,457E03
3,457E03
0,013
0,05 5,316E03
5,317E03
0,022
0,06 6,764E03
6,766E03
0,035
0,07 7,609E03

7,611E03
0,027
0,08 7,774E03
7,776E03
0,024
0,09 7,244E03
7,246E03
0,028
0,1 6,068E03
6,069E03
0,014
0,12
2,242E03 2,242E03 0,017
0,14
2,367E03 2,369E03 0,071
0,16
6,149E03 6,152E03 0,041
0,18
7,783E03 7,785E03 0,029
0,2
6,698E03 6,699E03 0,018

6.2 Parameters of execution

Version:
STA 5.02

Machine:
SGI ORIGIN 2000

Time CPU To use:
1,9 seconds

7
Summary of the results and remarks general

The simplified model presented in this case test makes it possible to validate the method of numerical resolution.
To deal with the real physical problem, it would be necessary to take into account the effects of inertia (mass of
post, effect of inertia of rotation around B of the superstructure) and of compression of the post (actual weight).

For modeling A, the error made with a step of time of 5. 104 S is about 0,01%;
for modeling B (not of times of 103 S) it is about 0,6%.

One will be able to supplement this case test by checking the convergence of the results for other step values
time and by comparing the results obtained with other diagrams of integration.

Organization (S): EDF/IMA/MMN

SDLL08 - Fit latticework on plane beams
(metal sections)
Summary:
This three-dimensional problem first of all consists in carrying out a modal analysis and then to study harmonic response of a mechanical structure of a plane netting of beams. This test of Mechanics of Structures corresponds to a dynamic analysis of a linear model having a linear behavior. It only one modeling includes/understands.
This problem thus makes it possible to test the element of beam of Euler Bernouilli in transverse inflection, the calculation of frequencies and of the modes of vibration by the method of Lanczos and the use of linear relations enters displacements of two points in modal analysis and harmonic answer.
The results are in agreement with the analytical results of guide VPCS.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLL08 Fits latticework on plane beams (metal sections)
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.008-C Page:
2/6

1 Problem of reference

1.1 Geometry

Z, W
F
C
FG
y, v
L1
B = H
G
E = I
X, U
With
D
L2
Length: L1 = L2 = 5 m
Cross-section (section out of I): IPE 200
surface
To = 2.872 103 m2
moment of inertia
Iz = 1.943 105 m4
(other parameters of beam not used)
Co-ordinates of the points (in meters):
With
B = H
C
D
E = I
F
G

X
2.5
2.5
2.5
2.5
2.5
2.5
0
y
2.5
0.
2.5
2.5
0.
2.5
0.
Z
0.
0.
0.
0.
0.
0.
0.

1.2

Material properties

E = 2.1011 Pa
= 7.800. kg/m3

1.3

Boundary conditions and loadings

Points A, C, D, F: (U = v = W = 0.)
Points B, E: rotulée connection (continuity of U, v, W)
Sinusoidal force at the point G
F
T
() = *F*
G
0 sin *T*
F =
0
1105 *NR*
= 80 rad S

1.4 Conditions

initial
With T = 0, structure at rest.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution is that given in card SDLL08/89 of the guide VPCS which presents method of calculation in the following way:

A method of Rayleigh-Ritz makes it possible to make calculation with two degrees of freedom from assumptions of following symmetrical deformations:

· for the point of X-coordinate there of the members AC and DF L1 length

y + L1

2
W
= *W*
AB
B sin
L1

· for the point of X-coordinate X of the cross-piece BE L2 length

X + L2

2
W

=
+
BE
WB *WG* sin
L2
L1
L2
y
X
With
B
C
B
G
E
WB
WB
WAC
W
W
G
BE

2.2

Results of reference

The first two Eigen frequencies and **symmetrical** clean modes (other frequencies clean of this system are not studied). For the clean modes, one with the value following: *WB*/*WG*

In harmonic answer one a:

·

WB max and *WG* max,

+

·

W
W
B
G max at the point G.

2.3

Uncertainty on the solution

Analytical solution.

2.4 References

bibliographical

[1]
J.M. BIGGS. Introduction to Structural Dynamics. New York: Mc Graw Hill, p.184 (1964).

---

3 Modeling

With

3.1

Characteristics of modeling

One uses the element of beam of Euler Bernouilli POU_D_E

y
C
F
B H
G
I
E
X
With
D

3 beams:
ABC, DEF, cut out HGI each one in 10 meshs SEG2
The nodes (B, H) and (E, I) have the same co-ordinates.
Limiting conditions:
beams ABC and DEF
DDL_IMPO:
(GROUP_NO: (PABC, PDEF)
DX: 0. , DY: 0. , DRY: 0.)
beam HGI
(GROUP_NO: (PHGI)
DX: 0. , DY: 0. , DRX: 0.)
nodes ends

(GROUP_NO: (NACDF)
DZ: 0.)
Liaison_ddl:
DZB DZH = 0. and DZE DZI = 0.
Force_nodale:
Node: G Fz: 1.E5
Names of the nodes:
With = N1
B = N6
C = N11
D = N21
E = N26
F = N31
H = N41
G = N46
I = N51

3.2
Characteristics of the grid

A number of nodes:
33
A number of meshs and types:
3*10 = 30 SEG2

3.3 Functionalities
tested
Orders
Keys

AFFE_CARA_ELEM
BEAM
“GENERAL”
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
LIAISON_DDL
FORCE_NODALE
NODE
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”

'POU_D_E
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“PLUS_PETITE”
COMB_MATR_ASSE
[U4.53.01]

3.4 Remarks

The blocking of ddl DX and DY in all the nodes makes it possible to select only the modes of inflection transverse (in the “vertical” plane).

4
Results of modeling A

4.1 Values
tested

Frequency (Hz)
Order of the clean mode
Reference
Aster
% difference

1
16.456
16.4190
0.22
2
38.165
38.0468
0.31
Clean mode: value of WB/WG
Order of the clean mode
Reference
Aster*
% difference
symmetrical
1
1.213
1.213
0.
2
0.412
0.412
0.
*
WB = DZ out of B (N6)
WG + WB = DZ in G (N46)
mode 1:
WB = 0.5480
WG + WB = 1.
mode 2:
WB = 0.6698
WG + WB = 0.9559
Harmonic answer:
Not
Type of value
Reference
Aster
% difference
(m)
B, E
WB max
0.098
0.1003
2.45

G
W
0.125
0.1271
1.60
G max*
G
W
0.227
0.2274
0.18
B + WG max
4.2 Remarks
Calculations carried out by:
MODE_ITER_SIMULT METHOD: “TRI_DIAG”
OPTION: “PLUS_PETITE”
NMAX_FREQ: 3
One obtains an antisymmetric mode for a frequency F = 22.5676 Hz. This Eigen frequency depends on the constant of provided torsion; this one is not defined in the bench-mark data.
Values WB/WG are not checked in the test but are obtained manually starting from WB and WG + WB.
Value (WG) max is not checked in the test. One has only access to WB max and (WB + WG) max. WG max is obtained manually by difference.
Contents of the file results:
the first 3 Eigen frequencies, displacement of the nodes B, E, G in harmonic answer.
4.3 Parameters
of execution
Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
4.0
Titrate:

5 Summary of the results

The values of the Eigen frequencies and the clean vectors are obtained with a precision < 0.3%.
The variation of 2.5% on the maximum arrows at the points B and E would deserve to check the solution of reference, to supplement the validation of the harmonic answer.

Organization (S): EDF/IMA/MMN

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.009 document

SDLL09 - Vibration of a slim beam of variable rectangular section (embed-free)

Summary:

This plane problem consists in seeking the frequencies of vibration of a free fixed beam with section rectangular variable. This test comprises only one modeling.
The variation of section of the beam is either homothetic, or nonhomothetic. Characteristics of section of the beam are given according to meshs' in two different ways:

· section and inertias,
· height and width.

This problem thus makes it possible to thus test the element of beam with variable section for a prismatic structure
that the calculation of the frequencies of vibration by iterations opposite. In addition, in the operator AFFE_CARA_ELEM [U4.24.01], one tests the remanence of certain key words.
The results obtained are in concord with those given in guide VPCS.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

---

1 Problem of reference

1.1 Geometry

y, v
L
y
y
bo
b1
B
H
H
O
h1
H
With
1
X, U
Z
Z
O
B

Z, W
1
bo
Rectangular sections
Length of the beam:
L = 1 m
Rectangular section:
Initial cross-section
Final cross-section
Case 1
Case 2
height:
Ho = 0.04 m
= 0.04 m
h1 = 0.01 m
width:
bo = 0.04 m
= 0.05 m
b1 = 0.01 m
surface:
Ao = 1.6 103 m2
= 2.103 m2
A1 = 1.104 m2
inertia:
lzo = 2.1333 107 m4
= 2.6667 107 m4
Iz1 = 8.3333 1010 m4
Co-ordinates of the points (m):
With
B
X
0.
1.
y
0.
0.
Z
0.
0.
1.2
Material properties
E = 2.1011 Pa
= 7.800 kg/m3

1.3
Boundary conditions and loadings

Not a: embedded U = v = 0 = 0.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLL09/89 of the guide VPCS which presents
method of calculation in the following way:
Exact calculation by numerical integration of the differential equation of the inflection of the beams (Theory
of Euler-Bernouilli).

2
2
v
E

I

Z

x2
2
= -
v

With
x2
t2
where *Iz* and *A* vary with the X-coordinate.
One obtains:
E
F
=
1
() *h1*
I
,
2 *I*
L2
12
with:
= *h0* = 4
h1
= *b0* = 4 or 5
b1

1
2
3
4
5
= 4
23.289
73.9
165.23
299.7
478.1
= 5
24.308
75.56
167.21
301.9
480.4

2.2
Results of reference

the first 5 clean modes of inflection.

2.3

Uncertainty on the solution

Semi-analytical solution.

2.4 References

bibliographical

H.H. MABIE, C.B. ROGERS, Transverse vibrations of double-tapered cantilever beams - Newspaper of the
Acoustical Society of America, n° 51, p. 1771-1774 (1972).

---

3 Modeling

With

3.1

Characteristics of modeling

Modeling: Elements of beam POU_D_E

y
B
With
X

Cutting:
beam AB: 30 meshs SEG2 of section variable
15 meshs in “General section”
15 meshs in “Rectangular section”

Limiting conditions:
in all the nodes
DDL_IMPO: (ALL: “YES” DZ: 0. , DRX: 0. , DRY: 0.)
at end A
(Node: WITH DX: 0. , DY: 0. , DRZ: 0.)

Names of the nodes:
Not A = N100
Not B = N200

3.2
Characteristics of the grid

Grid:
A number of nodes: 31
A number of meshs and types: 30 SEG2

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
BEAM
“GENERAL”
NET
[U4.24.01]
AFFE_CARA_ELEM
BEAM
“RIGHT-ANGLED”
NET
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
AFFE_MODELE
“MECHANICAL”
“POU_D_E”
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
OPTION
“ADJUSTS”
[U4.52.01]

Test of the remanence of a key word (SECTION and CARA).

4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference
frequency in HZ
Cases 1 ho/h1 = 4 bo/b1 = 4
homothetic
inflection 1
54.18
54.1354
0.08
inflection 2
171.94
171.7122
0.13
inflection 3
384.40
383.8764
0.14
inflection 4
697.24
696.1877
0.15
inflection 5
1112.28
1110.4727
0.16
Cases 2 ho/h1 = 4 bo/b1 = 5
nonhomothetic

inflection 1
56.55
56.4984
0.09
inflection 2
175.19
175.5306
+0.19
inflection 3
389.01
388.3426
0.17
inflection 4
702.36
700.9879
0.20
inflection 5
1117.63
1115.4275
0.20

4.2 Remarks

Calculations by
MODE_ITER_INV (…
CALC_FREQ: (FREQ: (53. , 1150.))) ;

4.3 Parameters of execution

Version: NEW3.03.15
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
7.72 seconds

---

5 Summary of the results

Good establishment of the element of non-prismatic beam with a fine grid.
A coarser modeling would be sufficient.

Author (S):
B. QUINNEZ

Organization (S): EDF/IMA/MMN

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.010 document

SDLL10 - Rectangular beam of section variable (embed-embedded)

Summary:
This plane problem consists in seeking the frequencies and the modes of vibration of a mechanical structure
composed of an embed-embedded beam whose surface of the cross-section varies exponentially. This test

of Mechanics of the Structures corresponds to a dynamic analysis of a linear model having one
linear behavior. It includes/understands only one modeling.
Via this problem, one tests the element of beam in inflection of variable Timoshenko of section
as well as the calculation of the frequencies and modes of vibration by the method of Lanczos. One also tests
functionality “normalizes to 1.” at the point of maximum amplitude in translation " of the modes of vibration.
By using a fine space discretization, the results obtained are in concord with the results
analytical given in guide VPCS.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

---

1 Problem of reference

1.1 Geometry

y, v
L
y
y
bo A
B
H
H
H
H
X, U
Z
Z
b1

bo
b1
initial
finale
Z, W
Length of the beam: L = 0.6 m
Constant thickness: H = 0.01 m
Rectangular section:
Initial cross-section:
Variation of the section:
width:
b0 = 0.03 m
B = b0 e2x with = 1.
surface:
A0 = 3.104 m2
With = A0 e2x
moment of inertia:
Iz0 = 0.25 108 m4
Iz = Iz0 e2x
Co-ordinates of the points (m):
With
B
X
0.
0.6
y
0.
0.
1.2
Material properties
E = 2.1011 Pa
= 0.3
= 7.800. kg/m3
1.3
Boundary conditions and loadings
Embedded points A and b:, U = v = 0. , = 0.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
4.0

Titrate:
SDLL10 Beam of rectangular section variable
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.010-C Page:
3/6

2
Reference solution
2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLL10/89 of the guide VPCS which presents method of calculation in the following way:

The pulsation is given by the roots of the equation:

I
1 - cos *rL*
() CH (*sL*) + *s2* - *r2* HS (*sL*) sin (*rL*) = 0
2rs
with:
To 2
4
0
I
2
2
2
2
2
2
=
;
=
+
;
=
-
if
-
>
I
R

I
S
I
(*I*) 0
E Iz0
Components of translation of the mode *F* ()
I X are then:

cos
- CH

( )
X
rL
sL
X = *E*
(
cos *X*-*ray*) - C (
H *sx*)
( )
( )
+
sin
-
I
(*S X*-*ray R* HS *sx*)
R
(
HS *sL*)

- *S*
(
sin *rL*)
( )
(

2.2
Results of reference
the first 4 Eigen frequencies and normalized clean modes with 1 for the largest component in translation.
2.3
Uncertainty on the solution
Analytical solution.

2.4 References
bibliographical

[1]
Working group Analyzes Dynamic. Committee of Validation of the Software packages of Calculation of Structure. French company of the Mechanics (1988).

---

3 Modeling
With

3.1
Characteristics of modeling

Element of beam POU_D_T (right Beam of Timoshenko)

y
B
With
X

Cutting: beam AB: 120 meshs SEG2 of section variable.

Limiting conditions:
in all the nodes
DDL_IMPO
(ALL: “YES”, DZ: 0. , DRX: 0. , DRY: 0.)
with the nodes
ends
(NODE: (AB) DX: 0. , DY: 0. , DRZ: 0.)

Names of the nodes:
Not A
X = 0.
= N1
X = 0.1

= N21
X = 0.2
= N41
X = 0.3
= N61
X = 0.4
= N81
X = 0.5
= N101
Not B
X = 0.6
= N121

3.2

Characteristics of the grid

A number of nodes:
121
A number of meshs and types:
120 SEG2

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
BEAM
“GENERAL”
NET
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
NODE
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_T”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]

MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“PLUS_PETITE”
NMAX_FREQ
NORM_MODE
NORMALIZES
“TRAN”
[U4.64.02]
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLL10 Beam of rectangular section variable
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.010-C Page:
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4
Results of modeling A
4.1 Values
tested
Order of the mode
Frequency
Aster
% difference
% tolerance
clean
Reference
1
143.303
145.924
1.598

1.6
2
396.821
398.511
0.426
0.45
3
779.425
777.115
0.296
0.3
4
1289.577
1278.011
0.897
0.9

The clean modes of Aster were normalized to 1. at the point of maximum amplitude in translation like in the reference.

Clean mode Fi (X) normalized with 1 at the point of maximum amplitude

I
X = 0.1
X = 0.2
X = 0.3
X = 0.4
X = 0.5
Reference
0.2349
0.6962
0.98960
0.8505
0.3507
Aster
1
0.2363
0.6970
0.9895
0.8516
0.3529
% difference
0.583
0.119
0.
0.132

0.631
% tolerance
0.6
0.15
0.1
0.15
0.7
Reference
0.4653
0.7558
0.
0.9232
0.6941
Aster
2
0.4670
0.7555
2.9104
0.9226
0.6971
% difference
0.37
0.041
2.9104
0.063
0.435
% tolerance
0.4
0.1
1.103
0.1
0.45
Reference
0.6278
0.1969
0.7783
0.2406
0.9366
Aster
3
0.6290
0.1952
0.7782

0.2377
0.9387
% difference
0.192
0.89
0.014
1.226
0.228
% tolerance
0.2
0.9
0.1
1.23
0.25
Reference
0.666
0.4832
0.
0.5901
0.9937
Aster
4
0.6656
0.4840
4.6104
0.5919
0.9928
% difference
0.081
0.18
4.6104
0.31
0.089
% tolerance
0.1
0.2
1.103
0.35
0.1

4.2 Remarks

Calculations carried out by:
MODE_ITER_SIMULT METHOD: “TRI_DIAG”
OPTION: “PLUS_PETITE”

NMAX_FREQ: 4
Contents of the file results:
the first 4 Eigen frequencies, clean vectors.
4.3 Parameters
of execution
Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
9.8 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLL10 Beam of rectangular section variable
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.010-C Page:
6/6
5
Summary of the results
Suitable modeling (frequencies and modes suitable for less than 2%) with a fine grid.
A calculation carried out on a coarse grid (12 meshs) shows more important variations with reference solution. This is especially due to the way in which the modes are normalized.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
5.0

Titrate:

SDLL14 - Modes of vibration of a thin elbow of piping
Date:
19/08/02
Author (S):
***P. MASSIN**, F. LEBOUVIER Key*
:
V2.02.014-A Page:
1/8

Organization (S): EDF/AMA, DeltaCAD

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.014

SDLL14 - Modes of vibration of an elbow
of thin piping

Summary:

This test consists in seeking the Eigen frequencies and the modes of vibration associated with a piping bent. It makes it possible to validate modelings finite elements PIPE (SEG3 and SEG4) and TUYAU_6M (SEG4).

The results obtained are compared with an analytical reference solution.
Handbook of Validation

---

1 Problem of reference

1.1 Geometry

y, v
Hollow circular cross-section
L
y
L =
2.0
m
With
R
= 1. m
C
D
= 0.020 m
E
D =
0.016
m
I
With
= 1.131 X 10-4 m ²
I = I = 4.637 X 10-9 m4

y
Z
R
I
= 9.274 X 10-9 m4
p

= 90°
O
B
X
X, U
Z
L
Z, W
D

1.2
Properties of material

The properties of material constituting the plate are:

E = 2.1 1011 Pa
Young modulus
= 0.3
Poisson's ratio
= 7800. Kg/m3 Masses
voluminal

1.3
Boundary conditions and loadings

· C.L. :
- sections out of C and D embedded
- Not a: displacements following y and Z null
- Not b: displacements according to X and Z null

1.4 Conditions
initial

Without object

---

2 Reference solution

2.1 Method of calculation used for the reference solution

Method of Rayleigh applied to elements of hurled right beam and to an element of thin curved beam makes it possible to determine parameters such as:

2
I.E.(internal excitation)
· inflection in the plan: F
I
Z
I =
i=1,2;
R
2
2
With
µ2
GI
·
I
p

transverse inflection: fi =
i=1,2;
R
2
2
With

Values 2
2
I and μi are drawn from an abacus.

This formulation is usable only for piping very slim:
L
· Elancement of the right parts higher than
20
of
I
· Thin Coude such as R
Z
100
with, angle in the center in radian. It is not
With
necessary to use here a coefficient of flexibility of the elbow.

2.2
Results of reference

· The first Four Eigen frequencies,
· The first Four clean modes (2 transverse modes, 2 modes in the plan).

- Frequency (transverse mode 1)
17.9 Hz
- Frequency (mode in plan 1)
24.8 Hz
- Frequency (transverse mode 2)
25.3 Hz
- Frequency (mode in plan 1)
27.0 Hz

2.3
Uncertainties on the solution

· ± 0.1% for the first transverse Eigen frequency,

· ± *3% for the other Eigen frequencies.*

2.4 References bibliographical

[1]
VPCS: Guide validation of the software packages of structural analysis: "test SDLL14", SFM, Technical AFNOR.
[2]
R.D. Blevins, formulated for natural frequency and shape mode, New York, Van Nostrand, 1979, P. 215.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

y, v
Modeling PIPE (SEG3)
Boundary conditions:
C
10
With
Points C and D:
8
- DDL of Beam: DX = DY = DZ = DRX = DRY = DRZ = 0

- DDL of Hull: UIm = VIm = Wim = 0 (m=2,3)
X, U UOm = VOm = WOm = 0 (m=2,3)
WI1 = WO1 = WO = 0
B
Not a:
- DDL of Beam: DY = DZ = 0
Not b:
10
Z, W
- DDL of Beam: DX = DZ = 0
D

3.2

Characteristics of the grid

A number of nodes: 57
A number of meshs and types: 28 SEG3

3.3 Functionalities tested

Orders Key word factor
Key word
AFFE_MODELE
AFFE
MODELISATION=' TUYAU'
AFFE_CARA_ELEM
BEAM: (SECTION: "CIRCLE")
ORIENTATION: (CARA: "GENE_TUYAU"
VALE: (X Y Z)
MACRO_MATR_ASSE
MATR_ASSE
OPTION=' RIGI_MECA'
OPTION=' MASS_MECA'
MODE_ITER_SIMULT
CALC_FREQ
OPTION=' PLUS_PETITE'

4
Results of modeling A

4.1 Values tested

Identification Moments
Reference Aster % difference
Frequency (Hz) Transverse 1

17.9
17.84
-0.308
Frequency (Hz) in plan 1

24.8
24.82

0.083
Frequency (Hz) Transverse 2

25.3
25.82
2.039
Frequency (Hz) in plan 2

27.0
27.65
2.406

4.2 Parameters of execution

Version: NEW 5.04.20

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 13.36 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

---

5 Modeling B

5.1 Characteristics of modeling

y, v
Modeling TUYAU_6M (SEG3)
Boundary conditions:
C
10
With
Points C and D:
8
- DDL of Beam: DX = DY = DZ = DRX = DRY = DRZ = 0

- DDL of Hull: UIm = VIm = Wim = 0 (m=2,6)
X, U UOm = VOm = WOm = 0 (m=2,6)
WI1 = WO1 = WO = 0
B
Not a:
- DDL of Beam: DY = DZ = 0
Not b:
10
Z, W
- DDL of Beam: DX = DZ = 0
D

5.2
Characteristics of the grid

A number of nodes: 57
A number of meshs and types: 28 SEG3

5.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELISATION=' TUYAU_6M'
AFFE_CARA_ELEM
BEAM: (SECTION: "CIRCLE")
ORIENTATION: (CARA: "GENE_TUYAU"
VALE: (X Y Z)
MACRO_MATR_ASSE

MATR_ASSE
OPTION=' RIGI_MECA'
OPTION=' MASS_MECA'
MODE_ITER_SIMULT
CALC_FREQ
OPTION=' PLUS_PETITE'

6
Results of modeling B

6.1 Values tested

Identification Moments
Reference Aster %
difference
Frequency (Hz) Transverse 1

17.9
17.74
-0.914
Frequency (Hz) in plan 1

24.8
24.67
-0.525
Frequency (Hz) Transverse 2

25.3
25.66
1.439
Frequency (Hz) in plan 2

27.0
27.49
1.800

6.2 Parameters of execution

Version: NEW 5.04.20

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 42.82 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

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7 Modeling C

7.1 Characteristics of modeling

Modeling PIPE (SEG4)
y, v
Boundary conditions:
C
10
With
Points C and D:
8
- DDL of Beam: DX = DY = DZ = DRX = DRY = DRZ = 0

- DDL of Hull: UIm = VIm = Wim = 0 (m=2,3)
X, U UOm = VOm = WOm = 0 (m=2,3)
WI1 = WO1 = WO = 0
B
Not a:
- DDL of Beam: DY = DZ = 0
Not b:

10
Z, W
- DDL of Beam: DX = DZ = 0
D

7.2
Characteristics of the grid

A number of nodes: 85
A number of meshs and types: 28 SEG4

7.3 Functionalities
tested

Orders Key word
factor
Key word
CREA_MAILLAGE
MODI_MAILLE
OPTION: “SEG3_4”
AFFE_MODELE
AFFE
MODELISATION=' TUYAU'
AFFE_CARA_ELEM
BEAM: (SECTION: “CIRCLE”)
ORIENTATION: (CARA: “GENE_TUYAU”
VALE: (X Y Z)
MACRO_MATR_ASSE
MATR_ASSE
OPTION=' RIGI_MECA'
OPTION=' MASS_MECA'
MODE_ITER_SIMULT
CALC_FREQ
OPTION=' PLUS_PETITE'

8
Results of modeling C

8.1 Values
tested

Identification Moments
Reference Aster %
difference

Frequency (Hz) Transverse 1

17.9
17.66
-1.332
Frequency (Hz) in plan 1

24.8
24.45
-1.400
Frequency (Hz) Transverse 2

25.3
24.97
-1.322
Frequency (Hz) in plan 2

27.0
26.75
-0.914

8.2 Remarks

The grid in SEG4 is obtained starting from a grid SEG3 with order CREA_MAILLAGE, MODI_MAILLE with option "SEG3_4". It is important that the node medium of the SEG3 is well with medium, Code_Aster checks this condition with a tolerance.

8.3 Parameters of execution

Version: NEW 5.04.20

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 28.44 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

Code_Aster ®
Version
5.0

9
Summary of the results

The results obtained with modeling PIPE (SEG3 and SEG4) and TUYAU_6M (SEG4) are satisfactory. The maximum change observed is lower than 2.1%.

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Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.015 document
SDLL15 - Beam hurled, embed-free,
with mass or offset inertia
Summary:
This three-dimensional problem consists in calculating the frequencies and the modes of vibration of a structure
mechanics made up of a right beam slim, embed-free, with tubular section and of a mass
offset attached at the loose lead of the beam. This test of Mechanics of the Structures corresponds to one
analyze dynamic of a linear model having a linear behavior. It comprises only one modeling.

This problem makes it possible to test the element of beam of Euler Bernouilli, the model of specific mass and calculation
modal by the method of Lanczos.
The results obtained are in concord with those of guide VPCS. Two calculations carried out (eccentricity of
the specific mass null or different from zero) make it possible to highlight the coupling of different modes when the specific mass is offset.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLL15 Beam hurled, embed-free
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.015-B Page:
2/6
1
Problem of reference
1.1 Geometry
Z, W
y, v
C
With
yc
B
L
X, U
Co-ordinates of the points (in m):
With
B
C
X
0.
10.
10.
y

0.
0.
yc
Z
0.
0.
0.
length of the beam: AB = L = 10 m
specific mass out of C: mc = 1000 kg
Tubular section:
external diameter
of = 0.350 m
internal diameter
di = 0.320 m
surface
To = 1.57865 102 m2
inertia
Iy = Iz = 2.21899 104 m4
polar inertia
IP = 4.43798 104 m4
2 studied cases:
1) yc = 0.
2) yc = 1. m
1.2
Material properties
E = 2.1 1011 Pa
= 7800 kg/m3
1.3
Boundary conditions and loadings
Not A embedded: (U = v = W = 0, = = =
X
y
Z
0).
1.4 Conditions
initial
Without object for the modal analysis.

4.0
Titrate:
SDLL15 Beam hurled, embed-free
Date:
07/01/98
Author (S):
B. QUINNEZ
Key:
V2.02.015-B Page:
3/6

2
Reference solution
2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLL15/89 of the guide VPCS which presents method of calculation in the following way:

The problem with not offset mass leads to uncoupled modes:

· traction and compression (effect of the mass alone),
· torsion (effect of inertia around neutral fibre),
· inflection in plans X, y and X, Z (effect of the mass).

The various Eigen frequencies are given with a model by finite elements of beam of Euler (slim beam).

For the first mode with an unbalance, a method of Rayleigh gives the formula approached:

3rd I
F = 1
Z
1
2
L3 m
(+
)
C
0.24 M

with M = total mass of the beam.

When the mass is offset, the modes of inflection (X, Z) and of torsion are coupled, as well as modes of inflection (X, y) and of traction and compression.

For the clean mode, the components at the point B make it possible to calculate the components in the center of gravity of the mass (point C) by:

U

U

0
Z
- y
C
B
C
C
xB

v
= v
+ - Z
0
+ X

C
B C
C
yB

W
W + y - X

0
C
B
C
C
Z

B
U = U -
C
B
zB
for this test

v = v
C
B
W = W +
C
B
xB
2.2
Results of reference
Case 1: the first 10 clean modes.
Case 2: the first 8 clean modes.
2.3
Uncertainty on the solution
Problem 1:
f1 analytical solution
other frequencies ± 1%
Problem 2:
± 1%
2.4 References
bibliographical

[1]
Working group Analyzes Dynamic. Commission of Validation of the Software packages of Calculation of
Structures. French company of Mécaniens. (1988)
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

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3 Modeling
With
3.1

Characteristics of modeling
Element of beam POU_D_E and discrete element DIS_TR
y
C
With
B
X
Cutting: beam AB: 20 meshs SEG2.
Limiting conditions:
with the node end A
DDL_IMPO: (NODE: WITH DX: 0. , DY: 0. , DZ: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)
Nodal mass out of B with an eccentricity
ey= 0.
Case 1
ey= 1.
Case 2
Names of the nodes:
Points
With = N100
B = N200
3.2
Characteristics of the grid
A number of nodes:
21
A number of meshs and types:
20 SEG2
3.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
BEAM
“CIRCLE”
ALL
[U4.24.01]
DISCRETE
“M_TR_D_N”
AFFE_CHAR_MECA
DDL_IMPO
NODE
[U4.25.01]
AFFE_MATERIAU
ALL

[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_E”
ALL
[U4.22.01]
“DIS_TR”
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“TRIA_DIAG”
[U4.52.01]
CALC_FREQ
OPTION
“PLUS_PETITE”
NMAX_FREQ
: 10 cases 1
: 8 cases 2

4
Results of modeling A
4.1 Values
tested
Case
Nature of the mode
Frequency Hz

% difference
clean
Reference
Aster
inflection 1,2
1.65
1.6554
0.33
inflection 3,4
16.07
16.0712
0.
CASE 1
inflection 5,6
50.02
50.0240
0.
traction 1
76.47
76.4727
0.
yc = 0.
torsion 1
80.47
80.4688
0.
inflection 7,8
103.20
103.20444
0.
fz + to 1
1.636
1.6363
0.
fy + tr 2
1.642
1.6416
0.
CASE 2
fy + tr 3
13.46
13.4551
0.

fz + to 4
13.59
13.5919
0.
yc = 1.
fz + to 5
28.90
28.8972
0.
fy + tr 6
31.96
31.9594
0.
fz + to 7
61.61
61.6091
0.
fy + tr 8
63.93
63.9289
0.
Mode

0.03
3.039 102
1.321
X B
1
wC/wB
1.030
1.030
0.
2
uC/vB
0.148
0.148
0.
3
uC/vB
2.882
2.880
0.07
4

wC/wB
0.922
0.923
0.108
5

1.922
1.92268
0.036
X B
with:
fz + to = inflection X, Z + torsion
fy + tr = inflection X, y + traction
4.2 Remarks
Calculations carried out by:
MODE_ITER_SIMULT
METHOD: “TRI_DIAG”
OPTION: “PLUS_PETITE” NMAX_FREQ:
10 Cases 1
8 Cases 2
U
In the test, one cannot check the values of the reports/ratios C for modes 2 and 3 (except
vB
W
manually). With regard to the values of
C, the technique is as follows: if one imposes
wB
W
W =
C =
B
1 (order NORM_MODE), one has then
1 + X and one can make checks on
W
B
B
values of X.
B
Contents of the file results:
Case 1: the first 11 Eigen frequencies, clean vectors and modal parameters.
Case 2: the first 9 Eigen frequencies, clean vectors and modal parameters.
4.3 Parameters
of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
7.2 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/035 - Ind A

---

5 Summary of the results

The modeling of unbalance gives exact results for the 8 frequencies of reference.
The precision of the clean modes is about 0.1% until mode 4.

Organization (S): EDF/EP/AMV

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.023 document

SDLL23 - Subjected embed-free beam with a seism (spectral answer)

Summary
This one-way problem consists in carrying out a spectral seismic analysis of a free fixed beam provided with two localised masses subjected to a three-dimensional excitation provided in the shape of a spectrum
oscillators in pseudo-acceleration.

Via this problem, one tests modal combinations DPC, SRSS, CQC and DSC of the operator COMB_SISM_MODAL [U4.54.04]. Combination SRSS is tested with taking into account of the neglected modes.
In addition, one tests the operators of preprocessing MODE_ITER_SIMULT [U4.52.02], NORM_MODE [U4.64.02],
MODE_STATIQUE [U4.52.04], DEFI_FONCTION [U4.21.02] and DEFI_NAPPE [U4.21.03].
The results obtained are in agreement with the card of validation suggested in guide VPCS.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-785/96/051 - Ind A

1
Problem of reference
1.1 Geometry
B
C
With
Length of the beam L = 10 m, the mass B is at a distance of 0.5 m of point A.

Cross section of the beam
Surface

To = 78.1 104 m2
Moments of inertia
L = 5696 108 m4
y

L = 2003 108 m4
Z
1.2

Material properties
Beam
E = 2.1011 Pa
= 0 kg/m3
(mass of the null beam)
Mass out of B
mB = 50000 kg
Mass out of C
mC = 5000 kg
1.3
Boundary conditions and loadings
Not A embedded
Spectrum of oscillator in acceleration applied in A in the three directions.
ms2
25
2.4
0.05 0.13
0.5
5.0

2
Reference solution
2.1
Method of calculation used for the reference solution
Guide VPCS (to be appeared): comparison with other codes.
For the comparison between the method CQC, comparison and Castem2000.
2.2
Results of reference

Absolute acceleration according to X at the points A, P1, P2, P3, P4.

2.3 References
bibliographical

[1]
J. PIRANDA: Note of use of the software of modal analysis MODAN - Version 0.2 (1990).
Laboratory of Mechanics Applied - University of Frank County Besancon (France).
Guide VPCS to be appeared.

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3 Modeling
With

3.1
Characteristics of modeling

y
B
C
With
X

Right beam modelled by 3 nodes and 2 SEG2 of the type POU_D_E
Mass modelled by discrete elements M_T_N

3.2
Characteristics of the grid

A number of nodes: 3
A number of meshs and types: 2 SEG2 (POU_D_E), 2 POI1 (DIS_T_N)

3.3 Functionalities
tested

Orders
Keys

MODE_ITER_SIMULT

CALC_FREQ
[U4.52.02]
NORM_MODE
“MASS_GENE”
[U4.64.02]
MODE_STATIQUE
[U4.52.04]
DEFI_FONCTION
FREQ
LOG
[U4.21.02]
DEFI_NAPPE
[U4.21.03]
COMB_SISM_MODAL
COMB_MODE
“DPC”
[U4.54.04]
“SRSS”
“CQC”
“DSC”

---

4 Results of modeling A

4.1 Values tested

Identification
Reference
Aster

% difference
Eigen frequencies
1
0.24691
0.24672
-0.07
2
0.41666
0.41606
-0.14
3
7.4074
7.3932
-0.19
4
12.5
12.467
-0.26
5
27.777
27.507
-0.97
6
41.666
41.740
0.17
Direction numero_mode
Factor of participation
DY 1
73.3
73.31
0.02
DZ 2
73.3
73.31
0.02
DY 3
223.
222.8
-0.10
DZ 4
-223.
-222.8

-0.10
DX 5
130.
130.1
0.10
DX 6
195.
195.1
0.05
Response on 3 modes (DPC)
DEPL B DY
1.254 10-2
1.247 10-2
-0.528
B DZ
2.8 10-3
2.832 10-3
1.167
C DY
1.269
1.282
1.027
C DZ
7.574 10-1
7.673 10-1
1.297
REAC A DX
0.000
1.146 10-5
1.15 10-5
WITH DY
1.231 106
1.240 106
0.790
WITH DZ
2.7 104
2.718 104
0.698
WITH DRY
2.56 105
2.626 105
2.613
WITH DRZ

5.91 105
5.969 105
1.005
Response on 6 modes (DPC)
DEPL B DX
1.32 10-4
1.333 10-4
1.031
B DY
1.255 10-2
1.247 10-2
-0.607
B DZ
3.829 10-3
3.814 10-3
-0.393
C DX
5.999 10-4
6.022 10-4
0.368
C DY
1.269
1.282
1.027
C DZ
7.579 10-1
7.673 10-1
1.230
REAC A DX
4.12 105
4.166 105
1.121
WITH DY
1.227 106
1.240 106
1.118
WITH DZ
7.96 105
7.816 105
-1.807
WITH DRY
4.49 105
4.481 105

-0.191
WITH DRZ
5.90 105
5.969 105
1.176
Response (SRSS) on 3 modes with static correction
DEPL B DX
1.76 10-4
1.760 10-4
0.032
B DY
1.267 10-2
1.247 10-2
-1.548
B DZ
3.3 10-3
3.264 10-3
-1.065
C DX
4.8E-4
4.801E-4
0.03
C DY
1.277
1.282
0.39
C DZ
0.762
0.767
0.69
REAC A DX
5.46E+5
5.500E+5
0.73
WITH DY
12.30E+5
12.40E+5
0.87
WITH DZ
4.90E+5
4.969E+5
1.43
WITH DRY

3.43 105
3.495 105
1.919
WITH DRZ
5.91 105
5.969 105
1.005
Response on 6 modes (CQC)
DEPL B DX
1.337 10-4
1.334 10-4
-0.243
B DY
1.247 10-2
1.247 10-2
0.0
B DZ
3.814 10-3
3.814 10-3
-0.001
C DX
6.012E-4
6.019E-4
0.12
C DY
1.282
1.282
0.0
C DZ
0.767
0.767
0.0
REAC A DX
4.18E+5
4.169E+5
-0.24

Titrate:
Embed-free SDLL23 Beam subjected to a seism
Date:
07/01/98
Author (S):
P. GUIHOT
Key:
V2.02.023-B Page:
6/6
WITH DY
12.40E+5
12.40E+5
0.0
WITH DZ
7.816E+5
7.816E+5
0.0
WITH DRY
4.481E+5
4.481E+5
-0.01
WITH DRZ
5.969E+5
5.969E+5
0.0
Response on 6 modes (DSC, lasted 5
S)
DEPL B DX
1.339 10-4
1.335 10-4
-0.290
B DY
1.248 10-2
1.247 10-2
-0.025
B DZ
3.816 10-3
3.815
-0.028
C DX
6.009 10-4
6.018 10-4
0.144

C DY
1.282
1.282
0.000
C DZ
7.673 10-1
7.673 10-1
0.000
REAC A DX
4.183 105
4.171 105
-0.290
WITH DY
1.240 106
1.240 106
-0.001
WITH DZ
7.816 105
7.816 105
-0.002
WITH DRY
4.483 105
4.482 105
-0.027
WITH DRZ
5.971 105
5.970 105
-0.018

4.2 Remarks

Value of the spectrum (interpolation):
Mode
1
2
3
4
5
6
Spectrum
2.972
5.058
25.
15.74
10.

10.
1
1.38E - 3
5.05E - 6
2.27E - 6
6.85E - 7
3.65E - 7

1
1.13E - 5
5.05E - 6
1.51E - 6
8.04E - 7

1
1.38E - 3
1.64E - 4
7.48E - 5

Stamp correlation CQC:

1
5.61E - 4
2.04E - 4

1
2.21E - 3

1

4.3 Parameters of execution

Version: 3.05.02
Machine: CRAY C90
System: UNICOS 8
Obstruction memory: 8 megawords
Time CPU To use: 14.43 seconds

5

Summary of the results
Perfect agreement of the Aster results with the card of validation suggested by the commission VPCS which
indicate a tolerance of 2% on the values of reference.

Organization (S): EDF/EP/AMV
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.100
SDLL100 - Transitory dynamic response
of a beam in simple traction
Summary:
This problem-test corresponds to a direct transitory analysis of a deadened linear system or not, made up of a beam in simple traction, subjected to a loading of the Heaviside type applied as from the initial moment.
The problem discretized with 1 single element of beam has an analytical reference solution.

A.C. LIGHT
Key:
V2.02.100-D Page:
2/6

1
Problem of reference

1.1 Geometry

y, v
With
B
F (T) = (T). Fx
X, U

1
R
X
T
R = 0.05 m I = 1. m
y
N01
N02
X

1.2
Material properties

E = 98 696.044 MPa
= 0.
= 3. 106 kg/m3
Without damping
: C = 0. or with damping proportional of Rayleigh
:
C = **K** + μ **M**
-4
, = 5.10, μ = 5.

1.3
Boundary conditions and loadings

Force applied to the N02 node in b: Fx = 1. 106 NR
Function (T) evolution of the loading: (T) = 1. , T 0.

1.4 Conditions
initial

Initial displacement no one.
Null initial speed.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

· Without damping: the analytical solution of the problem with 1 element is:

F
X
X
=
1 - cos
B (*T*)
2 (
(*T*
0
)
m 0

1
3rd
2

2
m
=
S
I, 0 =
, *T*
=
O
3

I 2
0
where *S* is the surface of the section (*R2*).
· With damping: the analytical solution of the problem with 1 element is:
F

µ + 2
2
0
µ +

X (*T*)
X
=
1 - exp-
T
0 sin
cos
2

(*T1*) + (*T*
B
1)
m
2
2
0

1

, µ coefficient damping proportional **C** = µ **M** + **K**

(- µ) 2 2 2 4
4
2
-
-
0
µ

0
=
1
2

2.2
Results of reference

xB displacement with *T* = *I T0 I* = 1,…, 10.

10
with:
T
= 2
0

0

2.3
Uncertainty on the solution

Analytical solution.

Note:

The reference solution corresponds to the solution obtained with the discretization to an element and by keeping a matrix masses full. That makes it possible to validate the algorithm but it is not the solution of the physical problem.

3 Modeling

With

3.1

Characteristics of modeling

POU_D_T

y
N01
N02
X

Cutting:
N01
N02
1 mesh SEG2

Limiting conditions: DDL_IMPO with the N01 node:
DX: 0. , DY: 0. , DZ: 0. , DRX: 0, DRY: 0, DRZ: 0

No time:
105 S.

Integration NEWMARK
= 0.25, = 0.5

WILSON integration
= 1.4

3.2

Characteristics of the grid

A number of nodes: 2
A number of meshs and types: 1 mesh SEG2

3.3 Functionalities

tested

Orders

Keys

COMB_MATR_ASSE
[U4.53.01]

4
Results of modeling A
4.1 Values
tested

Without damping:

Moment in dryness.
Reference
Aster
% diff.
WILSON aster
% diff.
NEWMARK
2.E3
2.4638E04
2.4519E04
0.5
2.4424E04
0.86
4.E3
8.9141E04
8.8948E04
1.93

8.8794E04
0.38
6.E3
1.6887E03
1.6868E03
0.11
1.6852E03
0.20
8.E3
2.3337E03
2.3325E03
0.05
2.3316E03
0.09
1.E2
2.5801E03
2.5801E03
0.03
2.5801E03
0
1.2E2
2.3337E03
2.3349E03
0.05
2.3359E03
0.09
1.4E2
1.6887E3
1.6906E03
0.43
1.6922E03
0.21
1.6E2
8.9141E04
8.9334E04
0.21
8.9489E04
0.4
1.8E2
2.4638E04
2.4758E04
0.48
2.4854E04

0.87
2.E2
0.0000
3.1989E09
-
9.3188E09
-
With damping:
Moment in dryness.
Reference
Aster
% diff.
WILSON aster
% diff.
NEWMARK
2.E3
2.3775E04
2.3662E04
0.47
2.3572E04
0.85
4.E3
8.3189E04
8.3015E04
0.21
8.2877E04
0.37
6.E3
1.5307E03
1.5290E03
0.11
1.5277E03
0.2
8.E3
2.0704E03
2.0694E03
0.04
2.0686E03
0.09
1.E2
2.2721E03
2.2721E03
0.

2.2720E03
0.004
1.2E2
2.0976E03
2.0984E03
0.04
2.0991E03
0.07
1.4E2
1.6488E03
1.6501E03
0.08
1.6511E03
0.14
1.6E2
1.1164E03
1.1176E03
0.11
1.1186E03
0.2
1.8E2
7.0165E04
7.0241E04
0.11
7.0302E04
0.19
2.E2
5.4263E04
5.4266E04
0.005
5.4269E04
0.01

4.2 Remarks

After the first two steps of time, the solution with damping is obtained with an error lower than 0.2%.

4.3 Parameters of execution

Version: 3.02.19
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords

Time CPU To use:
150 seconds

5
Summary of the results

The two algorithms give a solution with an error lower than 0.2% of the solution of reference after the first two steps of time.

This problem requires a step of time of integration of 105 S.

Organization (S): EDF/IMA/MMN

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.101 document

SDLL101 - Vibration of a beam with prestressed

Summary:
This plane problem consists in seeking the frequencies of vibration of a mechanical structure made up of one
hurled beam, of circular section, under tension embed-slide. This test of Mechanics of the Structures corresponds to a dynamic analysis of a linear model having a linear behavior. This test comprises two modelings.
In the first modeling, one tests the element of beam of Timoshenko subjected to a prestressing, it calculation of geometrical rigidity and the calculation of the Eigen frequencies by the method of Lanczos. In
the second modeling, one tests the element of beam of Euler-Bernouilli subjected to a prestressing, the calculation of
geometrical rigidity and the calculation of the Eigen frequencies by the method of Bathe and Wilson.
The results obtained are in concord with the results of guide VPCS. One notices a shift towards high frequencies of vibration when prestressing in the beam increases.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

---

1 Problem of reference

1.1 Geometry

With
B
P
P
Full circular section
diameter D: 0.01 m
Length of the beam
L: 2 m

1.2
Material properties
E = 2 1011 N/m2
= 0.3
= 7.800. kg/m3
1.3
Boundary conditions and loadings
· Poutre pose-posed,
· 4 loadings are studied P = 0. , P = 10. , P = 100. , P = 1.000. NR

2
Reference solution
2.1
Method of calculation used for the reference solution
The equation of vibration of a prestressed beam is:
4y
2y
2y
I.E.(internal excitation)
+ P
= - *S*
Z x4
x2
x2
prestressed traction if P > 0, of compression if P< 0, and led to the Eigen frequencies of inflection (assumption of Euler-Bernoulli)

1/ 2

1 2
I.E.(internal excitation)
F = i2

Z
I =
I
1 +
PL2
1,2,3,. ..
2 *L2*
I.E.(internal excitation) i2 2 *S*
Z

2.2
Results of reference

the first 5 Eigen frequencies.

2.3
Uncertainty on the solution

Analytical solution (assumption of the beams of Euler-Bernouilli).

2.4 References
bibliographical

[1]
Robert D. BLEVINS Formulated for natural frequency and shape mode - 1979 p.144 (formula 8.20 rectified).

---

3 Modeling
With

3.1
Characteristics of modeling
Elements of beam POU_D_T (right Beam of Timoshenko)
y
With
B
X
Cutting: 10 elements of beam
node a: translations in X and y blocked
node b: translation in y blocked.
Note:
The force P applied out of B generates a reaction - P in A.
3.2
Characteristics of the grid
A number of nodes:
21
A number of meshs and types:
20 SEG2
3.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
BEAM
"CIRCLE"
[U4.24.01]
AFFE_CHAR_MECA
FORCE_NODALE
NODE
[U4.25.01]
DDL_IMPO
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
"MECHANICAL"
"POU_D_T"
"ALL"
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_MATR_ELEM

OPTION
“RIGI_GEOM”
[U4.41.01]
SIEF_ELGA
CALC_VECT_ELEM
OPTION
CHAR_MECA
[U4.41.02]
CALC_CHAM_ELEM
DEPL
[U4.61.01]
OPTION
SIEF_ELGA_DEPL
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
NMAX_FREQ
“PLUS_PETITE”
COMB_MATR_ASSE
[U4.53.01]

---

4 Results of modeling A

4.1 Values tested

Pre constraint/order of the mode
Reference
Aster
% difference
clean
P = 0 1
4.97137
4.9711
0.01
2
19.8851
19.8829
0.01
3
44.7414
44.7320
0.02
4
79.5403
79.5203
0.02
5
124.2818
124.2706
0.01
P = 10 1
5.0728
5.0727
0.0
2
19.9874
19.9852
0.01
3
44.8439
44.8345
0.02
4
79.6429
79.6229
0.03
5
124.3844

124.3732
0.01
P = 100 1
5.9090
5.9088
0.00
2
20.8860
20.8839
0.01
3
45.7561
45.7467
0.02
4
80.5600
80.5400
0.03
5
125.3037
125.2923
0.01
P = 1.000 1
11.2577
11.2576
0.00
2
28.3462
28.3442
0.01
3
54.0370
54.0281
0.02
4
89.2134
89.1935
0.02
5
134.1511
134.1379
0.01

4.2 Parameters

of execution
Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
10 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

---

5 Modeling B

5.1 Characteristics of modeling

Elements of beam POU_D_E (Beam of Euler-Bernouilli)
y
With
B
X
Cutting: 19 elements of beam
node a: translations in X and y blocked
node b: translation in y blocked.

Note:
The force P applied out of B generates a reaction - P in A.

5.2 Characteristics of the grid

A number of nodes:
21

A number of meshs and types:
20 SEG2
5.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
BEAM
“CIRCLE”
[U4.24.01]
AFFE_CHAR_MECA
FORCE_NODALE
NODE
[U4.25.01]
DDL_IMPO
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_T”
“ALL”
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_MATR_ELEM
OPTION
“RIGI_GEOM”
[U4.41.01]
SIEF_ELGA
CALC_VECT_ELEM
OPTION
CHAR_MECA
[U4.41.02]
CALC_CHAM_ELEM
DEPL
[U4.61.01]
OPTION
SIEF_ELGA_DEPL
MODE_ITER_SIMULT
METHOD
“JACOBI”

[U4.52.02]
CALC_FREQ
OPTION
“PLUS_PETITE”
NMAX_FREQ
COMB_MATR_ASSE
[U4.53.01]
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

6
Results of modeling B
6.1 Values
tested
Pre constraint/order of the mode
Reference
Aster
% difference
clean
P = 0 1
4.97137
4.9713
0.00
2
19.8851
19.8853
0.00
3
44.7414
44.7439

0.01
4
79.5403
79.5574
0.02
5
124.2818
124.3594
0.06
P = 10 1
5.0728
5.0728
0.00
2
19.9874
19.9876
0.00
3
44.8439
44.8464
0.01
4
79.6429
79.6599
0.02
5
124.3844
124.4619
0.06
P = 100 1
5.9090
5.9090
0.00
2
20.8860
20.8862
0.00
3
45.7561
45.7585
0.01
4
80.5600

80.5768
0.02
5
125.3037
125.3807
0.06
P = 1.000 1
11.2577
11.2577
0.00
2
28.3462
28.3463
0.00
3
54.0370
54.0391
0.00
4
89.2134
89.2287
0.02
5
134.1511
134.2234
0.05

6.2 Parameters of execution

Version: 3.02.21
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
11 seconds

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

7 Summary of the results

The results obtained are in concord with the results of reference. It is noticed well that them frequencies of vibration increase when prestressing increases.

Organization (S): EDF/EP/AMV

Handbook of Validation
V2.02 booklet: Linear mechanics
V2.02.102 document

SDLL102 - Gantry subjected to electrodynamic forces

Summary:

This test is a three-dimensional problem of direct transitory dynamic calculation with forces distributed of electrodynamic origin applied to a gantry (bars on 3 insulating columns of a station of transformation).

This test was provided by the Center of Studies of the Grid system (EDF-DEPT). It was supplemented

since by
a benchmark international bench starting from experimental measurements (results of several foreign codes):
test CIGRE-structure D.
It makes it possible to compare results of displacements compared to those obtained by other industrial codes
using a finished method finite elements or differences.
This test contains a modeling with elements of the type SEG2.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

1
Problem of reference

1.1 Geometry

D
M3
S4
H
M3
S8
L
Z
S3
0.16
C
M3
S7
G
M3
S11 K

M3
S2
2.1 Y
S6
M2
M2
S10
M2
X
B
F
J
2.135
S1
M1
S5
M1
S9
M1
With
E
I
11.5
11.5
Cross sections of beams:
· frame support
S1:
To = 1.2061 102 m2,
Iz =
2.3681 105 m4;
S5:
To = 1.4621 102 m2,
Iz =
2.8709 105 m4;
S9:
To = 1.5530 102 m2,
Iz =
3.0493 105 m4
· insulating columns
S2:
To = 3.1428 102 m2,
Iz =
4.5070 105 m4;

S6:
To = 3.2592 102 m2,
Iz =
4.6738 105 m4;
S10:
To = 3.3416 102 m2,
Iz =
4.7927 105 m4
· connections
S3, S11:
To = 3.1944 102 m2,
Iz =
1.15 105 m4;
S7:
To = 4.2130 102 m2,
Iz =
1.15 105 m4;
· conducting
S4, S8:
circular R = 6.055 102 m
E = 6.2 103 m
1.2
Material properties
M1:
E = 2. 1011 Pa
= 8000 kg/m3
(frame support)
M2:
E = 5. 1010 Pa
= 2500 kg/m3
(insulating column)
M3:
E = 7. 1010 Pa
= 2700 kg/m3
(connection and conducting aluminium)

1.3
Boundary conditions and loadings

Points A, E, I: embedding
Points D, L: not-continuity of ux, y, Z
Forces of Laplace on drivers DH, HL;
·

two-phase current
= = 100 m
· conducting infinite separated from 1 m

I
I
2 (C (
bone
T
) *E T*
=
+
- - /

EFF
cos)
Ieff
effective intensity of the current

time-constant
· two short-circuit with reset
T
0 < T ² 0.135
0.135 < T < 0.580
0.580 ² T ² 0.885
I
15.6 kA
0

15.6 kA
EFF

0.066 S
-
0.062 S
1.4 Conditions
initial
T = 0, speed and zero acceleration.
2
Reference solution
2.1
Method of calculation used for the reference solution
· experimental measurements,
· numerical methods D.F or E.F.
2.2
Uncertainty on the solution
± 5 to 10% of dispersion of the computed values.
2.3 References
bibliographical
[1]
G. DEVESA: "Calculation of the electrodynamic strains on structures of drivers rigid electric stations: establishment in the mechanical computer code Aster and Validation ".
Note HM-72/5904
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

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3 Modeling
With
3.1

Characteristics of modeling
Modeling POU_D_E
D2
H1 H2
L1
D1
Z
L2
y
C
G
K
X
B
F
J
With
E
I
Discretization:
· elements AB, EF, IJ: 10 meshs: SEG2
· elements BC, FG, JK: 10 meshs: SEG2
· elements CD1, GH1, KL1: 1 mesh: SEG2
· elements D2H1, H2L1: 30 meshs: SEG2
Dynamic evolution on 1s discretized in step of time of 5. 104 S with the algorithm of NEWMARK (= 0.25 have, D = 0.5).
Storage of the results all the 20 steps of times is 102 S.

3.2
Characteristics of the grid
A number of nodes: 126
A number of meshs and types: 123 meshs SEG2

3.3 Functionalities
tested
Orders
Key word
Option
Keys
DEFI_FONC_ELEC
[U4.21.06]
AFFE_CHAR_MECA
FORCE_ELEC
[U4.25.01]
DYNA_LINE_TRAN

NEWMARK
[U4.54.01]
CALC_ELEM
EFGE_ELNO_DEPL
[U4.61.02]
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

4
Results of modeling A
4.1 Values
tested
Identification
Reference test
References
% difference
Aster 3.04.02
T = 0.12 S
uy in C2
60.49 mm
MX in S1
3140. Nm
3071. Nm
2.2
MX in S2
10150. Nm
9239. Nm
-9.
MX in S3
3130. Nm

2916. Nm
6.8
Mz in C2
1431. Nm
1296. Nm
9.5
T = 0.70 S
uy in C2
11.891 cm
MX in S1
6080. Nm
6327. Nm
+4.
MX in S2
19670. Nm
18931. Nm
3.8
MX in S3
6060. Nm
6015. Nm
0.8
Mz in C2
2746. Nm
2647. Nm
3.6
Maximum obtained with T = 0.12 S (1st short-circuit) or T = 0.70 S (2nd short-circuit) or reset (conformity test-calculation).

4.2 Remarks

The results obtained by ASTER are satisfactory compared to the other codes. They are almost always lower than measurements (effects of frames AB, EF, IJ overestimated). The maximum ones are chopped because of periodic storage.

Contents of the file results:

Displacements all 102 S and efforts in the elements at times T = 0.12 S, T = 0.27 S, T = 0.70 S.

4.3 Parameters of execution

Version: 3.04.12
Machine: CRAY C90
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
74.19 seconds
Handbook of Validation

5 Summary of the results

The results are acceptable compared to the test results and locate values produced by Code_Aster in good place among ten results of other software.

The values of reference of the file of test are those of version 3.04.02 of the code (not regression).

Titrate:
SDLL104 Structures primary education and secondary

Date:
30/08/01

Author (S):
J. PIGAT *Key*
:
V2.02.104-B Page:
1/6

Organization (S): EDF/RNE/AMV

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.104 document

SDLL104 - Structures primary education and secondary subjected to a random excitation

Summary:

A principal beam of strong rigidity and important mass (primary structure), embedded at its base, support in three points of transmission of efforts a light and flexible beam (secondary structure).

The primary structure is excited at its base by an acceleration given by its DSP.

The test compares a direct calculation of the whole of the two structures and a chainé calculation where the answer of principal beam at the points of connection is used like the excitation of the secondary beam.

The following functionalities are tested:

- ***stamp interspectrale analytical preset by the function of KANAI-TAJIMI,***
- ***random dynamic response moving absolute, imposed acceleration,***
- ***modal answer interspectrale,***
- ***modal excitation interspectrale.***

This approach is representative of what is required for the industrial studies: to determine them answers of various secondary structures knowing the answer of the primary structure.

---

1 Problem of reference

1.1 Geometry

Observation of the result
Dy
PB
dx
Pa

Beam Pa:

Section: 0.1 mm X 0.1 mm
Length: 3.0 m

Beam PB:

Section: 0.001 mm X 0.001 mm

Length: 2.0 m

Report/ratio of mass between PB and Pa: 0.33 E04

1.2
Material properties

Young modulus beams A and b:
E = 2.1 E+11 N/M2
Poisson's ratio beams A and b:
= 0.3
Density beam Pa:
With = 2000 kg/m3
Density beam PB:
B = 1000 kg/m3

1.3
Boundary conditions and loadings

The movement is authorized in the plan (DX, DY).

Beam Pa is embedded in the support.

The beam PB is connected to beam Pa by three points. In each one, displacements in direction DX and DY of the node of Pa and the PB node are identical. Rotations are not dependent.

The matrix interspectrale which transmits displacements of structure Pa to the structure PB in chained calculation is of dimension 6 (6 ddl of transmission).

Author (S):
J. PIGAT Key
:
V2.02.104-B Page:
3/6

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is the direct calculation of the whole of the two structures.

It is supposed that the mass and the rigidity of secondary structure Pa do not disturb it behavior of the primary structure. Thus chained calculation is supposed to be equivalent to direct calculation.
One can check on the table below that the structure PB modifies the Eigen frequencies little of structure Pa.

Calculated Eigen frequencies (Hz)

Pa
PB
Pa and PB

1
6.5711
6.5711
0.
2
10.2655
10.2654
0.001
3 18.3759

18.3759 0.
4
26.2871
26.2871
0.
5

33.2716
33.2716
0.
6
59.1708
59.1708
0.
7
69.4570
69.4571
0.0001
8
105.3094 105.3091
0.0001
9 114.5567

114.5559 0.0007
10
118.9369
118.9376 0.0006

2.2
Results of reference

One observes the spectral concentration of acceleration on the node of the beam PB of X-coordinates 2.4 m (it
node PB25).

2.3 References
bibliographical

[1]
C. DUVAL "harmonic Response under random excitation in Code_Aster: principles
theoretical and examples of use " - Note HP-61/92.148
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

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3 Modeling
With

3.1
Characteristics of modeling

Discrete element in translation of the type DIS_T

PB11
PB15
PB21 PB25
PB31
PA1
PA11
PA21
PA31

Elements used: POU_D_T. The characteristics of beam are defined by:

CARELEM
=
AFFE_CARA_ELEM
(
BEAM

:
(
GROUP_MA
:
GRMAPRIM
......
SECTION:
“RIGHT-ANGLED”
CARA
:
(“HZ”
“HY”)
VALE
:
(0.1
0.1)
)

...) ;

The method of calculation asks for the calculation of static modes corresponding to the DDL excitation.

The Eigen frequencies taking into account in calculations are all the frequencies in the band [0, 35 Hz].

3.2
Characteristics of the grid

A number of nodes:
Pa: 31
PB: 21
A number of meshs and types:
Pa: 30 SEG2
PB: 20 SEG2

3.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO

LIAISON_DDL
MODE_ITER_INV

MODE_STATIQUE DDL_IMPO
AVEC_CMP
DEFI_INTE_SPEC KANAI_TAJIMI

DYNA_ALEA_MODAL EXCIT

MODE_STAT
ANSWER
REST_SPEC_PHYS

4

Results of modeling A

4.1 Values tested

Values of the spectral concentration of acceleration at point PB25:

Frequency Direct Node
Chains
%
difference
5. Hz
PB25
3.6913
3.7052
0.38%
10. Hz
PB25
75.439
75.797
0.47%
15. Hz
PB25
1.6777
1.6929
0.91%
20. Hz
PB25
1.1367
1.0987
3.34%
25. Hz
PB25
0.2927
0.2630
10.12%

4.2 Parameters of execution

Version: STA 5.02

Machine: SGI-Origin 2000

System:
IRIX 64
Obstruction memory:
8 megawords
Time CPU To use:
11.11 seconds

5
Summary of the results

The results obtained confirm on the one hand the assumption of equivalence between direct calculation and calculation
chained, in addition the good coherence of the calculation algorithm of dynamic response random.

A variation is inevitable between calculations of the two methods: that obtained to 25 Hz is too high (11%).

5.0

Titrate:
SDLL105 Pipe subjected to sources of random fluid excitations
Date:
30/08/01
Author (S):
J. PIGAT *Key*
:
V2.02.105-B Page:
1/6

Organization (S): EDF/RNE/AMV

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.105 document

SDLL105 - Pipe subjected to sources
random fluid excitations

Summary:

A right piping embedded at an end in the wall of a tank and supporting a mass with the other end is subjected to a fluid excitation.

The excitation is defined by its spectral concentration of power in the form of a "white vibration".

It covers all the types of source established in the code:

.
source of flow-volume,
.
source of flow-mass,
.
source of pressure,
.
source of force,
.
imposed effort.

One is interested in the spectral concentration of power of the response in a degree of freedom of pressure located on
node supporting the mass.

The random dynamic response is given here moving absolute.

---

1 *Problem of reference*

1.1 Geometry

4.0 m
6.0 m
acoustic section
section accoustics-mechanics
SOURCE
Tank
dx
m = 10 kg

Circular pipe of section:

External diameter: 0.1 m
Thickness: 3 mm

One does not take account of the field of gravity.

1.2
Material properties

Young modulus of the pipe:
E = 2.1 E+11 NR
Coefficient of compressibility of the pipe:
= 0.3
Density of the pipe:
= 7800 kg/m3
Density of the fluid:
F = 8.3 kg/m3
Celerity of the fluid:
C = 495 m/s

1.3
Boundary conditions and loadings

The DDL Dy, dz, drx, dry, drz are blocked for all the pipe.

On the acoustic section dx is also blocked and the only free DDL are NEAR and PHI.

At the end on the side tank: CLOSE = 0. PHI = 0.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams

2
Reference solution

2.1
Method of calculation used for the reference solution

No reference solution. The values tested for the not-regression are those obtained with version 3.02.17.

2.2
Results of reference

Spectral concentration of power of the pressure to the node at the right end of the tube, the frequencies 10, 12, 14, 36, 38, 40 Hz. These frequencies are close to the two Eigen frequencies catches in count (12.38 and 37.36 Hz).

2.3 References bibliographical

[1]
C. DUVAL "Dynamic response under random excitations in Code_Aster: principles theoretical and examples of use " - Note HP-61/92.148

3 Modeling With

3.1 Characteristics of modeling

4.0 m
6.0 m
dx
A7
A6
A5
A4
AM5 AM6 AM7 AM8 AM9 AM10
AM4
A3A2 A1 AM1AM2 AM3

Elements used for the pipes: FLUI_STRU

Element used for the mass in AM10: DIS_T

In all the calculation cases, the exiting spectral concentration is a white vibration of level 1.

The sources of flow-volume and flow-rate pressures are applied to node AM1.
The sources of mass and force are applied between nodes AM1 and AM2.

The last calculation case corresponds to a force imposed on node AM10 in the direction dx.

The clean modes of frequency in the interval [0, 100 Hz] were taken into account in calculation, that is to say the first two modes.

Damping is introduced in modal form into the operator of dynamic response random. For all the calculation cases, it is taken equal to 1%

3.2 Characteristics of the grid

A number of nodes: 17

A number of meshs and types: 16 SEG2, 1POI1

3.3 Functionalities tested

Orders

MODE_ITER_SIMULT

CONSTANT DEFI_INTE_SPEC

DYNA_ALEA_MODAL EXCIT SIZE
:
“SOUR_DEBI_VOLU”

SIZE
:
“SOUR_DEBI_MASS”

SIZE
:
“SOUR_PRESS”

SIZE
:
“SOUR_FORCE”

SIZE
:
“EFFO”
ANSWER

REST_SPEC_PHYS

3.4 Remarks

The spectral concentrations of fluid source are expressed in their physical units. For a source of volume flow rate in (m3/s) 2/Hz.

4
Results of modeling A

4.1
Values of not-regression tested

Values of the spectral concentration of acceleration at point PB25:

Frequency	Type of source	Aster
10 Hz	SOUR_DEBI_VOLU	9.1954E+11
12 Hz	SOUR_DEBI_VOLU	4.3709E+13

14 Hz
SOUR_DEBI_VOLU
3.6428E+12
36 Hz
SOUR_DEBI_VOLU
1.1142E+13
38 Hz
SOUR_DEBI_VOLU
3.6976E+13
40 Hz
SOUR_DEBI_VOLU
2.6238E+12

10 Hz
SOUR_DEBI_MASS
1.3347E+10
12 Hz
SOUR_DEBI_MASS
6.3448E+11
14 Hz
SOUR_DEBI_MASS
5.2879E+10
36 Hz
SOUR_DEBI_MASS
1.6173E+11
38 Hz
SOUR_DEBI_MASS
5.3675E+11
40 Hz
SOUR_DEBI_MASS
3.8088E+10

10 Hz
SOUR_PRESS
9.5991E+00
12 Hz
SOUR_PRESS
2.5952E+02
14 Hz
SOUR_PRESS

1.2365E+01
36 Hz
SOUR_PRESS
3.2428E+00
38 Hz
SOUR_PRESS
1.3681E+01
40 Hz
SOUR_PRESS
1.1649E+00

10 Hz
SOUR_FORCE
1.9931E+05
12 Hz
SOUR_FORCE
5.3887E+06
14 Hz
SOUR_FORCE
2.5675E+05
36 Hz
SOUR_FORCE
6.7334E+04
38 Hz
SOUR_FORCE
2.8408E+05
40 Hz
SOUR_FORCE
2.4189E+04

10 Hz
EFFO
2.6542E03
12 Hz
EFFO
4.5780E02
14 Hz
EFFO
9.0980E04
36 Hz

EFFO
3.3472E02
38 Hz
EFFO
0.1186
40 Hz
EFFO
8.8587E03

4.2 Parameters
of execution

Version: STA 5.02
Machine: SGI-Origin 2000

System:
IRIX 64
Obstruction memory:
8 megawords
Time CPU To use:
3.21 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

5
Summary of the results

This test makes it possible to pass in the options corresponding to the various types of source. It acts *primarily of a test developer.*

Not having a reference solution, it is simply a question of not regressing between the versions.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.106 document

SDLL106 - Beam subjected to an excitation

random distributed

Summary:

An Bi-embedded beam is subjected over all its length to an effort distributed. Profile of distribution of the force is identical to all the frequencies.

The random movement of this beam is evaluated by a stochastic approach: the density is determined spectral of power of displacement in various points of the beam.

The two possibilities are tested:

.

space function of the efforts applied with interspectre unit (method 1),

.

interspectre builds directly for the excited ddl (method 2).

This test is an illustration of the response of a structure subjected to a Eolienne excitation.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

1
Problem of reference

1.1 Geometry

obstacle
flexible
excitation
DY
DX

Beam:

Square section: 0.001 m X 0.001 m
Length: 0.8 m

One does not take account of the field of gravity.

1.2
Material properties

Young modulus:
E = 2.1 E+11 NR
Coefficient of compressibility:
= 0.3
Density:
= 7000 kg/m3

1.3
Boundary conditions and loadings

The beam is embedded at the two ends.

Ddl DZ is blocked in any point.

The effort applied is distributed with the following space distribution:

1
/
2
01
P1
P2
P3
P4
P5
P6
P7
P8
P9
0
l/4
l/2
3l/4
L
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
SDLL106 Beam subjected to a random excitation distributed
Date:
29/08/00
Author (S):
J. PIGAT *Key*
:

2
Reference solution

2.1
Method of calculation used for the reference solution

Direct calculation defines an assembled vector of space distribution of the effort and applies the density spectral of effort G
( )
FF on this distribution (method 1).

Broken up calculation defines the excitation as a matrix interspectrale of dimension 3 (equalizes with a many excited nodes) and apply, in effort imposed on the nodes, the following matrix interspectrale (method 2):

1 1 1

4 2 4

1
1. G
( )

1
FF
2
2

1 1 1

4 2 4

The two results must be identical without any approximation.

2.2 Results of reference

Spectral concentration of power of displacement of the P3 node at the frequencies: 4. , 6. , 8. , 10. and 12 Hz.

2.3 References bibliographical

*[1]
C. DUVAL “Dynamic response under random excitation in Code_Aster: principles theoretical and examples of use " - Note HP-61/92.148*

---

3 Modeling With

3.1 Characteristics of modeling

Discrete element in translation of the type DIS_T

Observation of the DSP of displacement
P1
P2
P3
P4
P5
P6
P7
P8
P9
Load application

Elements of beam: POU_D_T

The exiting spectral concentration is a white vibration of level 1.

The first 2 clean modes were taken into account in calculation.

Damping is introduced in the form of modal damping into the operator of answer random dynamics. For all the calculation cases, it is taken equal to 5%

3.2
Characteristics of the grid

A number of nodes: 9

A number of meshs and types: 8 SEG2

3.3 Functionalities tested

Orders

AFFE_CHAR_MECA FORCE_NODALE

MODE_ITER_INV

CONSTANT DEFI_INTE_SPEC

DYNA_ALEA_MODAL EXCIT
SIZE:

"EFFO"

CHAM_NO
ANSWER

REST_SPEC_PHYS

3.4 Remarks

The spectral concentrations are expressed in their physical unit. For a force it will be in N2/Hz.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

4
Results of modeling A

4.1 Values
tested

Spectral concentration of displacement at point AM10:

Frequency
Method 1
Method 2
% difference

4 Hz
4.0298E02
4.0298E02
0%
6 Hz
9.2971E02
9.2971E02
0%
8 Hz
9.5164E01
9.5164E01
0%
10 Hz
1.7617E01
1.7617E01
0%
12 Hz
2.6695E02
2.6695E02
0%

4.2 Parameters of execution

Version: STA 5.02
Machine: SGI-Origin 2000

System:
IRIX 64
Obstruction memory:
8 megawords
Time CPU To use:
2.39 seconds

5
Summary of the results

Method 1 (space distribution of the efforts) and indirect method (by decomposition on the three excited nodes) provide the same result.

This checking ensures a good coherence of the two methods and the quality of their programming.

Organization (S): EDF/EP/AMV

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.108 document
SDLL108 - "Table with coffee" of NEUBERT

Summary

This multidirectional problem consists in carrying out a spectral seismic analysis of a made up structure elements of beams without masses and discrete masses to the nodes. It includes/understands two

modelings
correspondent with two smoothnesses of discretization.
The seismic excitation is provided in the shape of three spectra of response of oscillators in acceleration to
supports according to axes' X, Y and Z.
Via this problem, one tests order MODE_STATIQUE [U4.52.04] and the options of
quadratic combination of the modes and quadratic combination of the directions of the excitations of order COMB_SISM_MODAL [U4.54.04].
The results obtained are in concord with the results of reference.

1
Problem of reference
1.1 Geometry

438,15
692,15
L = 0.69215 m
L = 0.43815 m
H = 0.473075 m
473,075
y
X
Z
hollow circular section: D = 0.060 m
E
D = 0.052 m
I
S = 0.7037 X 103 m2
Iy = Iz = 0.2772 X 106 m4

WITH = A = 2.
y
Z
C = 0.5545 X 106 m4
y

1.2
Material properties

E = 1.92276 E11 N/m2
= 0.3
= 0. kg/m3

1.3
Boundary conditions and loadings

· Structure embedded at its base,
· Modal Amortissements of 2%.
Definition of the spectrum of acceleration to the supports
Freq
X Z
Y
100
17.3
11.5
110
16.3
10.9
120
15.3
10.2
130
14.3
9.6
300
10.2
6.66
· for a damping of 2%,
· acceleration in G.

2
Reference solution

2.1
Method of calculation used for the reference solution

Comparison with other codes.

2.2
Results of reference

· Déplacements at the points constituting the corners of the table,
· Réactions of supports to anchorings,
· efforts intern with the "corners".

2.3 References
bibliographical

[1]
NEUBERT and EZELL: Dynamics behavior of has foundation like structure.

---

3 Modeling
With

3.1
Characteristics of modeling

219,075

254,
10
219,075
11
9
2
8
12
Net E2: N1 - N7
7
13
219,075
3

E3: N7 - N6
6
16
1

E12: N7 - N8
14
254,
5
17
X
15
4
Z
18
Masses of corners
: 4,444 kg
Intermediate masses: 1,566 kg
3.2
Characteristics of the grid
A number of nodes: 18
A number of meshs and types: 18 MECA_POU_D_T and 14 MECA_DIS_T_N
3.3 Functionalities
tested
Orders
Keys
MODE_STATIQUE
[U4.52.04]
MODE_ITER_INV

CALC_FREQ
[U4.52.02]
NORM_MODE
MASS_GENE
[U4.64.02]
DEFI_FONCTION
[U4.21.02]
DEFI_NAPPE
[U4.21.03]
COMB_SISM_MODAL
[U4.54.04]

3.4 Remarks

The modes are standardized with the generalized mass with 1.
The total answer is obtained by a quadratic combination of the modes and a combination quadratic of the directions of the excitations.

4
Results of modeling A

4.1 Values
tested

Identification
Reference
Aster
% difference
Displacement:
N5 DX
3.408E-04
3.409E-04

0.013
DY
4.364E-06
4.417E-06
1.218
DZ
3.019E-04
3.019E-04
0.010
DRX
3.684E-04
3.686E-04
0.044
DRY
4.988E-05
5.024E-05
0.718
DRZ
5.086E-04
5.090E-06
0.073
Reactions:
N15 FX
1.255E+03
1.257E+03
0.051
FY
1.257E+03
1.273E+03
1.282
FZ
1.220E+03
1.224E+03
0.381
MX
3.247E+02
3.248E+02
0.016
MY
4.345E+00
4.355E+00
0.239
MZ

3.483E+02
3.482E+02
-0.010
Efforts:
E2 N7 FX
1.135E+03
1.135E+03
-0.024
FY
1.241E+03
1.253E+03
0.922
FZ
1.101E+03
1.102E+03
0.145
MX
2.275E+02
2.275E+02
0.004
MY
4.346E+00
4.355E+00
0.218
MZ
2.196E+02
2.197E+02
0.048
E3 N7 FX
1.899E+02
1.913E+02
0.729
FY
1.039E+03
1.039E+03
0.016
FZ
1.306E+02
1.319E+02
0.987
MX
2.275E+02
2.275E+02

0.003
MY
3.057E+01
3.064E+01
0.220
MZ
2.100E-01
2.103E-01
0.171
E12 N7 FX
2.978E+02
2.997E+02
0.633
FY
6.351E+02
6.377E+02
0.409
FZ
2.673E+02
2.681E+02
0.299
MX
1.080E-01
1.080E-01
0.457
MY
3.388E+01
3.395E+01
0.205
MZ
2.196E+02
2.197E+02
0.048

4.2 Remarks

· Displacements of the corners (N5, N7, N10, N12) are identical,
· The reactions to the supports (N15, N16, N17, N18) are identical,
· Efforts generalized in the total reference mark.

4.3 Parameters of execution

Version: 3.05.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory: 8 megawords

Time CPU To use: 17.13 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

---

5 Modeling
B
5.1
Characteristics of modeling

155,75
155,75
127
127
12
127
13
155,75
127
14
11
155,75
15
5
10
16
17
9
4
Net E3: N6 - N17
18
24
8
155,75
22

E4: N17 - N18

23
6
19
21
127

E19: N17 - N16
28
3
20
1
27
190,5
7
25
2
26
Masses of corners
: 4,444 kg
Intermediate masses: 0,783 kg
5.2
Characteristics of the grid
A number of nodes: 24
A number of meshs and types: 28 (MECA_POU_D_T) and 24 MECA_DIS_T_N
5.3 Functionalities
tested
Orders
Keys
MODE_STATIQUE
[U4.52.04]
MODE_ITER_INV
CALC_FREQ
[U4.52.02]
NORM_MODE
[U4.64.02]
DEFI_FONCTION
[U4.21.02]
DEFI_NAPPE
[U4.21.03]
COMB_SISM_MODAL
[U4.54.04]
5.4 Remarks
The modes are standardized with the generalized mass with 1.

The total answer is obtained by quadratic combination of the modes and a quadratic combination directions of the excitations.

---

6 Results of modeling B

6.1 Values tested

Identification	Reference	Aster	% difference
Displacement:			
N17 DX	3.429E-04	3.419E-04	-0.278
DY	4.364E-06	4.392E-06	0.658
DZ	3.036E-04	3.027E-04	-0.300
DRX	3.701E-04	3.698E-04	-0.078

DRY
4.750E-05
4.762E-05
0.253
DRZ
5.110E-04
5.105E-04
-0.102
Reactions:
N25 FX
1.254E+03
1.253E+03
-0.072
FY
1.254E+03
1.263E+03
0.706
FZ
1.219E+03
1.219E+03
0.037
MX
3.249E+02
3.245E+02
-0.132
MY
4.124E+00
4.128E+00
0.104
MZ
3.486E+02
3.482E+02
-0.133
Efforts:
E3 N17 FX
1.130E+03
1.131E+03
0.062
FY
1.245E+03
1.249E+03
0.351
FZ

1.098E+03
1.098E+03
-0.007
MX
2.286E+02
2.282E+02
-0.174
MY
4.125E+00
4.128E+00
0.072
MZ
2.208E+02
2.205E+02
-0.134
E4 N17 FX
1.881E+02
1.893E+02
0.670
FY
1.042E+03
1.042E+03
-0.023
FZ
1.311E+02
1.320E+02
0.703
MX
2.286E+02
2.282E+02
-0.175
MY
2.910E+01
2.918E+01
0.269
MZ
1.860E-01
1.857E-01
-0.159
E19 N17 FX
2.935E+02
2.966E+02
1.053

FY
6.367E+02
6.390E+02
0.359
FZ
2.653E+02
2.653E+02
0.006
MX
1.860E-01
1.860E-01
0.040
MY
3.231E+01
3.236E+01
0.148
MZ
2.208E+02
2.205E+02
-0.134

6.2 Remarks

· Displacements of the corners (N9, N12, N17, N20) are identical,
· The reactions to the supports (N25, N26, N27, N28) are identical,
· Efforts generalized in the total reference mark.

**6.3 Parameters
of execution**

Version: 3.05.02
Machine: CRAY
System: UNICOS
Obstruction memory: 8 megawords
Time CPU To use: 18.03 seconds
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/96/051 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLL108 “Counts with coffee” of NEUBERT
Date:
08/01/98
Author (S):

7 Summaries of the results

One obtains a relatively good agreement between the solution calculated with Aster and the reference solution
(% of difference lower than 1%), except in modeling A, Depl N5 DY and Réaction N15 FY where variations reach 1,2%.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.113

SDLL113 - Under-structuring dynamic transient: beam in simple traction

Summary:

The structure considered is an annular beam of section in simple traction, embedded on a side, and subjected at its end with a force of the Heaviside type. Its transitory dynamic response is calculated by under-structuring.
The beam is modelled by elements of the beams type of Timoshenko (linear model). Two modelings are proposed according to whether the beam is deadened or not. Damping tested is of type RAYLEIGH (damping proportional).
The results of reference result from a direct transitory calculation by modal recombination without under-structuring with operator DYNA_TRAN_MODAL [U4.54.03]. This test thus makes it possible to validate the tools of transitory calculation of response per under-structuring, in the linear case.

Author (S):
G. Key ROUSSEAU

1
Problem of reference

1.1 Geometry

y
With
N5
N10
F
X
Z
section
L

Length of the beam: L = 1 m

Section: Interior ray = 0.09 m

External ray = 0.10 m

1.2
Properties of materials

E = 1x1010 Pa
= 0.3
= 1x104 kg/m3

Modeling a: not of damping
Modeling b: Damping proportional (RAYLEIGH):

C = K + M with = 6.5x106 S and = 16.0 s1.

These values correspond to a reduced damping of 1% on the first mode of the structure.

1.3
Boundary conditions and loadings

On all the structure one imposes DY = DZ = DRX = DRY = DRZ = 0.
On point A one imposes the condition of embedding DX = 0.
In N10 one applies a constant force as from the moment t=0: Fx = 100 NR.

Fx (NR)
T (S)
-100

1.4 Conditions
initial

The structure is initially at rest.

2
Reference solution

2.1
Method of calculation used for the reference solution

There is an analytical solution detailed in the reference [bib1].

The following notations are adopted:

E

: Young modulus

: mass
voluminal
L
: length of the bar
With
: section of the bar
NR
: normal effort directed according to axis X
: damping coefficients of Rayleigh

One also poses:

= (2 -)
N
N 1
where
N = 1 2
, 3
, ,...
2

1
= (+ /
N
N
N).
2

Displacement in a point M (X) unspecified is given by:

- T

(
Nx
8NL
N E
N N

2

2

U X, T) =
+

.
2
(-) 1
C
bone 1
T
N
+
sin 1 -
T
EA
2
(N N)
2
(N N)
EA n=1
(2n -)
1
1 -

N

2.2
Results of reference

Values of the fields of displacement, speed and acceleration of the loose lead (N10 node) are worth at the moment T = 0.0195 S:

Displacement (m)
Speed (Mr. s1) Acceleration (Mr. s2)
Calculation without damping
8.3766x107
1.6753 X 103 0
Calculation with structural damping

1.00462x106
1.20384x103 1.21564

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
G. ROBERT: Analytical solutions in dynamics of the structures. Report/ratio Samtech n°121, March 1996.

---

3 Modeling
With

3.1
Characteristics of modeling

The beam is cut out in two parts of equal size. Each substructure considered is
with a grid in segments to which are affected of the elements of the type "POU_D_T".

F
X
L/2
L/2

The structure is studied using the method of under-structuring transitory with interfaces of the type "Craig-Bampton" (blocked interfaces).

The modal base used is made up of 4 clean modes for the substructure of left, of 5 clean modes for the substructure of right-hand side to which the constrained modes associated are added with degrees of freedom of interface (2).

Base projection of the substructure of left:

With
N5
Modes with interface
With
N5
Constrained mode
blocked
dx = 1
Base projection of the substructure of right-hand side:
N5
N10
N5
N10
N5
N10
Fx
dx = 1
Modes with interface
blocked
Constrained mode

3.2
Characteristics of the grids

The grid of the complete beam to carry out the calculation of reference shows the characteristics following:

file of the type grid Aster (.mail)

A number of nodes = 11
A number of meshs = 10 SEG2

The grid of the half-beam to carry out calculation by under-structuring, presents them following characteristics:

file of the type Ideas (.msup)
A number of nodes = 6
A number of meshs = 5 SEG2

3.3
Functionalities tested

Orders
Key word factor
Key word
Argument
Keys
MODE_ITER_SIMULT CALC_FREQ
NMAX_FREQ

[U4.52.02]
DEFI_INTERF_DYNA INTERFACES
TYPE
"CRAIGB" [U4.55.03]
TRADITIONAL DEFI_BASE_MODALE

[U4.55.04]
MACR_ELEM_DYNA
"TRADITIONAL" OPTION
[U4.55.05]
DYNA_TRAN_MODAL EXCIT
VECT_GENE

[U4.54.03]
REST_BASE_PHYS INTERPOL
"FLAX"
[U4.64.01]
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

Code_Aster ®

4
Results of modeling A

4.1 Values
tested

The values are restored on a grid skeleton made up of the two substructures. Grid
initial which contains 6 nodes is duplicated to create the substructure of right-hand side. The node of
end
thus corresponds to node 12.

Identification Reference
Under-structuring Difference
(%)
(beam supplements)
Node 12: displacement (m)
6.2818E7
6.2818E7
< 0.1
Node 12: speed (m.s1)
2.0957E3 2.0957E3 <
0.1
Node 12: acceleration (m.s2)
1.1139E+1 1.1139E+1 <
0.1

4.2 Remarks

One can be astonished that the adopted reference corresponds to the complete beam modelled by 10 elements and not with the analytical solution. It is that the development of the solution in series of clean modes converges very slowly: the modal solution is very far away from the solution here theoretical. The relevant comparison is thus well that selected.

Calculation by modal recombination is carried out on the basis of complete modal structure (11 modes) taking into account the adopted discretization. In the same way, the dimension of the base of projection used for calculation by dynamic under-structuring 11 (substructure of left is: 4 modes clean + 1 constrained mode; substructure of right-hand side: 5 clean modes + 1 constrained mode). It is thus normal to obtain an excellent agreement between the modeling of the complete beam and that of beam divided into two substructures.

4.3 Parameters of execution

Version: STA 5.03
Machine: SGI ORIGIN 2000
Obstruction memory: 64 Mo, Time CPU To use: 10,29 seconds.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

---

5 Modeling B

5.1
Characteristics of modeling

The characteristics of this modeling are identical to the preceding one (modeling A). Only difference lies in the fact that the structure is deadened. Damping used is of type proportional:

C = K + M with = 6.5x106 S and = 16.0 s1.

These values correspond to a reduced damping of 1% on the first mode of the structure.

5.2
Characteristics of the grid

The characteristics of the grid are also identical to those of modeling A (cf [§ 3.2]).

5.3
Functionalities tested

Orders
Key word factor
Key word
Argument
Keys
MODE_ITER_SIMULT CALC_FREQ
NMAX_FREQ

[U4.52.02]
DEFI_INTERF_DYNA INTERFACES
TYPE
"CRAIGB" [U4.55.03]
TRADITIONAL DEFI_BASE_MODALE

[U4.55.04]
MACR_ELEM_DYNA MATR_AMOR
OPTION
"TRADITIONAL"
[U4.55.05]
ASSE_MATR_GENE
OPTION
"AMOR_GENE"
[U4.55.08]

DYNA_TRAN_MODAL EXCIT
VECT_GENE

[U4.54.03]
AMOR_GENE

REST_BASE_PHYS INTERPOL

“FLAX” [U4.64.01]

6
Results of modeling B

6.1 Values
tested

The results are restored on a grid skeleton made up of the two substructures. Grid
initial which contains 6 nodes is thus duplicated to create the substructure of right-hand side. The
node
of end thus corresponds to node 12.

Identification Reference
Under-structuring Difference
(%)
(complete model)
Node 12: displacement (m)
9.54882E7
9.54882E7
< 0.1
Node 12: speed (m.s1)
1.22190E3 1.22190E3 <
0.1
Node 12: acceleration (m.s2)
1.91712E+0 1.91712E+0
<
0.1

6.2 Remarks

One can be astonished that the adopted reference corresponds to the complete beam modelled by 10 elements and not with the analytical solution. Important differences between the numerical solutions and theoretical are ascribable with the reduced number of elements. The use of 50 elements instead of 10 would have allowed to approach theoretical acceleration with a margin of 1%. That put aside, one can note that the use of a method of under-structuring provides the same results as those of the beam complete.

Calculation by modal superposition is carried out on the basis of complete modal structure (11 modes). In the same way, the dimension of the base of projection used for calculation by under-structuring dynamics is 11 (substructure of left: 4 clean modes + 1 constrained mode; substructure of right-hand side: 5 clean modes + 1 constrained mode). It is thus normal to obtain an excellent agreement enters the modeling of the complete beam and its modeling in two substructures.

6.3 Parameters of execution

Version: STA 5.03
Machine: SGI ORIGIN 2000
Obstruction memory: 64 Mo, Time CPU To use: 13,41 seconds.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-62/01/012/A

---

7 ***Summary of the results***

As well in the case not deadened as in the deadened case, the results obtained using the model complete and by under-structuring do not present significant variations. Operators of calculation linear transient by under-structuring are thus validated.

In the deadened case, the agreement between the solutions numerical and analytical would have been better while taking
more elements (50 instead of 10 for example).

Lastly, let us announce that the results obtained by Code_Aster were compared with results obtained by the SAMCEF software. They are included in the table below. One notes that in the case not deadened, the two software provides nearby results, quite as far away from the solution analytical.

Identification
Case not deadened
Deadened case

Code_Aster
The SAMCEF software
Code_Aster
The SAMCEF software
N12, displacement (m)
6.282E7 6.290E7

9.549E7 9.557E7
N12, speed (m/s)
2.096E3 2.080E3
1.222E3 1.222E3
N12, acceleration (m/s ²)
1.114E+1 1.075E+1
1.917E+0 1.910E+0

Titrate:
SDLL118 - Beam subjected to an axial excitation fluid-rubber band
Date:
01/03/04
Author (S):
***A. ADOBES**, Key Mr. LAINET*
:

Organization (S): EDF-R & D /MFTT, CS

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.118

SDLL118 - Beam subjected to an excitation fluid-rubber band axial

Summary:

One considers a PVC tube placed at the center of a cylindrical enclosure of section circular and subjected to the action of an axial water flow. This hardware configuration corresponds to the experimental device of Tanaka and Al [bib1] which is used to measure the evolutions of frequency and reduced damping of the first mode tube according to the mean velocity of the flow.

The goal of this case-test is to validate the resorption of model MEFISTEAU [R4.07.04] making it possible to calculate them modal characteristics of a telegraphic structure under confined axial flow, by taking account of one excitation of the fluid-rubber band type.

The functionalities particular to test are as follows:

· operator DEFI_FLUI_STRU [U4.25.01]: definition of the parameters for the taking into account of coupling fluid-rubber band, in the case of a configuration of the type "beam of tubes under axial flow" (key word factor FAISCEAU_AXIAL),
· operator CALC_FLUI_STRU [U47.66.02]: calculation of the evolutions of the frequencies and depreciation modal tiny rooms according to the mean velocity of the flow, by the implementation of the model MEFISTEAU.

The numerical results of the simulation of the device of Tanaka and Al are validated by comparison with experimental results. Taking into account relatively important uncertainties on the values experimental, the results of reference for nonthe regression of the code are those obtained numerically during the restitution of the case-test.

---

1 Problem of reference

1.1 Geometry

The tube considered is a hollow roll whose characteristic dimensions are as follows:

length
L
= 1 m,
external diameter
ext. = 13 mm,
internal diameter
int = 8,8 Misters.

The tube is placed in the center of a cylindrical enclosure of circular section. The internal diameter of the enclosure is worth D = 5 cm.

The surface roughness of the tube is worth = 105 Mr.

1.2 Properties of materials

The physical characteristics of material PVC constituting the tube are as follows:

Young modulus
E = 2,80. 109 Pa,
Poisson's ratio = 0,3,

density
= 1500 kg/m3.

Water surrounding the tube has the following properties:

density
water = 1000 kg/m3,
kinematic viscosity water = 1,1.106 m2/s.

1.3
Boundary conditions and loadings

The two ends of the tube are connected to fixed supports by two metal stems. The relative one flexibility of inflection of these stems releases the degrees of freedom of rotation of the ends of the tube. One
can thus estimate that the conditions of self-supporting quality of the tube are of the rotulé-rotulé type, the stems
metal introducing of each end an additional stiffness of rotation.

Moreover, these stems make it possible to apply an axial load to the tube, which can thus be prestressed in
traction or in compression. In practice, two configurations are studied:

· nonprestressed tube: no effort is applied. This configuration corresponds to
modeling A of the case-test,
· tube prestressed in compression by application of an axial load of 40 NR at an end.
This configuration corresponds to modeling B of the case-test.

1.4 Reference
bibliographical

[1]
Mr. TANAKA, K. FUJITA, A. HOTTA and NR. KONO: "Parallel flow-induced damping of PWR fuel assembly ", ASME Conference, Pittsburgh, Pa, PVP vol. 133 (1988)
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

2
Reference solution

The experimental measurements taken on the device of Tanaka and Al provide the values of reference for the validation of the model.

Two graphs below, representing the evolutions of the frequencies and damping tiny room of the first mode doubles inflection according to the mean velocity of the flow, allow to compare the results of the model with the experimental results.

Taking into account uncertainties on measurements, the tolerance of relative variation for the validation of the model
is rather broad. This is why experimental measurements cannot be used as values of reference for the case-test, a narrower tolerance being necessary to guarantee nonthe regression of the code. values of reference used are thus those obtained numerically during the restitution of the case test.

---

3 Modeling With

3.1 Characteristics of modeling

The tube is represented by 100 elements of right beams of Timoshenko (MECA_POU_D_T), supported per as many meshs segments to 2 nodes (SEG2). Two elements MECA_DIS_TR are additions with the nodes ends of the tube, allowing to model the metal stems by stiffnesses of rotation discrete.

One carries out with the elements of beam the characteristics of circular section:

external ray
Rext = 6,5.103 m,

thickness E
=
2,1.103 Mr.
(cf paragraph [§1.1])

One also assigns to these elements a material of behavior ELAS:

Young modulus
E = 2,80. 109 Pa,

Poisson's ratio = 0,3,

density
= 1500 kg/m3.
(cf paragraph [§1.2])

One assigns to the discrete elements the same stiffness of rotation around the two orthogonal axes to the neutral fibre of the tube:

Kr = 6,29 Nm/rad

This stiffness of rotation was adjusted in order to find the Eigen frequency of the first double mode in air.

The degrees of freedom in translation DX and DZ of the nodes ends N001 and N101 are blocked so to prohibit a rigid movement of body of the tube (axial translatory movement). One blocks also the DY of the N001 node. Moreover, in each node, one blocks the degree of freedom of rotation DRY, in order to prohibit any movement of torsion.

The tube is immersed in a cylindrical enclosure of 2,5 cm interior ray (cf paragraph [§1.1]). The profiles of density and kinematic viscosity of surrounding water are presumedly constant along the tube:

density
water = 1000 kg/m3,

kinematic viscosity water = 1,1.106 m2/s.
(cf paragraph [§1.2])

No axial load is applied to the tube which is thus not prestressed.

The evolutions of the frequency and the reduced damping of the first double mode of inflection are calculated for a beach mean velocities of flow from 0 to 8 m/s, by step of 1 m/s.
One takes account of an initial reduced damping of the tube of the 4,8%.

3.2
Characteristics of the grid

The total number of nodes used for the grid is 101.
The meshs (of type SEG2) are 100.
The file of grid is with the format ASTER.
Handbook of Validation

3.3 Stages of calculation

Validation of the operators of coupling fluid-structure, for configurations of the type "beam tubes under axial flow" is made in two principal stages.

The first consists in defining the parameters of taking into account of the coupling fluid-structure with operator DEFI_FLUI_STRU followed by key word FAISCEAU_AXIAL.
The second is the calculation of the evolutions of modal frequency and reduced damping according to mean velocity of the flow, with operator CALC_FLUI_STRU and by the implementation of model MEFISTEAU.

3.4 Functionalities tested

Orders Key word
factor Key word
DEFI_FLUI_STRU
FAISCEAU_AXIAL
TYPE_PAS: "CARRE_LIGN"

NOT: 1.5

TYPE_RESEAU: 1/3

CALC_FLUI_STRU BASE_MODALE
MODE_MECA
MODI_BASE_MODALE

4
Results of modeling A

4.1 Values
tested

The tests relate to the frequency and the reduced damping of the first double mode of inflection of tube, at the mean velocity of flow of 0 m/s and 4 m/s. 2 types of test are carried out:

· a test of comparison with experimental measurements,
· a test to guarantee nonthe regression of the code.

4.1.1 Frequency of the first mode doubles inflection

· Test of comparison with the experiment, at the rate of flow of 0 m/s:

The tolerance of relative variation compared to the experimental value is worth 0,1%.

Number of the mode
Experimental value

Computed value
Relative variation
1
7 Hz
7,0011331924304 Hz
+0,016%
2
7 Hz
7,0011331924505 Hz
+0,016%

· Test of nonregression of the code, at the rate of flow of 4 m/s:

The tolerance of relative variation compared to the reference is worth 10 8%.

Number of the mode
Value of reference
Computed value
Relative variation
1
6,812275 Hz
6,8122749601350 Hz
-5,85.10-9%
2
6,812275 Hz
6,8122749601557 Hz
-5,85.10-9%

4.1.2 Reduced damping of the first mode doubles inflection

· Test of comparison with the experiment, at the rate of flow of 4 m/s:

The tolerance of relative variation compared to the reference is worth 1%.

Number of the mode
Experimental value
Computed value
Relative variation
1
17 %
16,972486655473 %
-0,162 %
2
17 %

16,972486655445 %
-0,162 %

· Test of nonregression of the code, at the rate of flow of 4 m/s:

The tolerance of relative variation compared to the reference is worth 10 6%.

Number of the mode
Value of reference
Computed value
Relative variation
1
16,97249 %
16,972486655473 %
-1,97.10-7%
2
16,97249 %
16,972486655445 %
-1,97.10-7%

4.2 Remarks

The values of reference those are obtained by Code_Aster during the restitution of the case-test, which
thus allows to check nonthe regression of the code during its evolution.

---

5 Modeling

B

5.1
Characteristics of modeling

Modeling B is identical to modeling A (cf paragraph [§3.1]), but this time the tube is prestressed in compression.

An axial load of compression of 23,7 NR is applied to the node N101 end. The intensity of the effort has thus readjusted compared to the provided experimental value of 40 NR, in order to find correctly the value of frequency of the first mode doubles in air (cf paragraphs [§1.2], [§1.3]). It readjustment can apply by the summary modeling of the metal stems ensuring it self-supporting quality and the setting in compression.

One deduces from the nodal effort the vector of elementary efforts, then an assembled vector which is built according to the classification of the degrees of freedom of the tube. Static deformation due to the setting in compression is then obtained by multiplying the vector assembled by the reverse of the matrix of rigidity structural. Using this static deformation, one calculates then a stress field with elements, whose is deduced a geometrical matrix of rigidity. This one is then added to stamp structural rigidity in order to obtain the matrix of rigidity of the tube in compression, which is finally used for the calculation of the modes in air.

The evolutions of the frequency and the reduced damping of the first double mode of inflection are calculated for a beach mean velocities of flow from 0 to 8 m/s, by step of 1 m/s. One holds count of an initial reduced damping of the tube of 4,3%.

5.2
Characteristics of the grid

The characteristics of the grid of this second modeling are the same ones as those of modeling A, is:
101 nodes used and 100 meshs of the type SEG2.

The file of grid is with the format ASTER.

5.3
Stages of calculation

Just as for modeling A, the functionalities to be validated are those of the operators of coupling fluid-structure for configurations of the type “beam of tubes under axial flow” (cf paragraph [§3.3]).

Moreover, modeling B makes it possible to test other functionalities.
The first makes it possible to carry out the calculation of a field of displacements to the nodes by inversion of
stamp rigidity structural and product of the reverse by a vector of assembled effort, with operators FACT_LDLT and RESO_LDLT.
The second allows the calculation of a geometrical matrix of rigidity using a stress field with the elements, with the operator CALC_MATR_ELEM, option RIGI_GEOM.

5.4 Functionalities tested

Orders Key word
factor Key word
FACT_LDLT

RESO_LDLT

CALC_MATR_ELEM RIGI_GEOM

DEFI_FONC_FLUI

DEFI_FLUI_STRU FAISCEAU_AXIAL

DEFI_MATERIAU ELAS_FLUI

CALC_FLUI_STRU BASE_MODALE
MODE_MECA
MODI_BASE_MODALE

---

6 Results of modeling B

6.1 Values tested

The tests relate to the frequency and the reduced damping of the first double mode of inflection of tube, at the mean velocity of flow of 0 m/s and 4 m/s. 2 types of test are carried out:

- ***a test of comparison with experimental measurements,***
- ***a test to guarantee nonthe regression of the code.***

6.1.1 Frequency of the first mode doubles inflection

· Test of comparison with the experiment, at the rate of flow of 0 m/s:

The tolerance of relative variation compared to the reference is worth 0,1%.

Number of the mode	Experimental value	Computed value	Relative variation
1	5,1 Hz	5,1046169521712 Hz	+0,091%
2	5,1 Hz	5,1046169521914 Hz	+0,091%

· Test of nonregression of the code, at the rate of flow of 4 m/s:

The tolerance of relative variation compared to the reference is worth 10 7%.

Number of the mode	Value of reference	Computed value	Relative variation
1	4,842109 Hz		

4,8421086446841 Hz
-7,34.10-8%
2
4,842109 Hz
4,8421086447056 Hz
-7,34.10-8%

6.1.2 Reduced damping of the first mode doubles inflection

· Test of comparison with the experiment, at the rate of flow of 4 m/s:

The tolerance of relative variation compared to the reference is worth 10%.

Number of the mode
Experimental value
Computed value
Relative variation
1
21,1 %
21,935720674426 %
+3,96 %
2
21,1 %
21,935720674292 %
+3,96 %

· Test of nonregression of the code, at the rate of flow of 4 m/s:

The tolerance of relative variation compared to the reference is worth 10 7%.

Number of the mode
Value of reference
Computed value
Relative variation
1
21,93572 %
21,935720674426 %
+3,07.10-8%
2
21,93572 %
21,935720674292 %
+3,07.10-8%

6.2 Remarks

The values of reference those are obtained by Code_Aster during the restitution of the case-test, which
allows to check nonthe regression of the code during its evolution.

Handbook of Validation
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Titrate:
SDLL130 - Seismic response of a beam BA to linear behavior
Date:
15/10/03
Author (S):
***S. MILL,** L. DAVENNE, F.GATUINGT*
Key: V2.02.130-A Page:
1/8

Organization (S): EDF-R & D /AMA, LMT Cachan

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.130

SDLL130 - Seismic response of a beam in
reinforced concrete (rectangular section) with behavior
linear

Summary:

The problem consists in analyzing the seismic response of a concrete beam reinforced via one modeling beam multifibre (POU_D_EM, modeling B).
The calculation of reference (modeling A) is made using Code_Aster with "traditional" elements of beam Euler Bernoulli (POU_D_E).
Handbook of Validation

V2.02 booklet: Linear dynamics of the beams
HT-66/03/008/A

---

1 Characteristics general

1.1 Geometry

It is about a beam simply supported on its two supports [Figure 1.1-a].

y
X
5.400 mm
500 mm
Frameworks HA8 separated by 100 mm
5.000 mm
20 mm
44 mm
20 mm
32 mm
28
y
500 mm
Z
Tally HA8 spaced 100 mm
232
200 mm
44 mm

Appear 1.1-a: geometry of the structure

1.2
Material properties

.
concrete: E = 37.272 MPa, = 0.2, = 2400 kg/m3
.
steel: E = 200.000 MPa, = 0.33, = 7800 kg/m3
.
damping: of type Rayleigh (K+M), with 5% on modes 1 and 2

1.3
Boundary conditions and loadings

Simple support in b: Dy = 0
Support "doubles" in a: dx = Dy = 0
To avoid the clean modes except plan, one blocks the following degrees of freedom on all the beam:
X-ray = ry = dz = 0

Loading: seism ac_s2_c_1 [Figure 1.3-a], in axis OY applied to the two supports (factor of amplification of the signal = 137).

NB: the transverse reinforcements are not taken into account in calculations

---

3
2

1
0
-1
-2
-3
0
2
4
6
8
10
12
14
16
Time (S)

Appear 1.3-a: Accélérogramme ac_s2_c_1 imposed on the structure

2
Reference solution Modeling A

The reference is obtained by a Code_Aster calculation with traditional elements of beam of Euler (POU_D_E). The characteristics for this calculation of reference are obtained while homogenizing steel-concrete section:

Ea
200000
Section:
2
S
= S +
S = 1
,
0 +
× ,
0 0017 = 109
,
0
m
eq
B

E

has
37272
B
Ea
-
200000
Quadratic moment:
3
-5
-3
4
I
= I +
I =,
2 078.10
+
× 122
,
8
.10
= 514
,
2
.10
m
eq
B

E
has
37272
B

The density selected is that of the concrete (the weight of steel is neglected).

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Code_Aster ®
Version
7.1

Titrate:

3
Modeling B (POU_D_EM)

3.1
Characteristics of modeling

Longitudinal grid of the beam:
It is composed of 17 nodes and 16 pairs of elements POU_D_EM (16 elements for the concrete and 16 for
steel).

Cross section of the beam:
The concrete is modelled by a grid (AFFE_SECT) composed of 2 X 20 quadrilaterals (40 fibres)

Appear 3.1-a: Discretization of the section

Steel is modelled by 4 specific fibres (AFFE_FIBRE)

The coefficients and for damping are calculated using the following formula

1 2
1
1 1
=

2

2
2

-
2
1

2
1
2

-
2
1

where
1
and 2 are the first two own pulsations (F =
2
) and 1 and 2 is them
depreciation wished on the first two modes.
With F
37 8
, Hz
1 =
and F
,
149 2 Hz
2 =
(see paragraph [§4]), for modal depreciation of
5%, we find:
5

5
,
8 .10-
=
and =
985
,

18
.

For the calculation of the temporal answer, the step of selected time is 1/100ème of second.

3.2 Functionalities
tested

Orders

CREA_MAILLAGE
CREA_GROUP_MA

AFFE_MODELE GRID

AFFE
ALL
"YES"
PHENOMENON
"MECHANICAL"
MODELING
"POU_D_EM"
DEFI_MATERIAU
"ELAS"

AFFE_MATERIAU
GROUP_MA
MATER
AFFE_CARA_ELEM BEAM
GROUP_MA

SECTION

ORIENTATION
GROUP_MA

CARA
“ANGL_VRIL”
AFFE_SECT
GROUP_MA

MAILLAGE_SECT
“YES”

TOUT_SECT

AFFE_PONCT
GROUP_MA
“DIAMETER”
CARA
VALE
MODEL AFFE_CHAR_MECA

DDL_IMPO
GROUP_NO

CALC_MATR_ELEM OPTION
RIGI_MECA

MASS_MECA

AMOR_MECA
NUME_DDL MATR_RIGI

METHOD

"LDLT"
RENUM
"WITHOUT"
ASSE_MATRICE MATR_ELEM

NUME_DDL
MODE_ITER_SIMULT MATR_A

MATR_B

CALC_FREQ
OPTION
"PLUS_PETITE"
NMAX_FREQ
CALC_CHAR_SEISME MONO_APPUI
"YES"
DIRECTION
DYNA_LINE_TRAN MATR_MASS

MATR_RIGI

NEWMARK

EXCIT
VECT_ASSE

FONC_MULT
INCREMENT

CALC_ELEM OPTION

`SIEF_ELGA_DEPL

'

CALC_NO OPTION
"REAC_NODA"

4 Results

The curves of reaction according to time and arrow in the center according to time are presented on the figures [Figure 4-a] with [Figure 4-d].

300
200
100
0
-100
-200
Aster ref.
ASTER
-300
0
2
4
6
8
10
12
14
16
Time (S)

Appear 4-a: Reaction to the first supports according to time

150
100
50

0
-50
-100
-150
-200
ASTER ref.
ASTER
-250
2
2,2
2,4
2,6
2,8
3

Appear 4-b: Detail of the reaction between 2 and 3 seconds

10
8
6
4
2
0
-2
-4
-6
-8

ASTER ref.
ASTER
-10
0
5
10
15
Time (S)

Appear 4-c: Arrow in the center according to time

9
7
5
3
1
ASTER ref.
ASTER
-1
-3
2,5
2,55
2,6
2,65
2,7
2,75
2,8

Appear 4-d: Detail of the arrow between 2,5 and 2,8 seconds

Tests of results (TEST_RESU) are carried out for the first three Eigen frequencies. One also test the reaction on the first support and the arrow in the center is tested at the moments 1s (not 100) and 2s (not 200), then for the 2 first extremums of the curves, at the moments 2,68s (not 268) and 4,68s (not 468).

Eigen frequency
ASTER ref.
ASTER
Relative error %

1
37,80
37,83
0,07

2
149,20
149,28
0,05

3
200,30
200,39
0,04

REACTION
ASTER ref.

ASTER
Relative error %

1,00 S
1,8878.104
1,8479.104
2,1

2,00 S
6,3393.104
6,2184.104
1,9

2,68 S
-2,3222.105
-2,2443.105
3,4

4,68 S
2,4692.105
2,3979.105
2,9

ARROW ASTER
Ref.
ASTER
Relative error %

1,00 S
-6,0694.10-4
-5,9846.10-4
1,4

2,00 S
-2,3507.10-3
-2,3362.10-3
0,6

2,68 S
8,5790.10-3
8,3929.10-3
2,2

4,68 S
-9,1084.10-3
-8,9530.10-3
1,7

5
Summary of the results

The results obtained using modeling beam multifibre (POU_D_EM) are in concord with the traditional modeling of right beam of Euler (POU_D_E) of Code_Aster.

Version
6.4

Titrate:
Seismic SDLL131- Calculation of a piping VVP. Comparison Aster-SYSPIPE Dates:
05/03/04
Author (S):
Y. PONS, D. NUNEZ, L. VIVAN* Key*
:
V2.02.131-A Page:
1/16

Organization (S): EDF-R & D /AMA, (*) CS IF

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.131

SDLL131 - Seismic calculation of a piping VVP. Comparison Aster-SYSPIPE

Summary:

This test contributes to the validation of the operator of spectral analysis COMB_SISM_MODAL of Code_Aster.
The studied structure is a line of piping VVP subjected to an excitation multi supports. It is with a

grid in
elements of right beam POU_D_T and curve POU_C_T.

The numerical reference solution is given by code SYSPIPE of FRAMATOME.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

1
Problem of reference

1.1 Geometry

· ***Isométrie:***

C1
N10 N12
N4
SP14
N3
C2
N13
N49
DAB
N1
M55
DAB
N17
PRICKING STEAM GENERATOR
M61
N48
SP13
N19
M60
N47
M54

N17
N46
SP13
N50
M56
M57
N19
N51
Z
SP12
N52
M58
M59
SP12
Y
N39
N39
X
N53
N43
C3
N44
N45
CROSSING BR

Studied line VVP presents a developed length of 28,4m.
The supports weight (SP12, SP13 and SP14) and the blocking device car (DAB) are not taken in count in the seismic analysis.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
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Code_Aster ®
Version
6.4

Titrate:
Seismic SDLL131- Calculation of a piping VVP. Comparison Aster-SYSPIPE Dates:
05/03/04
Author (S):
Y. PONS, *D. NUNEZ*, L. VIVAN* Key*

Co-ordinates of the points (m):

NODES
COOR X (m)
COOR Y (m)
COOR Z (m)
N3
-0,91514 10,46 30,861
bend C1
N4
-1,7194 11,368
32,081
center curve
-1,7194
11,368
30,861
N12
-4,5175 14,526
32,069
bend C2
N13
-5,3224 15,435
30,849
center curve
-4,5175
14,526
30,849
N43
-5,3224 15,435
15,409
bend C3
N44
-5,7184 16,583
14,189
center curve
-5,7184
16,583
15,409

pricking Steam Generator
N1
-0,91514 10,46 29,944
crossing Br
N45
-5,8819 17,058
14,187
support SP14
N10
-3,6221 13,515
32,076
N17
-5,3224 15,435
29
N46
-4,7079 15,646
29
DAB+attache
N47
-4,6449 15,569
29
N48
-5,9369 15,223
29
N49
-5,9386 15,123
29
N19
-5,3224 15,435
28
support SP13
N50
-5,4169 15,402
28
N51
-5,2278 15,467
28
N39
-5,3224 15,435
17,4
support SP12
N52
-5,4169 15,402

17,4
N53
-5,2278 15,467
17,4

· ***Caractéristiques of the sections:***

Rext (m)
ep (m)
GROUP_MA
ring Steam Generator
0,408 0,038 GMAT04
current right portion
0,406 0,03 GMAT02
attach DAB
0,406 0,03 GMAT06
anchoring support
0,406 0,4 GMAT05
elbows C1, C2 and C3
0,406 0,032 GMAT03

Coefficient of flexibility RCC-M of the elbows: k=6,43.
Radius of curvature: Rc=1,22m.

1.2
Material properties

materials E
(Pa)
(Kg/m3)

(°C-1)
GROUP_MA
MAT02
2,04E+11 8100,2 0,3
1,092E-05 GMAT02
MAT03
2,04E+11 8098 0,3
1,092E-05
GMAT03
MAT04
2,04E+11 8053,6 0,3
1,092E-05 GMAT04
MAT05
2,04E+11 0 0,3
1,092E-05
GMAT05
MAT06
2,04E+11 1774,4 0,3
1,092E-05 GMAT06

1.3
Boundary conditions and loadings

.
Boundary conditions

Embedding pricking Steam Generator and crossed Br: DX=DY=DZ=DRX=DRY=DRZ=0 with the nodes N1 and N45

.
Seismic loading Normally Acceptable Seism (1/2 seism of dimensioning)

- *Multiple Excitation (several spectra by direction):*

node N1 (pricking Steam Generator) in directions X and Y

frequency (Hz)
0,2.0,5.1,7 2,3 3.3,3.4,5 6 9 10 20 100
acceleration (G) *0,031 0,1 0,53*
0,65
0,73
0,69
0,52
0,39
0,29 0,284 0,23 0,23

node N45 (crossed Br) in directions X and Y

frequency (Hz)
1.1,4 2,65
4,8 10 20 25 100
acceleration (G) *0,13 0,43 1,48*
0,86
0,38
0,29
0,22
0,22

nodes N1 and N45 (pricking Steam Generator and crossed Br) in direction Z

frequency (Hz)
0,2 0,3 0,5
1
2 3 4 5 7 10 20
25
100
acceleration (G) *0,0155 0,025 0,044 0,1.0,2 0,25 0,28 0,28 0,22 0,15 0,12 0,1 0,1*

- *Seismic Differentials Displacement*

u=0,004m with the node N45 (crossed Br) according to the local direction U.
U results from axis X by a rotation of angle =109,02° around axis Z.
This loading amounts applying ucos displacements and usin along axes X and Y.

Several cases of displacements are mentioned in the note of calculation FRAMATOME [bib1] but only one is retained in this test.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is obtained by:

· software SYSPIPE of FRAMATOME,
· Code_Aster: test of nonregression based on an equivalent command set.

2.2
Results of reference

The line of piping was the subject of a complete lawful study. Results of the analysis seismic are mentioned in the note of the manufacturer [bib1].

2.3
Uncertainty on the solution

Numerical solution, obtained with identical data and comparable elements.

2.4 References bibliographical

[1]
Note calculation FRAMATOME ITMC/DC/414: Lines interior vapor Br of the sections Fessenheim.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

---

3 Modeling
With

3.1
Characteristics of modeling

The model comprises 12 elements POU_C_T (4 by elbow) and 49 elements POU_D_T.

3.2
Characteristics of the grid

A number of nodes: 62
A number of meshs and type: 61 SEG2

· ***Connectivité:***

net
node 1
node 2
net
node 1
node 2
M1 N4 N5 M32

N36
N37
M2 N5 N6 M33
N37
N38
M3 N6 N7 M34
N38
N39
M4 N7 N8 M35
N39
N40
M5 N8 N9 M36
N40
N41
M6 N9
N10
M37
N41
N42
M7 N10 N11 M38 N42
N43
M8 N11 N12 M39 N44
N45
M9 N13
N14 M40 N3
N55
M10 N14 N15 M41 N55
N56
M11 N15 N16 M42 N56
N57
M12 N16 N17 M43 N57
N4
M13 N17 N18 M44 N12
N59
M14 N18 N19 M45 N59
N60
M15 N19 N20 M46 N60
N61
M16 N20 N21 M47 N61
N13
M17 N21 N22 M48 N43
N63
M18 N22 N23 M49 N63

N64
M19 N23 N24 M50 N64
N65
M20 N24 N25 M51 N65
N44
M21 N25 N26 M52 N1
N2
M22 N26 N27 M53 N2
N3
M23 N27 N28 M54 N46
N47
M24 N28 N29 M55 N48
N49
M25 N29 N30 M56 N19
N50
M26 N30 N31 M57 N19
N51
M27 N31 N32 M58 N39
N52
M28 N32 N33 M59 N39
N53
M29 N33 N34 M60 N17
N46
M30 N34 N35 M61 N17
N48
M31 N35 N36

· ***Groupe of mesh:***

GROUP_MA Nb nets
list meshs contained in the group
M1 m2 m3 M4 M5
M6 M7 M8 M9 M10
M11 M12 M13 M14 M15
M16 M17 M18 M19 M20
GMAT02
39
M21 M22 M23 M24 M25
M26 M27 M28 M29 M30
M31 M32 M33 M34 M35
M36 M37 M38 M39
M40 M41 M42 M43 M44
GMAT03
12
M45 M46 M47 M48 M49
M50 M51

GMAT04
2
M52 M53

M54 M55 M56 M57 M58
GMAT05
6
M59

GMAT06
2
M60 M61

3.3 Functionalities tested

Orders

“MECHANICAL” AFFE_MODELE
“POU_D_T”

“MECHANICAL” AFFE_MODELE
“POU_C_T”

AFFE_CARA_ELEM BEAM
GROUP_MA
RING
DEFI_ARC
GROUP_MA
CENTER

GROUP_MA
COEF_FLEX

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

DEFI_MATERIAU ELAS

AFFE_MATERIAU

MACRO_MATR_ASSE

POST_ELEM MASS_INER

MACRO_MODE_MECA CALC_FREQ

NORM_MODE

“MASS_GENE”

CALC_ELEM

CALC_NO

DEFI_FONCTION

DEFI_NAPPE

MODE_SATIQUE MODE_STAT

PSEUDO_MODE

COMB_SISM_MODAL MODE_CORR

AMOR_REDUIT

EXCIT
GROUP_NO

COMB_MODE

COMB_MULT_APPUI

COMB_DIRECTION

DEPL_MULT_APPUI

COMB_DEPL_APPUI

IMPR_RESU

4
Results of modeling A

4.1 Frequencies clean

mode
Code_Aster
Reference %
variation
1 5,0791
5,0793
-0,004
2 8,7391

8,7402
-0,012
3 11,642
11,633
0,075
4 23,104
23,111
-0,029

4.2
Spectral analysis multi supports

4.2.1 Primary component (inertial effect)

· ***Method of calculation***

- Modal Base comprising the 4 preceding modes,
- Reduced Damping of 5% for all the modes,
- Taking into account of the static contribution of the neglected clean modes (>25 Hz),
- Combination of the modal answers according to method CQC:
COMB_MODE=_F (TYPE=' CQC'),
- Quadratic Office plurality of the answers by supports:
COMB_MULT_APPUI=_F (TYPE=' QUAD'),
- Quadratic Office plurality of the directional answers:
COMB_DIRECTION=_F (TYPE=' QUAD'),

· ***Référence SYSPIPE***

Generalized efforts: EFGE_ELNO_DEPL (N.m)

NET NODE CMP
Code_Aster
Reference %
variation
M52 N1 MT 132314,352 131471 0,641

MFY
34671,9174 34622 0,144

MFZ
34062,3639 33951 0,328
M40 N3 MT 132347,543 131466 0,671

MFY
13271,7861 13716 -3,239

MFZ
12698,7018 12679 0,155
M43 N4 MT 25427,8116 25624 -0,766

MFY
96610,7623 95915 0,725

MFZ
8474,33445 8335 1,672
M5 N8 MT 24995,7612 24868 0,514

MFY
12762,0643 12564 1,576

MFZ
42196,6397 42006 0,454
M44 N12 MT 25027,5711 24931 0,387

MFY
15984,253 15811 1,096

MFZ
17688,0827 17390 1,714
M47 N13 MT 40765,3048 40491 0,677

MFY
3066,98979 3201,1
-4,190

MFZ
6599,21353 6521 1,199
M24 N28 MT 41227,5405 40943 0,695

MFY
37631,0924 37086 1,470

MFZ
45605,1023 44926 1,512
M48 N43 MT 41265,0496 41104 0,392

MFY
51189,9272 50726 0,915

MFZ
13728,1788 13628 0,735
M51 N44 MT 67834,6989 67395 0,652

MFY
27343,0908 27167 0,648

MFZ
33365,2076 32890 1,445
M39 N45 MT 67893,3287 67396 0,738

MFY
38018,4979 37285 1,967

MFZ
23350,1075 23551 -0,853

[Figure 4.2.1-a] the evolution of a total size of equivalent moment gives
2
2
2
MT + Mr. FY + Mr. FZ according to the curvilinear X-coordinate of the analyzed section. A variation is noted
maximum of 1,2% between SYSPIPE and Code_Aster with the N29 node of the M25 mesh.

160000

140000

)
SYSPIPE

***.m** 120000*
NR

Code_Aster
T
(

100000
in

I
valley
80000

U

T
éq

60000

E
N
m
40000

O

m
20000

0

0
5
10
15
20
25
30

ABSC_CURV (m)

Appear 4.2.1-a: Primary component - Field of moment are equivalent

---

· Référence Code_Aster

The reference is obtained by calculating the total response with differential displacements null.

Generalized efforts: EFGE_ELNO_DEPL (N.m)

NET NODE CMP Code_Aster
Reference %
variation
M52 N1 MT
132314,352 132314,352 0,000

MFY
34671,9174 34671,9174 0,000

MFZ
34062,3639 34062,3639 0,000
M40 N3 MT
132347,543 132347,543 0,000

MFY
13271,7861 13271,7861 0,000

MFZ
12698,7018 12698,7018 0,000
M43 N4 MT 25427,8116 25427,8116 0,000

MFY
96610,7623 96610,7623 0,000

MFZ
8474,33445 8474,33445
0,000
M5 N8 MT 24995,7612 24995,7612 0,000

MFY
12762,0643 12762,0643 0,000

MFZ
42196,6397 42196,6397 0,000
M44 N12 MT 25027,5711 25027,5711 0,000

MFY
15984,253 15984,253 0,000

MFZ
17688,0827 17688,0827 0,000
M47 N13 MT 40765,3048 40765,3048 0,000

MFY
3066,98979 3066,98979
0,000

MFZ
6599,21353 6599,21353
0,000
M24 N28 MT 41227,5405 41227,5405 0,000

MFY
37631,0924 37631,0924 0,000

MFZ
45605,1023 45605,1023 0,000
M48 N43 MT 41265,0496 41265,0496 0,000

MFY
51189,9272 51189,9272 0,000

MFZ
13728,1788 13728,1788 0,000
M51 N44 MT 67834,6989 67834,6989 0,000

MFY
27343,0908 27343,0908 0,000

MFZ
33365,2076 33365,2076 0,000
M39 N45 MT 67893,3287 67893,3287 0,000

MFY
38018,4979 38018,4979 0,000

MFZ
23350,1075 23350,1075 0,000

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4.2.2 Secondary component (static effect of differential displacements)

· ***Method of calculation***

- Linear Office plurality of the loadings in displacement imposed of crossing Br (node N45) according to DX and DY:

DEPL_MULT_APPUI= (
_F (NOM_CAS=' DDS Br U local following DX',
NUME_CAS=1,
MODE_STAT=MSTAT,
NOEUD=N45,
DX=ucos,),
_F (NOM_CAS=' DDS Br U local following DY',
NUME_CAS=2,
MODE_STAT=MSTAT,
NOEUD=N45,
DY=usin,),),

COMB_DEPL_APPUI=_F (
TOUT=' OUI',
TYPE=' LINE',),

with u=0,004mm and =109,02°

Code_Aster ®
Version

· ***Référence SYSPIPE***

Generalized efforts: EFGE_ELNO_DEPL (N.m)

NET NODE CMP Code_Aster
Reference %
variation
M52 N1 MT
-3514,643 -3519 -0,124

MFY
-8718,626 -8731 -0,142

MFZ
3839,959 3847 -0,183
M40 N3 MT
-3498,378 -3519 -0,586

*MFY**
4627,678 4620 0,166

*MFZ**
-6559,864 -6572 -0,185
*M43 N4 MT**
-5466,298 -5482 -0,286

MFY
-2661,552 -2645
0,626

MFZ
707,119 704 0,443
M5 N8 MT

-5451,862 -5458 -0,112

MFY
-7813,834 -7819 -0,066

MFZ
-1373,902 -1376 -0,153
M44 N12 MT -5452,502 -5459 -0,119

*MFY**
232,577 221 5,239

*MFZ**
16264,520 16280 -0,095
*M47 N13 MT**
-1080,825 -1091 -0,933

MFY
-4608,238 -4612 -0,082

MFZ
17959,849 17978 -0,101
M24 N28 MT -1090,004 -1091 -0,091

MFY
616,317 617 -0,111

MFZ
-581,559 -581 0,096
M48 N43 MT -1087,843 -1091 -0,289

*MFY**
1008,866 1008 0,086

*MFZ**
18334,269 18351 -0,091
*M51 N44 MT**
-1295,762 -1299 -0,249

MFY
-803,728 -799 0,592

MFZ
16745,356 16759 -0,081
*M39 N45 MT**

-1298,075 -1299 -0,071

*MFY**
14896,226 14908 -0,079

*MFZ**
680,911 681 -0,013

(*): The signs of the moments of reference are reversed. Conventions of sign of Code_Aster and SISPIPE are different.

[Figure 4.2.2-a] the evolution of a total size of equivalent moment gives
2
2
2
MT + Mr. FY + Mr. FZ according to the curvilinear X-coordinate of the analyzed section. A variation is noted
maximum of 0,93% between SYSPIPE and Code_Aster with the N4 node of the M1 mesh.

20000

18000
SYSPIPE

) 16000

Code_Aster

.m

NR

14000

T

(

in 12000

I

valley 10000

U

8000

T

éq

E

N

6000

m

O

4000

m

2000

0

0

5

10

15

20

25

30

ABSC_CURV (m)

Appear 4.2.2-a: secondary component - field of moment are equivalent

· Référence Code_Aster

The solution is obtained with operator MECA_STATIQUE by imposing on the N45 node them displacements DX=ucos and DY=usin.

Generalized efforts: EFGE_ELNO_DEPL (N.m)

NET NODE
CMP Code_Aster
Reference %
variation
M52 N1 MT -3514,643 -3514,643
0,000
MFY
-8718,626 -8718,626
0,000
MFZ
3839,959 3839,959 0,000
M40 N3 MT -3498,378 -3498,378
0,000
MFY
4627,678 4627,678 0,000

MFZ
-6559,864 -6559,864
0,000
M43 N4 MT -5466,298 -5466,298
0,000
MFY
-2661,552 -2661,552
0,000
MFZ
707,119 707,119 0,000
M5 N8 MT -5451,862 -5451,862
0,000
MFY
-7813,834 -7813,834
0,000
MFZ
-1373,902 -1373,902
0,000
M44 N12 MT -5452,502 -5452,502
0,000
MFY
232,577 232,577 0,000
MFZ
16264,520 16264,520
0,000
M47 N13 MT -1080,825 -1080,825
0,000
MFY
-4608,238 -4608,238
0,000
MFZ
17959,849 17959,849
0,000
M24 N28 MT -1090,004 -1090,004
0,000
MFY
616,317 616,317 0,000
MFZ
-581,559 -581,559 0,000
M48 N43 MT -1087,843 -1087,843
0,000
MFY
1008,866 1008,866 0,000

MFZ
18334,269 18334,269
0,000
M51 N44 MT -1295,762 -1295,762
0,000
MFY
-803,728 -803,728 0,000
MFZ
16745,356 16745,356
0,000
M39 N45 MT -1298,075 -1298,075
0,000
MFY
14896,226 14896,226
0,000
MFZ
680,911 680,911 0,000

5
Summary of the results

The answers obtained with the two codes are very close. Variations surplus not 1% on primary and secondary components. More important differences are observed in elbows. The latter are modelled with a curved element in SYSPIPE and 4 elements POU_C_T in Code_Aster.

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Code_Aster ®
Version
6.0

Titrate:
SDLL132 - Clean modes of a frame

Date:
15/04/03
Author (S):
J-L. Key FLEJOU
:
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Organization (S): EDF-R & D /TESE

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.132

SDLL132 - Clean modes of a frame in multifibre beams

Summary:

This test relates to the validation of option MASS_INER, as well as calculation of the clean modes of the frame
when the model contains POU_D_TGM (multifibre beams). The results of the reference solution are obtained by making the same study but with a model of beams based on POU_D_E.

This test makes it possible to validate, by making a modal analysis of the structure:

· linear finite elements of type POU_D_TGM.
· results of the orders: POST_ELEM, NORM_MODE, EXTR_MODE.
· results of MACRO_MODE_MECA.

1
Problem of reference

1.1 Geometry

The case test is a metal frame made up of beams and posts.

Co-ordinates of the principal nodes of the grid:

Coord. X
Coord. Y
Coord. Z
Not
(in m)
(in m)
(in m)
To 2.0
2.5
0.0
B 4.0
0.0
0.0
C 2.0
-2.5
0.0
D 0.0
0.0
0.0
E 2.0
2.5
3.0
F 4.0
0.0
3.0
G 2.0
-2.5
3.0
H 0.0
0.0
3.0
I 2.0
0.0 3.0

Titrate:
SDLL132 - Clean modes of a frame

Date:
15/04/03
Author (S):
J-L. Key FLEJOU
:
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1.2
Mechanical characteristics of the beams

The beams of the case test are standard sections of the steel construction. Units of theirs mechanical characteristics are homogeneous with [m].

HEA200 IPE220 IPE160 HEA140 IPE120
Beams
BF, DH
HF
I.E.(INTERNAL EXCITATION), CG
AE
FG, GH
With 5.39E03
3.34E03
2.01E03 3.14E03 1.32E03
IY 3.69E05
2.77E05
8.70E06 1.03E05 3.18E06
IZ 1.34E05
2.05E06
6.83E07 3.89E06 2.77E07
AY
1.474994 1.789865 1.792884 1.464032 1.774392
AZ
4.466038 2.633754 2.586199 4.464173 2.590182
JX 1.97E07
8.66E08
3.37E08 7.76E08 1.63E08
JG 1.06E07

2.23E08
3.89E09 1.47E08 8.73E10

Sizes EY, EZ, IYR2, IZR2 are null for all the beams.

1.3
Properties of material

Only one material is used:

Young 2.10e+11
Pa
Rho 7.85e+03
kg/m3

1.4
Boundary conditions

The points A, B, C, D are embedded.

DX = 0
DY = 0
DZ = 0
DRX = 0
DRY = 0
DRZ = 0

2
Reference solution

2.1
Method of calculation used for the reference solution

The values of the reference solution are obtained with the frame, produced with a model with base POU_D_E.

2.2
Results of reference

Values obtained by order POST_ELEM, with key word MASS_INER:

Sizes	*Value*
MASS	*5.85759E+02*
CDG_X	*2.00000E+00*
CDG_Z	*2.03968E+00*
IX_PRIN_G	*1.56562E+03*
IY_PRIN_G	*1.81822E+03*
IZ_PRIN_G	*2.23486E+03*

The table below gives the clean modes calculated with a model of POU_D_E. Modes are filtered by order EXTR_MODE with criterion MASS_EFFE_UN and a threshold of 5.0E-04.

NUME FREQUENCY MASS_EFFE_UN CUMUL_DX MASS_EFFE_UN CUMUL_DY
MASS_EFFE_UN CUMUL_DZ
MODE
DX
DY
DZ
1 1.00E+01 2.41E01 2.41E01

1.69E26 1.69E26
7.04E30 7.04E30
2 1.24E+01 4.33E01 6.74E01
3.99E24 4.01E24
2.64E27 2.65E27
3 1.31E+01 3.84E24 6.74E01
5.29E01 5.29E01
4.13E04 4.13E04
4 1.75E+01 7.73E04 6.74E01
4.54E26 5.29E01
2.74E28 4.13E04
5 1.91E+01 7.92E02 7.54E01
1.88E27 5.29E01
4.25E28 4.13E04
6 2.24E+01 6.29E27 7.54E01
1.38E01 6.67E01
2.22E04 6.35E04
7 2.69E+01 1.21E29 7.54E01
6.00E02 7.27E01
1.50E07 6.35E04
10 3.36E+01 2.42E30 7.54E01
6.37E04 7.27E01
6.26E06 6.41E04
13 3.53E+01 1.67E03 7.55E01
7.43E30 7.27E01
1.13E29 6.41E04
14 3.70E+01 1.21E02 7.68E01
9.09E30 7.27E01
2.84E33 6.41E04

2.3
Uncertainty on the solution

Without object.

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3 Modeling With

3.1 Characteristics of modeling and the grid

The model is composed of POU_D_TGM (multifibre beams). All the sections, are in form of "I" and are described with 30 fibres: 1 in the sole and web thickness, 10 in the width of soles and 10 in the height of the heart.

3.2 Functionalities tested

The case test comprises three stages:

· the first calculates the structural features with the order post_elem,
· the second stage consists in calculating the clean modes of the structures using orders calc_matr_elem, nume_ddl, asse_matrice, mode_iter_simult and with to normalize with the result of the concept post_elem,
· the third stage calculates the clean modes of the structure with the macro-order MACRO_MODE_MECA by normalizing the modes with the result of concept POST_ELEM.

Orders

AFFE_CARA_ELEM BEAM

AFFE_FIBRE
POST_ELEM MASS_INER

CALC_MATR_ELEM OPTION
"RIGI_MECA"

“MASS_MECA”
MODE_ITER_SIMULT TYPE_RESU
“DYNAMIC”
CALC_FREQ
BANDAGE
NORM_MODE NORMALIZES
“MASS_GENE”
MACRO_MODE_MECA NORMALIZES
“MASS_GENE”

3.3
Sizes tested and results

The table below summarizes the results obtained by orders POST_ELEM, with the key word MASS_INER, for model POU_D_TGM and compares them with the values of reference obtained with one model of POU_D_E.

Sizes	Values References	Values POU_D_TGM	Error Relative
MASS	5.8576E+02	5.8576E+02	7.04E07
CDG_X	2.0000E+00	2.0000E+00	0.00E+00
CDG_Z	2.0397E+00	2.0397E+00	2.16E06
IX_PRIN_G	1.5656E+03	1.5656E+03	1.11E06
IY_PRIN_G	1.8182E+03	1.8182E+03	1.80E07
IZ_PRIN_G	2.2349E+03	2.2349E+03	4.72E07

In this test, the authorized maximum relative error is fixed at 2.0E-05.

The table below gives the clean modes calculated with a model of POU_D_TGM. Modes are filtered by order EXTR_MODE with criterion MASS_EFFE_UN and a threshold of 5.0E-04. The maximum relative error authorized on the calculation of the frequencies is fixed at 2.0E-02. The absolute error maximum authorized on the calculation of the MASS_EFFE_UN is fixed at 1.0E-02.

NUME FREQUENCY MASS_EFFE_UN CUMUL_DX MASS_EFFE_UN CUMUL_DY
MASS_EFFE_UN CUMUL_DZ
MODE
DX
DY
DZ
1 1.00E+01 2.45E01 2.45E01
1.38E27 1.38E27
7.12E31 7.12E31
2 1.23E+01 4.30E01 6.75E01
1.28E25 1.30E25
7.59E29 7.66E29
3 1.29E+01 1.10E25 6.75E01
5.35E01 5.35E01
4.02E04 4.02E04
4 1.73E+01 1.90E03 6.77E01
4.08E28 5.35E01
5.99E31 4.02E04
5 1.91E+01 7.67E02 7.54E01
2.18E27 5.35E01
3.36E30 4.02E04

6 2.21E+01 7.04E28 7.54E01
1.40E01 6.75E01
2.28E04 6.30E04
7 2.68E+01 7.31E28 7.54E01
5.57E02 7.31E01
1.34E07 6.30E04
8 3.49E+01 2.32E03 7.56E01
5.33E29 7.31E01
2.56E31 6.30E04
9 3.76E+01 1.72E02 7.73E01
1.77E29 7.31E01
8.92E34 6.30E04

The table below compares the results obtained with model POU_D_TGM and the values of reference obtained with a model of POU_D_E (NUME_MODE 1, 2, 3, 5, 6, 7), for which there is not no particular remarks.

NUME
FREQUENCY MASS_EFFE_UN
MASS_EFFE_UN MASS_EFFE_UN_DZ
MODE
DX
DY
Values references
1
10.0386 2.4062E01
1.6855E26 7.0440E30
POU_D_TGM
1 10.0299
2.4507E01
1.3770E27
7.1158E31
Relative error

8.7E04
1.8E02

Absolute error

8.7E03
4.4E03

Values references
2
12.3631 4.3310E01
3.9884E24 2.6399E27
POU_D_TGM
2 12.2722
4.3008E01
1.2845E25
7.5937E29
Relative error

7.4E03
7.0E03

Absolute error

9.1E02
3.0E03

Values references
3
13.0613 3.8389E24
5.2880E01 4.1267E04
POU_D_TGM
3 12.8877
1.1018E25
5.3471E01
4.0172E04
Relative error

1.3E02

1.1E02
2.7E02
Absolute error

1.7E01 --- 5.9E03
1.1E05
Values references
5
19.1421 7.9213E02

1.8759E27 4.2482E28
POU_D_TGM
5 19.0752
7.6706E02
2.1807E27
3.3632E30
Relative error

3.5E03
3.3E02

Absolute error

6.7E02
2.5E03

Values references
6
22.359 6.2877E27
1.3777E01
2.2223E04
POU_D_TGM
6 22.1023
7.0371E28
1.4041E01
2.2790E04
Relative error

1.2E02

1.9E02
2.5E02
Absolute error

2.6E01 --- 2.6E03
5.7E06
Values references
7
26.9214 1.2099E29
6.0029E02 1.5014E07
POU_D_TGM
7 26.7993

7.3140E28
5.5675E02
1.3418E07
Relative error

4.6E03

7.8E02

Absolute error

1.2E01

4.4E03

The table below compares the results obtained with model POU_D_TGM and the values of reference obtained with a model of POU_D_E (NUME_MODE 4, 8, 9) for which some remarks are necessary.

NUME
FREQUENCY MASS_EFFE_UN MASS_EFFE_UN MASS_EFFE_UN_DZ
MODE

DX
DY
Values references
4
17.5316 7.7262E04 4.5440E26 2.7423E28
POU_D_TGM
4 17.3126
1.9020E03
4.0831E28
5.9912E31
Relative error

1.3E02
5.9E01

Absolute error

2.2E01
1.1E03

Values references
13
35.2798 1.6712E03 7.4262E30 1.1337E29
POU_D_TGM
8 34.9301
2.3155E03
5.3345E29
2.5636E31
Relative error

1.0E02
2.8E01

Absolute error

3.5E01
6.4E04

Values references
14

37.0148 1.2125E02 9.0891E30 2.8395E33
POU_D_TGM
9 37.6334
1.7201E02
1.7660E29
8.9176E34
Relative error

1.6E02
3.0E01

Absolute error

6.2E01
5.1E03

For the NUME_MODE 4, the frequency is correct, on the other hand there is a relative error of 59% on MASS_EFFE_UN_DX (1.9E-03 to be compared with 7.7E-04), and an absolute error of 1.1E-03. The value of
MASS_EFFE_UN_DX indicates a weak participation of this mode to the dynamic response of structure. The two analyses are thus in agreement, there is well a mode in the vicinity of 17.5Hz, and its contribution is very weak with respect to the dynamic response of the structure.

After analysis of the results, calculated mode with 34.9Hz (NUME_MODE 8 for model POU_D_TGM) corresponds to the mode of reference to 35.3Hz (NUME_MODE 13). On the other hand there is a relative error
from 28% on the MASS_EFFE_UN_DX (2.3E-03 to be compared with 1.7E-03) and an absolute error of 6.4E-04.
The value of MASS_EFFE_UN_DX indicates a weak participation of this mode to the dynamic response structure, the two analyses are thus in agreement.

After analysis of the results, calculated mode with 37.6Hz (NUME_MODE 9 for model POU_D_TGM) corresponds to the mode of reference to 37.0Hz (NUME_MODE 14). On the other hand there is a relative error
from 30% on the MASS_EFFE_UN_DX (1.7E-02 to be compared with 1.2E-02) and an absolute error of 5.1E-03.
The value of MASS_EFFE_UN_DX indicates a weak participation of this mode to the dynamic response structure, the two analyses are thus in agreement.

Mode, of the reference solution, which corresponds to the frequency of 33.6Hz (NUME_MODE 10) is not

not found by modeling in POU_D_TGM. The MASS_EFFE_UN_DY, corresponding to this mode is of 6.37E-04, lower than 0.1%. This value indicates a weak participation of this mode to dynamic response of the structure. The fact that one does not find this mode, with a modeling POU_D_TGM, thus will not influence the dynamic analysis which one could make thereafter.

3.4 Parameters of execution

Version:
6.0
Machine:
IRIX64
Obstruction memory: 16Mo
Time CPU To use
: 9.0sec

---

4 Summary of the results

The results of reference are obtained with a model of POU_D_E.
The analyses carried out with a modeling in POU_D_TGM are in agreement with the solution of reference.

Code_Aster *®*
Version
8.0

Titrate:
SDLL134 - Method of Connors for the analysis of the behavior
Date:
06/10/05
Author (S):
A. ADOBES*, L. SALMONA Key*
:
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Organization (S): EDF-R & D /MFTT, CS IF

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.134 document

SDLL134 - Method of Connors for the analysis of vibratory behavior of the tubes of Steam Generator

Summary:

This case test aims at the validation of the establishment in Code_Aster of the method of Connors, in so much
that method of analysis of the vibratory behavior of the tubes of Steam Generator.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/05/005/A

1
Problem of reference

1.1 Geometry

C

B
D

M1
M2

L1
L2

K1
K2

J1
J2

I1
I2

H1
H2

G1
G2
y

F1
F2

X

With
E
Co-ordinates of the points:

WITH B C
D
E
X -0.2944
-0.2944
0. 0.2944
0.2944
y 0.
9.693
9.9874 9.693 0.

F1 G1 H1
I1

J1
X -0.2944
-0.2944
-0.2944
-0.2944
-0.2944
y 1.068 2.136
3.204 4.272 5.34

K1 L1 M1
X -0.2944
-0.2944
-0.2944
y 6.408 7.476
8.544

F2 G2 H2
I2
J2
X 0.2944
0.2944
0.2944
0.2944
0.2944
y 1.068 2.136
3.204 4.272 5.34

K2 L2 m2
X 0.2944
0.2944
0.2944
y 6.408 7.476
8.544

1.2
Properties of materials and characteristic of the tube

Elastic properties

E = 202000 MPa

= 0.3

= 8330 kg/m3

The tube is hollow. Its external ray is worth 9.525 mm and its thickness 1.09 Misters.

1.3
Boundary conditions

Boundary conditions:

· on the points A, B, D and E: embedding (DX=DY=DZ=RX=RY=RZ=0).
· on the points F1, G1, H1, I1, J1, K1, L1, M1, F2, G2, H2, I2, J2, K2, L2 and m2: support (DX=DY=DZ=0).

Fluid loading:

The internal fluid and the external fluid are distinguished. Each one has a dependent density curvilinear X-coordinate along the tube. Moreover, for the external fluid, the profile speed inter-tubes transverse with the tube in the plan of the tube is provided.

1.4
Type of network and characteristic of the model of Connors

The network is a square step of step reduces 1.439895. The constant of Connors is supposed to be ranging between 3.0 and 5.0 with 3 values équiréparties in this interval, that is to say 3.0, 4.0 and 5.0. Damping necessary to the application of the method of Connors is damping in fluid at rest. It is taken equal to 0.64%.

2
Reference solution

2.1
Method of calculation used for the reference solution

One is interested in the mode 21 which is more penalizing on the vibratory level. Its frequency (estimated with assistance MODE_ITER_SIMULT with 61.53761 Hz) is regarded as a data of problem. The values of interest for the case-test are, on the one hand effective speed in
V, and
in addition the critical engine failure speed Cn
V. Their values are given by the equations
(see nomenclature of the variables in [R4.07.04]):

2
2
S (S) V (S) N (S)

ds
Cn
V

=
tube
m N
Nex

F
2
N
E
D
1
2
2
D
S (S) V (S) N (S)
2
S
E
ds
i=1 Ki Lexi

S (S) V 2 (S) 2
N (S)

ds

V = tube
S
in
m (S) 2
N (S)

ds
m
tube

By using the spreadsheet Excel, it is possible to calculate these values for the different ones constants of Connors requested.

2.2
Results of reference

The value of reference is the sum of the various values for each constant of Connors. One thus has for effective speed and the critical engine failure speed of the respective values of 3.0039 and 6.9156.

2.3
Uncertainty on the solution

It is about an semi-analytical solution. Only uncertainty relates to the frequency of mode 21.

2.4 References
bibliographical

[1]
T. KESTENS, Mr. LAINET: Coupling fluid-structure for the tubular structures and them
coaxial hulls, document [R7.07.04].

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3 Modeling
With

3.1
Characteristics of modeling

Elements 1D POU_D_T (SEG2)

B
D

With
E

3.2
Characteristics of the grid

A number of nodes: 311
A number of meshs and types: 310 SEG2

3.3 Functionalities
tested

Orders

DEFI_FLUI_STRU CSTE_CONNORS

NB_CONNORS
CALC_FLUI_STRU AMOR_REDUIT_CONN

4
Results of modeling A

4.1 Values tested

Size Reference
Aster %
difference
Summon Cn
V
6.9156037078201 6.9156037078201 1.03E-13
Summon of in
V
3.0039489978201 3.0039544634875 1.82E-04

---

5 Summary of the results

The error made by Code_Aster on speeds (critical and effective) is with more than 1.82 10 4% it who is acceptable and valid the establishment of the method of Connors in the software.

Organization (S): EDF-R & D /AMA, IRCN

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.311 document

SDLL311 - Transitory dynamic response of one beam in traction under imposed displacement

Summary:

This problem-test corresponds to a linear transitory analysis of a bar requested in traction by application

of a displacement imposed at an end, the other end being embedded. Function displacement of time is of type "Heaviside" imposed as from the initial moment.

The results obtained in the middle of the beam for a modeling with four elements are compared with analytical solution of the problem discretized by four elements by not taking into account the peaks instantaneous speed and of acceleration at the initial moment on the level of the end where displacement is imposed.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/03/008/A

1
Problem of reference

1.1 Geometry

y, v
With
B
C
/2
/2
X, U
U (C) = F (T) .u
R
F
R = 0,05 m
= 1 m
1
T

1.2
Material properties

E = 98 696,044 MPa

= 0

= 3.106 kg/m3

Damping proportional of Rayleigh: C = K
+ µM, =
-
510 4
.
, µ = 5

1.3
Boundary conditions and loadings

Displacement imposed at the end C: U (C) = U F (T) with U = -
10 3 m and F (T) evolution in function
time of the Heaviside type: F (T) =,
1 T 0.

Embedded end A.

1.4 Conditions
initial

Initial displacement no one in any point.

Null initial speed in any point.

2
Reference solution

2.1
Method of calculation used for the reference solution

The discretized problem checks:

M
M
ll
ld U
C
C

ll
ld
&
U
K
K

ll
ld
&
U 0
L
L
L

+
+
= ,
MR. T
M U
T
T
& D
& C
C U
&d K
K U
F
ld
dd
ld
dd

ld
dd D
D

with index L: ddl free
index D: ddl imposed

F (T
D
) external loadings applied to the nodes ends and leading to displacements
imposed ud is unknown, one thus eliminates these equations and one obtains:

[M] {u&} + [C] {u&} + [K] {U} = - [M] {u&} - [C] {u&} - [K] {U
ll
L
ll
L
ll
L
ld
D
ld
D
ld
D}.

The only nonnull terms of the second member of this system are related to the variables kinematics relating to the node end where displacement is imposed. However, with t=0, udC
&
and u&dC is not
defined but in t=0- and t=0+, udC
&
and u&dC is null. All the complexity of the problem comes from that.

To obtain a reference solution, we considered udC
&
and u&dC uniformly null it
who amounts not considering that the forces intern elastic at the end C. This is debatable of one physical point of view but, by adopting the same assumptions at the time of the modeling of the problem,
the validation of Code_Aster can be concluded.

One calculates the reference solution by dealing with the following problem:

[Mll] {ul&} + [Cll] {u&l} + [Kll] {ul} = [- Kld] {U (
D T}
) with {ul (0)}= 0 and {u&l (0)}= 0.

With this intention, one transports the problem in the modal base of the system which checks:

[M] {u&} + [K] {U
ll
L
ll
L} = 0.

Damping being diagonal, the diagonal system is obtained:

[Mg] {X&} + [cg] {X&} + [kg] {X} = {G (T)} where {G (T)}= {G} for T 0,

with {X (0)} = 0 and {X& (0)}= 0.

In modal space, one thus solves three equations (3 ddls free) differential of the second order then one returns in physical space. One obtains then the displacement of the point medium:

3
U (T) = e-it (has
~
~
I
(
cos T
I) + Bi sin (T
B
I),
i=1

~
with I: ième own pseudo-pulsation of the deadened system.

2.2
Results of reference

Displacement, speed and acceleration of the point medium B of the beam.

Displacement of the point medium B
1,00E-03
8,00E-04
6,00E-04
(m) 4,00E-04
U B
2,00E-04
0,00E+00
0
0,005
0,01
0,015
0,02
0,025
0,03
-2,00E-04
time (S)

2.3
Uncertainty on the solution

Analytical solution of the problem discretized in four elements length equalizes while considering speed and acceleration uniformly null at the point C where displacement is imposed.

3 Modeling
With

3.1
Characteristics of modeling

Modeling in element of beam 3D: POU_D_T

y
A.
.
. B
.
. C
X
NR 1
N2
NR 3
NR 4
NR 5

Cutting:
AC = 4 meshs SEG2 equal length

Limiting conditions:
· Noeud N1 (A) embedded
DDL_IMPO DX=DY=DZ=DRX=DRY=DRZ=0

· Noeud N5 (C) in imposed displacement following X
DDL_IMPO DY=DZ=DRX=DRY=DRZ=0 DX (T) = U

Resolution:
Algorithm of direct integration of Newmark
No time: T = 105 S
Duration of observation: 0,03 S

3.2
Characteristics of the grid

Node S numbers: 5
A number of meshs and type: 4 meshs SEG2

3.3
Functionalities tested

Orders

DYNA_LINE_TRAN NEWMARK
C.L. DIRICHLET BY VECTASS

4
Results of modeling A

4.1 Values tested

· Déplacement at the point medium B

Time (S)	*Displacement Reference (m)*	*Displacement Aster (m)*	*Difference (%)*
0,0054	*87,376 e3*	*87,3763 e3*	*28,6 E 3%*
0,0055	*87,360 e3*	*87,3598 e3*	*21,9 E 3%*
0,0108	*26,818 e3*	*26,8178 e3*	*57,0 E 3%*
0,0109	*26,800 e3*	*26,8000 e3*	*10,3 E 3%*
0,0163	*64,386 e3*	*64,3865 e3*	*84,9 E 3%*
0,0164	*64,366 e3*	*64,3663 e3*	*42,7 E 3%*
0,0217	*41,083 e3*	*41,0828 e3*	*49,6 E 3%*
0,0218	*41,084 e3*		

41,0844 e3
94,0 E 3%
0,0271
55,525 e3
55,5247 e3
62,6 E 3%
0,0272
55,530 e3
55,5305 e3
93,3 E 3%

5 Modeling
B

5.1
Characteristics of modeling

idem that modeling A

5.2
Characteristics of the grid

idem that modeling A

5.3

Functionalities tested

Orders

DYNA_LINE_TRAN NEWMARK
C.L. DIRICHLET BY LOAD

6
Results of modeling B

6.1 Values
tested

· Déplacement at the point medium B

Time
Displacement
Displacement
Difference
(S)
Reference (m)
Aster (m)
(%)
0,0054
87,376 e3
87,3763 e3
28,7 E 3%
0,0055
87,360 e3
87,3598 e3
21,9 E 3%
0,0108
26,818 e3
26,8178 e3
56,9 E 3%
0,0109
26,800 e3
26,8000 e3
10,4 E 3%
0,0163
64,386 e3
64,3865 e3

85,0 E 3%
0,0164
64,366 e3
64,3663 e3
42,9 E 3%
0,0217
41,083 e3
41,0827 e3
49,6 E 3%
0,0218
41,084 e3
41,0844 e3
94,0 E 3%
0,0271
55,525 e3
55,5247 e3
62,6 E 3%
0,0272
55,530 e3
55,5305 e3
93,2 E 3%

7
Summary of the results

The results given by Code_Aster are in perfect agreement with the results of the analytical model, that displacement boils about it beam is imposed by a VECTOR ASSEMBLES or by a LOAD.

Caution: the questions of Dirichlet in DYNA_LINE_TRAN are compatible only with method of integration of NEWMARK.

Author (S):
J.M. PROIX, m.t. BOURDEIX, P. HEMON, O. WILK

Organization (S): EDF/AMA, IAT St CYR, CNAM

SDLL400 - Beam in vibration with center of excentré torsion

Summary:

This test results from the validation independent of version 4 of the models of beam.

It makes it possible to test the taking into account of an eccentricity of the center of torsion on the calculation of frequencies clean of a right beam (a modeling with elements POU_D_E, right beam of Euler).

1
Problem of reference

1.1 Geometry
With
B
L = 7,5 m

Appear 1.1-A
Right beam length 7,5 Mr.

Characteristics of the section:

It is about the U-shaped beam presented [Figure 1.1-b].
B
G: centre of gravity
E
C: center torsion
Z
C
G
H
E
y

Appear 1.1-B: Section of the U-shaped beam
H = 200 mm
B = 273 mm
E = 8,2 mm

One has by [bib1] the following data:

Iy = Iz = 5,022 105 m4
ZGC = 221,5 mm

One calculates starting from the geometry of the section:

S =
6,117
103 m2
Jx = 1,28
107 m4
Ay = 3,65

1.2
Properties of materials

Young modulus:
E = 2.07 1011 Pa

Poisson's ratio: = 0,3
Density:
= 7850 kg/m3

1.3
Boundary conditions

Boundary condition:

Plane problem: Blocked DZ and DRY.
Supported nodes A and B: Blocked DX and DY

The taking into account of the eccentricity is done using operand LIAISON_DDL of the order AFFE_CHAR_MECA.

The ddl are always in G, and one takes account of the eccentricity by: DY (G) =DY (C) + GC X

2
Reference solutions

2.1
Method of calculation used for the reference solutions

They are the Eigen frequencies solutions of the homogeneous problem without damping.

It is partially given in [bib1]. The method of resolution, of finite elements type, concerns a model POU_D_TG. However, a series of results is provided if the effects of torsion of warping are neglected, which brings back modeling to a POU_D_T.

N° mode
1
2
3
4

5
Frequency (Hz)
3,797
7,788
11,74
15,68
19,62

Table 2.1-A: Results of reference according to [bib1]

One can grant a certain confidence to these results published in a newspaper at reading panel. However uncertainties exist if one wants to reproduce these calculations: constants of Jx torsion and of shearing ky are not provided in the article. They should have been recomputed starting from the geometry of
the section.

2.2
Results of reference

Eigen frequencies of the beam without damping

2.3
Uncertainty on the solution

Comparison between codes (STONE [bib2] and ASTER), and analytical solution.

2.4 References
bibliographical

[1]
WU J.S. & CHEN K.Z. : Dynamic Analysis of has channel beam had to has moving load. J. of Sound and Vibration, vol. 188, n° 3, pp 337-345, 1995.
[2]
Code STONE version 4 of October 30, 1996, IAT
[3]
Report/ratio n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation beams ASTER"
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

The model is composed of 15 elements right beam of Euler.

3.2
Characteristics of the grid

15 elements POU_D_E

3.3 Functionalities
tested

Orders

MODE_ITER_SIMULT METHOD
JACOBI

4
Results of modeling A

4.1 Results

Results mode

STONE
Results
Aster Variation
(%)
1 3,79432
3.7966
0.063
2 7,43340
7.4513
0.242
3 11,4450
11.5108
0.575
4 15,3439
15.5027
1.036
5 19,4766
19.8060
1.692

Table 4.1-A: Comparison ASTER/CAILLOU in POU_D_E with eccentricity

Mode
Reference results
Aster results
Variation (%)
1 3.79700
3.7966
-0.008
2 7.78800
7.4513
-4.322
3 11.7400
11.5108
-1.952
4 15.6800
15.5027
-1.130
5 19.6200
19.8060
0.948

Table 4.1-B: Comparison ASTER/Référence [bib1] in POU_D_E with eccentricity

5
Summary of the results

The results are rather close to the reference solution (numerical). (variation < 5%), for which certain data missed and thus had to be estimated. They correspond on the other hand very well with the results of the code STONE of the IAT (given identical to those of Code_Aster).

This makes it possible to validate the taking into account of the offsetting of the center of torsion in the matrices of
mass and of rigidity.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
Document: V2.02.401
SDLL401 - Tilted right beam with 20°, subjected
with sinusoidal efforts
Summary:
This test results from the validation independent of version 4 of the models of beams.
It makes it possible to check the internal efforts on an inclined beam, for sinusoidal loadings in function
time (a modeling with elements POU_D_T, right beam of Timoshenko).

Version
4.0
Titrate:
SDLL401 tilted right Beam with 20°, subjected to sinusoidal efforts
Date:
01/12/98
Author (S):
J.M. PROIX, m.t. BOURDEIX, P. HEMON, O. WILK
Key:
V2.02.401-A Page:
2/6

1 Problem of reference

1.1 Geometry

B
With
20°
X
Appear 1.1-a
B
With
20°
X
Appear 1.1-b

Right beam length 1 Mr.
slope 20° compared to X (trigonometrical direction).
Characteristics of the section:
*S = *0.01 ² m ²*

1.2 Properties of materials

Young modulus
E = 2. 1011 Pa
Poisson's ratio
= 0,3
Density
= 7800 kg/m3

1.3 Boundary conditions and loading

Boundary condition:
· For the loading distributed [1.1-1]
Embedded nodes A and B: DX, DY, DZ, DRX, DRY, DRZ blocked
· For the specific loading [1.1-2]
Embedded node A: DX, DY, DZ, DRX, DRY, DRZ blocked

Loadings:

•

*F (T) = 1000 * cos (T) according to direction AB*
either distributed or applied at the end B

•

M
T = 1000
(T)
T ()
** cos*
applied at the end B

2
Reference solutions

2.1
Method of calculation used for the reference solutions

2.1.1 Loading distributed of traction and compression

A right beam length L working only in traction and compression is subjected to one loading distributed constant according to X but varying in a sinusoidal way according to time. It is embedded at its two ends.

2u
2

U
S
- E S
= F (T

)
t2
x2
U (0

) = 0, U (L) = 0.
To solve, one applies to the equation the transform of Fourier in time:
2 U

=
2
1
4
2
-
U +
F
( )
2
X
E
E S
U: transform of Fourier of U,
F: transform of Fourier of F.
Thus, we have for F (T) = F cos (2 T
O):

2 O
sin
X
2

has
F

2

has

U (X, T
O

) =

cos
L
1
2
2

ES 4

has

-

2 O
O
sin
L

has

2

O
-

cos
X
1
cos

(2 T
O).

has -

E
2

with: has
= .
The use of the law of behavior gives us the tractive effort compression:

2 O
cos
X

F has

2

has

NR (X, T
O
) =
1 -

cos
L
2

has

2 O
O

sin
L

has

2

O
+ sin
X

cos 2 T.

has

O

2.1.2 Loadings
specific

A beam comforts length L working only in traction compression (or torsion) is subjected to a sinusoidal force in time, (or a moment) applied at its loose lead.

2.1.2.1 Traction

2u
2

U
S
- ES
= 0

t2
x2

U
1
U (0) = 0

, ( )
L =
F (T).
X
ES
The technique of resolution is equivalent to that of the paragraph [§ 2.1.1.1].
For F (T) = F cos (2 T
O), we have:
2

sin
O X
F has

has

U (,
X T) =

cos (2

O T)
ES 2
2

O
cos
O L

has

E
2
with A
=
2

cos
O X

has

and NR (,
X T) = F
cos (2
O T)
2

cos
O L

has

2.1.2.2 Torsion

2 X

2
G
I
- I
X = F (T
p
)
2

X
X

t2
U (0) = 0, U (L) = 0

E
G = (21+)

2
0
4
sin
X
0 0
, 1

B F
4
B
I
=
m,

,
=
p
X (X T)
(
cos 2
T
0)
2
G I

2

2
p
0
0
cos
L
B

2

0
cos
X

B
I = I
M
,
=
cos
p
T (X T)
F

2
X
(
T
0)

2

0
cos
L

B
G
with B =

2.2
Results of reference
Interior efforts (NR and MT)
2.3
Uncertainty on the solution
Analytical solution.
2.4 References
bibliographical

[1]
Report/ratio n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation beams ASTER"

3 Modeling
With

3.1
Characteristics of modeling
The model is composed of 2 elements right beam of Timoshenko.
3.2
Characteristics of the grid
2 elements POU_D_T
3.3 Functionalities
tested
Orders
Keys
DYNA_LINE_TRAN
NEWMARK
[U4.54.01]
EXCIT
CHARGE
FONC_MULT
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/98/040 - Ind A

4
Results of modeling A
4.1 Results
4.1.1 Charge divided into traction
Analytical results
Aster results
Variation (%)
Normal effort for X = 0
T = 1/3 S
4.7247E+02
4.7247E+02

9.12E07
T = 2/3 S
3.92944E+02
3.9294E+02
6.08E07
Normal effort for X = L/2
T = 1/3 S
0.0000E+00
2.1985E12
*2.20E12**
T = 2/3 S
0.0000E+00
2.5087E12
*2.51E12**
** Absolute deviation*
4.1.2 Charge
specific
4.1.2.1 Loading in traction
Normal effort for X = 0
Analytical results
Aster results
Variation (%)
T = 1/3 S
9.44957E+02
9.44956E+02
7.59E07
T = 2/3 S
7.8588E+02
7.8588E+02
3.01E06
4.1.2.2 Loading in torsion
Torque for X = 0
Analytical results
Aster results
Variation (%)
T = 1/3 S
9.4495E+02
9.4495E+02
1.88E06
T = 2/3 S
7.8588E+02
7.8589E+02
7.29E06

4.2 Parameters
of execution
Version: 4.02
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU to use:
10 seconds
5
Summary of the results
This test makes it possible to check that the efforts intern elements of beam in dynamics are correct.
The results show a very good agreement with the analytical solution, for a made up grid
only of two elements POU_D_T.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HI-75/98/040 - Ind A

Author (S):
E. BOYERE, G. ROBERT, F. SOULIE Key

Organization (S): EDF-R & D /AMA, SAMTECH

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
V2.02.403 document

SDLL403 - Vibrations of a pendulum in rotation

Summary

The applicability of this test is the modal analysis of the structures. The studied structure is a pendulum in rotation around an axis fixed and plunged in a field of gravity. The pendulum itself is articulated around one center perpendicular to the axis of rotation and located at a certain distance from this one. One is interested in the first six Eigen frequencies.

The interest of this test lies in the following aspects:

- *analyze modal with taking into account of initial constraints (geometrical stiffness)*
- *analyze modal with taking into account of the centrifugal stiffening*
- *important relative difference between two successive frequencies of the spectrum*

Currently, the taking into account of the centrifugal stiffening is not possible that with voluminal elements. The element used is element HEXA20 and one employs the method of Sorensen for the calculation of the frequencies clean.

The first Eigen frequency is compared with an analytical reference. The following frequencies are compared with numerical values obtained by a software independent of Code_Aster and using modelings "beam" and "plane constraint".

Handbook of Validation

1
Problem of reference

1.1 Geometry

H
has
L

Characteristics:

Length of the pendulum
L = 0.6 m
Eccentricity
= 0.1 m has
Height of the profile
H = 0.01 m
Width of the profile
B = 0.004 m
Section
S = bh

Inertia of inflection
IZ = bh3/12

1.2
Properties of materials

Young modulus
E = 7. E 10 N/m2
Poisson's ratio
= 0.3
Density
= 2700 kg/m3

1.3
Boundary conditions and loading

The beam is articulated at point A. the clevis pin is axis Y. the initial state of stress which allows to carry out the geometrical calculation of the stiffnesses and centrifuges is obtained by imposing a speed of rotation and gravity.

Acceleration of gravity
G = -9.81 m/s ² (parallel with axis Z)

Number of revolutions
= 10 rad/s

The static position of balance 0 correspondent with loading is calculated by the relation:

3
2
G cos = (3a + 2
0
L cos0) sin 0

One finds 0 = 11.269931365°

The conditions on displacements at point A are as follows:

U = v = W = 0; X = Z = 0

One considers moreover than the section passing by A remains rigid.

1.4 Conditions
initial

Without object in modal analysis.

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

2
Reference solution

2.1
Method of calculation used for the reference solution

.
first Eigen frequency

The facts of the case are selected in such a way that the stiffnesses in inflection and in extension are large with respect to the stiffnesses geometrical and centrifugal. Under these conditions, the value of the first Eigen frequency is obtained analytically by considering a pendulum rigid.

While taking as degree of freedom the angle enters the pendulum and axis X the equation of movement is written:

2 &
= 3
2
L
G cos - (3a + 2L cos) sin

One considers here the small oscillations of the pendulum around a position of balance statics 0. By linearizing the equation of the movement in the vicinity of this position, one obtains the equation with the small disturbances:

2L &

+ [3
2
G sin + (3a cos + 2L cos2
0
0
)] = 0
0

One deduces the pulsation from it from the first mode:

3g
3a

2

=
sin +
cos + cos
2

2
0
L

2
0
0
L

This own pulsation can be still written in the form

K () + K (2
)
=

I

with

K () 1

2
2
2
has
L
2
=
SL

G sin + SL cos + cos
0
0
0
2
2
3

(
E
géométriqu
stiffness
)
K (2
)
1
3
2
2
= -
SL

sin 0
3

(
centrifugal
stiffness
)
1
3
I = SL
3
(
rotation

in

inertia
)
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

Code_Aster ®
Version
7.3

Titrate:
SDLL403 - Vibrations of a pendulum in rotation

Date:
04/10/04
Author (S):
***E. BOYERE**, G. ROBERT, F. SOULIE Key*
:
V2.02.403-A Page:
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.
other Eigen frequencies

The values of reference of frequencies 2 to 6 are obtained numerically by means of version 7 of software the SAMCEF software. Two different modelings were used: 20 elements of deformable beam with the shearing action and 20X4 elements of membrane with 8 nodes. results obtained in both cases are identical if one limits oneself to the first 4 digits significant. Considering the corrections of stiffness are small with respect to the terms of stiffness linear, one can check that frequencies 2 to 6 differ little from the analytical values obtained for a nondeformable beam hurled with the sharp effort. In fact, the maximum variation between the numerical and analytical values 1% do not exceed.

2.2
Results of reference

The first 5 critical loads are classified by order of increasing module.

Mode

Eigen frequency (Hz)

1 1.75556
2 100.2
3 324.0
4 674.4
5 1150.
6 1748.

2.3
Uncertainty on the solution

Analytical solution for the first frequency. Numerical solution for the others. The tolerance estimated numerical results is 1%.

2.4 References
bibliographical

Without object.
Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

Code_Aster ®
Version
7.3

Titrate:
SDLL403 - Vibrations of a pendulum in rotation

Date:
04/10/04
Author (S):
***E. BOYERE**, G. ROBERT, F. SOULIE Key*
:
V2.02.403-A Page:
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3 Modeling
With

3.1

Characteristics of modeling

The beam is with a grid by means of elements HEXA20.

Boundary conditions:

At point A such as X = 0.1, Y = 0, Z= 0:

DX = DY = DY = DRX = DRZ = 0

In addition, all the nodes of the section passing by A are rigidly dependent.

3.2
Characteristics of the grid

A number of nodes:
1077
A number of meshs:
160 HEXA20
8
QUAD8

3.3 Functionalities
tested

Orders

AFFE_MODELE AFFE
MODELING
“3D”

AFFE_CHAR_MECA GRAVITY

ROTATION
DDL_IMPO
LIAISON_SOLIDE
CALC_MATR_ELEM OPTION
“RIGI_GEOM”

"RIGI_ROTA"
"MASS_MECA"
MODE_ITER_SIMULT METHOD
"SORENSEN"

CALC_FREQ
OPTION
PLUS_PETITE

NMAX_FREQ

Handbook of Validation
V2.02 booklet: Linear dynamics of the beams
HT-66/04/005/A

Code_Aster ®
Version
7.3

Titrate:
SDLL403 - Vibrations of a pendulum in rotation

Date:
04/10/04
Author (S):
***E. BOYERE**, G. ROBERT, F. SOULIE Key*
:
V2.02.403-A Page:
7/8

4
Results of modeling A

4.1 Values
tested

Frequencies in Hz

Reference mode
Code_Aster

Relative variation (%)
1 1.75556
1.7871
2.121
2
100.2 100.272 0.072
3 324.0
324.65
0.200
4
674.4 677.1 0.407
5 1150.
1157.8
0.677
6 1748.
1766.7
1.072

5
Summary of the results

Good agreement with the reference solution (less than 1. % of error on all the modes safe on first where the error is 2.2%).

This test could not be carried out with an element of beam because the calculation of the centrifugal matrix of rigidity
is not available for this type of element. In the same way, as it is not available for
discrete elements, we could not use connection 3D-beam. In order to stage this problem, all
the nodes of surface containing point A were bound by a solid connection.

Author (S):
***G. ROUSSEAU**, C. VARE, J. PELLET*

Organization (S): EDF/EP/AMV, EDFIMA/MNN

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
V2.03.001 document

SDLS01 - Thin, free or embedded square plate at the edge

Summary:
The applicability of this case test relates to the dynamics of the structures, and more particularly modal calculation and the harmonic calculation of answer.
For modal calculation, it is a question of calculating the clean modes of inflection of a thin square plate in
two configurations:
· Plaque embedded on an edge,
· Free Plaque.
The plate is with a grid in triangular elements to which elements DKT are affected.
Four different modelings are tested:
· Modal Calcul Edges of the plate directed according to axes' of the reference mark,
· Modal Calcul unspecified Orientation of the plate and harmonic response for the plate embedded,
· Modal Calcul by traditional and cyclic dynamic sousstructuration,

· Modal Calcul following a condensation of Guyan.
The results of reference of modal calculations result from analytical calculations. They validate on the one hand
tools for creation of the matrices of mass and rigidity, as well as the operators of
traditional and cyclic dynamic under-structuring implemented in Code_Aster. In addition, it
case test validates modal calculation following a condensation of Guyan (condensation of the matrix of mass).
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

1
Problem of reference
1.1 Geometry
With
D
With
D
T
y, v
H
K
G
I
J
has
B
C
B
has
C

X, U
Dimensioned = 1.m has
thickness T = 0.01 m
Co-ordinates of the points (in m):
With
B
C
D
G
H
I
J
K
X
0.
1.
1.
0.
0.5
0.25
0.75
0.75
0.25
y
0.
0.
1.
1.
0.5
0.25
0.25
0.75
0.75
Z
0.
0.
0.
0.
0.
0.
0.
0.
0.

1.2
Material properties
E
= 211011 Pa
= 0 3
= 7800 kg m3
.
.
/
1.3
Boundary conditions and loadings
Case 1: dimensioned embedded AB
for any point P such as y
=
P
0 :
U = v = W = 0.
= = =
X
y
Z
0.
Case 2: free plate
1.4 Conditions
initial
Without object for the modal analysis
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

2

Reference solution
2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLS01/89 of the guide VPCS which presents method of calculation in the following way:

The formulation of M.V. BARTON, for a plate of with dimensions A, conduit with:

1
And 2
F
=
2

I =
I
I
1 2
, , ...
2 A 2
12 (1 - 2

)

with, for a Poisson's ratio = 0 3
. :
1°: Plate embedded on a side
2°: Free plate
I
2
I
2
I
I
1
3.492
1 to 6
0.
2
8.525
7
13.49
3
21.43
8
19.79

4
27.33
9
24.43
5
31.11
10
35.02
6
54.44
11
35.02
(6 modes of solid body at null frequency).
This reference solution applies to the thin sections such as: T/has <.
0 1 .
Coefficients I are establish by development limited on the modal deformations of a network of cross beams (beam encastréelibre and beam librelibre).

2.2
Results of reference

Case 1: the first 6 clean modes
Case 2: the first 11 clean modes

2.3
Uncertainty on the solution

Semianalytic solution.

2.4 References
bibliographical

[1]
Mr. V. BARTON Vibrations of rectangular and skew cantilever punts. Newspaper of Applied Mechanics, flight 18, p. 129134 (1951)

---

3 Modeling
With

3.1
Characteristics of modeling A

Modeling DKT

y
D
C
K
J
G
H
I
X
With
B

Names of the nodes:
Points
With = N1
B = N78
C = N145
D = N80
G = N65
H = N17
I = N73
J = N121
K = N71

Limiting conditions:

Case 1 in all the nodes on the side AB:
DDL_IMPO: (GROUP_NO: AB DX: 0. , DY: 0. , DZ: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)
Cases 2 none

3.2
Characteristics of the grid

A number of nodes: 145
A number of meshs and types: 256 TRIA3

3.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
HULL

ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MODELE
“MECHANICAL”
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
“BAND”
[U4.52.01]
CALC_ELEM
OPTION
“EPOT_ELEM_DEPL”
[U4.61.02]
“ECIN_ELEM_DEPL”

4
Results of modeling A
4.1 Values
tested
Frequency (Hz)

Clean mode
Reference
Aster
% difference
Tolerance
1°: Plate embedded on a side
1
8.7266
8.6718
0.63
2
21.3042
21.2904
0.06
3
53.5542
53.0992
0.85
1. 102
4
68.2984
67.9269
0.54
5
77.7448
77.4294
0.40
6
136.0471
135.7635
0.21
Aster epot = ecin
1
1.4796 104
2
1.7331 104
3
4.3802 104
4
3.7367 104
5
5.4956 104
6

1.3483 105
2°: Free plate
7
33.7119
33.6839
0.08
8
49.4558
48.9362
1.05
9
61.0513
60.5849
0.76
1.1 102
10
87.5160
87.0993
0.48
11
87.5160
87.0993
0.48
Aster epot = ecin
7
2.2396 104
8
4.7270 104
9
7.2453 104
10
1.4974 105
11
1.4974 105

4.2 Remarks

MODE_ITER_SIMULT
OPTIONS: “BAND”
FREQ: (8. , 140.)
CASE 1
FREQ: (32. , 90.)
CASE 2

Contents of the file results:

1° :

the first 6 Eigen frequencies, clean vectors and modal parameters
deformation energy and kinetic energy of the 6 modes.
2° :
5 Eigen frequencies, clean vectors and modal parameters (F > 0)
deformation energy and kinetics of the 5 modes.

4.3 Parameters
of execution

Version: 3.04.05
Machine: CRAY C98
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
18.91 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

---

5 Modeling B

5.1 Characteristics of modeling B

Modeling DKT with grid identical to modeling A.
Rotation of the plate such as side AB is on the line 3y = 4x

C
y
J
I
B
G
D
K
H
With
X

Names of the nodes:
Points
With = N1
B = N78
C = N145
D = N80
G = N65
H = N17
I = N73
J = N121
K = N71

Limiting conditions:

Case 1 in all the nodes on the side AB:
DDL_IMPO: (GROUP_NO: AB DX: 0. , DY: 0. , DZ: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Case 2: none
Harmonic answer:
Nodal force point C (N145): Fz = 98100
Material: AMOR_ALPHA: 0.1 AMOR_BETA: 0.1

5.2

Characteristics of the grid

A number of nodes: 145
A number of meshs and types: 256 TRIA3

5.3 Functionalities

tested

Orders

Keys

AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MODELE
'MECHANICAL
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
AMOR_ALPHA
AMORBETA
[U4.23.01]
MODE_ITER_SIMULT
“BAND”
[U4.52.01]
DYNA_LINE_HARM
[U4.54.02]
CALC_ELEM
OPTION
EFGE_ELNO_DEPL
[U4.61.02]
SIGM_ELNO_DEPL

6 Results of modeling B

6.1 Values tested

The values of the Eigen frequencies are identical to those of modeling A.

Harmonic answer:

FREQ:
50 Hz
NODE:
N145
NET:
M255

	Reference	**Aster 3.03.15**	**Aster 3.05.16**	**% difference**
DEPL "DZ"	2.90290E02	2.90290E02	0.0	
	5.20606E02	5.20606E02		
DEPL "DRX"	2.52920E02	2.52920E02	0.0	
	9.44717E02	9.44717E02		
QUICKLY "DZ"	1.63553E+01	1.63553E+01		

0.0
9.11973E+00
9.11973E+00
QUICKLY “DRX”
2.96792E+01
2.96792E+01
0.0
7.94573E+00
7.94573E+00
ACCE “DZ”
2.86505E+03
2.86505E+03
0.0
5.13817E+03
5.13817E+03
ACCE “DRX”
2.49622E+03
2.49622E+03
0.0
9.32398E+03
9.32398E+03
“EFGE_ELNO_DEPL” “MXX”
1.14053E+01
1.14053E+01
0.0
1.45539E+03
1.45539E+03
“EFGE_ELNO_DEPL” “MYY”
1.10224E+01
1.10224E+01
0.0
1.31441E+03
1.31441E+03
“EFGE_ELNO_DEPL” “MXY”
1.03148E+01
1.03148E+01
0.0
3.55382E+02
3.55382E+02
“EFGE_ELNO_DEPL” “QX”
3.66163E+02
3.66163E+02
0.0

3.77331E+03
3.77331E+03
“EFGE_ELNO_DEPL” “QY”
3.14676E+02
3.14676E+02
0.0
2.06813E+03
2.06813E+03
“SIGM_ELNO_DEPL” “SIXZ”
5.49245E+04
5.49245E+04
0.0
5.65997E+05
5.65997E+05
“SIGM_ELNO_DEPL” “SIYZ”
4.72014E+04
4.72014E+04
0.0
3.10219E+05
3.10219E+05

6.2 Remarks

MODE_ITER_SIMULT
OPTIONS: “BAND”
FREQ: (8. , 140.)
CASE 1
FREQ: (32. , 90.)
CASE 2

Contents of the file results:

1° :
the first 6 Eigen frequencies, clean vectors and modal parameters.
2° :
the first 11 Eigen frequencies, clean vectors and modal parameters.
3° :
displacement DZ DRX with the N145 node
efforts generalized and forced M255 mesh

6.3 Parameters of execution

Version: 3.03.10
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords

---

7 Modeling
C

7.1
Characteristics of modeling C

G

In the 2 cases, the plate is cut out in 4 parts of equal size. Each sousstructure
considered is with a grid in triangles to which elements of plate DKT are affected.

Case 1: Plate embedded on an edge

The structure is studied using the method of sousstructuration traditional with interfaces of the type
CRAIG_BAMPTON. The modal base used for each sousstructure is made up of 25 modes
clean and of the constrained modes associated the interfaces.

Case 2: Free plate

The structure is studied using the method of sousstructuration cyclic with interfaces of the type
HARMONIC CRAIG_BAMPTON and taking into account of the specificity of the node of the axis (not
G).
base modal used for the basic sector is made up of 25 clean modes and the modes
harmonics associated with the interfaces.

7.2
Characteristics of the grid

A number of nodes: 121
A number of meshs and types: 200 TRIA3

7.3 Functionalities
tested
Orders
Keys

MACR_ELEM_DYNA
BASE_MODALE
[U4.55.05]
MACR_ELEM_DYNA
OPTION
“RITZ”
DEFI_MODELE_GENE
SOUS_STRUC
NAME
DEFI_MODELE_GENE
SOUS_STRUC
MACR_ELEM_DYNA
DEFI_MODELE_GENE
SOUS_STRUC
ANGL_NAUT
DEFI_MODELE_GENE
CONNECTION
SOUS_STRUC_1
SOUS_STRUC_2
[U4.55.06]
DDEFI_MODELE_GENE
CONNECTION
INTERFACE_1
INTERFACE_2
NUME_DDL_GENE
MODELE_GENE
[U4.55.07]
ASSE_MATR_GENE
NUME_DDL_GENE
[U4.55.08]
ASSE_MATR_GENE
OPTION
“MASS_GENE”
“RIGI_GENE”
DEFI_SQUELETTE
MODELE_GENE
[U4.75.01]
DEFI_SQUELETTE
SOUS_STRUC
NAME
REST_BASE_PHYS
SKELETON
[U4.64.01]

REST_BASE_PHYS
TOUT_ORDRE
MODE_ITER_CYCL
CONNECTION
CENTER
“YES”
MODE_ITER_CYCL
CALCULATION
TOUT_DIAM
“CENTER”
[U4.52.03]
MODE_ITER_CYCL
CALCULATION
OPTION
DEFI_SQUELETTE
MODE_CYCL
[U4.75.01]
DEFI_SQUELETTE
SECTOR

8
Results of modeling C

8.1 Values
tested

Order of
Frequency (Hz)
clean mode I
Reference

Aster
% difference
Tolerance
1°: Plate embedded on a side
1
8.7266
8.6419
0.97
2
21.3042
21.2253
0.37
3
53.5542
52.9693
1.09
1.25 102
4
68.2984
67.5444
1.10
5
77.7448
77.3966
0.45
6
136.0471
134.5785
1.08
2°: Free plate
7
33.7119
33.6808
0.09
8
49.4558
48.9785
0.96
9
61.0513
60.6739
0.62
1. 102

10
87.5160
87.0662
0.51
11
87.5160
87.0662
0.51
8.2 Parameters
of execution
Version: 3.05.13
Machine: CRAY C98
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
112.81 seconds

---

9 Modeling
D
9.1
Characteristics of modeling D
DKT + sousstructuration of GUYAN
y
D
NR
C

K
J
O
G
M
H
I
With
B
L
X
Limiting conditions: Free plate
Condensation of the matrices of mass and rigidity on the nodes:
(A, B, C, D, G, H, I, J, K, L, M, NR, O).
9.2
Characteristics of the grid
A number of nodes: 145
A number of meshs and types: 256 TRIA3
9.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MODELE
'MECHANICAL
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
“BAND”
[U4.52.01]
MACR_ELEM_STAT
RIGI_MECA

10
Results of modeling D
10.1 Values
tested
Order of
Frequency (Hz)
clean mode I
Reference
Aster
% difference
Tolerance
2°: Free plate
7
33.7119
33.8758
0.48
8
49.4558
49.5240
0.14
1.1 102
9
61.0513

61.6240
0.94

10.2 Remarks

One seeks to calculate the first 3 nonnull Eigen frequencies of the problem of the free plate on its edges.
If one condenses the matrices on the only nodes:
(A, B, C, D, G, H, I, J, K)
The precision of the frequencies is not whereas 2%.
To obtain the results wanted with the awaited precision (1%), it is necessary to add the points (L, M, NR, O).

11
Summary of the results

· Modélisations A and b:
Precision on the Eigen frequencies ² 1% until the sixth mode of inflection.
· Modélisation C:
In sousstructuration, the quality of the results could be improved by the use of a grid of finer sousstructure.
· Modélisation D:
To obtain an accuracy of 1% on the Eigen frequencies, it is necessary to condense too on the 4 nodes mediums of the edges L, M, NR and O.

Titrate:
SDLS02 Plates mean rhombus embedded at the edge
Date:
08/01/98
Author (S):
B. QUINNEZ
Key:
V2.03.002-C Page:
1/6
Organization (S): EDF/IMA/MMN

Handbook of Validation

V2.03 booklet: Linear dynamics of the hulls and the plates

V2.03.002 document

SDLS02 - Plate mean rhombus embedded at the edge

Summary:

This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure composed of a parallelepipedic plate (nonrectangular), embedded on only one side. This test of mechanics of the structures corresponds to a dynamic analysis of a surface model having one linear behavior. It comprises only one modeling.

This problem makes it possible to test the element of plate DKT and the calculation of frequencies of vibration by the method of Lanczos.

The results obtained on the first two Eigen frequencies are in concord with those of the guide VPCS.

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLS02 Plates mean rhombus embedded at the edge
Date:
08/01/98
Author (S):
B. QUINNEZ
Key:
V2.03.002-C Page:
2/6

1 Problem of reference

1.1 Geometry

Z, W
y
T
With
D

y, v
O

has
has
has
C
X
B
has
X, U
side has = 1. m, thickness T = 0.01 m, = 30°
Co-ordinates of the points (in m):
With
B
C
D
X
0.
has
has (1 + sin)
sin has
y
0.
0.
cos has
cos has
Z
0.
0.
0.
0.
1.2
Properties of materials
E = 2.1 1011 Pa
= 0.3
= 7.800. kg/m3

1.3
Boundary conditions and loadings
Embedded side AB:
for any point P such as *y*
= 0.
p
U = *v* = *W* = 0.
= = =
X
y
Z
0.
1.4 Conditions
initial
Without object for the modal analysis.

2
Reference solution
2.1
Method of calculation used for the reference solution
The formula of reference is that given in card SDLS02/89 of the guide VPCS which presents
method of calculation in the following way:
The formulation of M.V. BARTON, for a plate on side, led to:
1
E T 2
F
=
2

I =
I
, , ...
2
I
1 2
2
has
12 (1 - 2

)
2 =
where:
G
( )
I
with, for a Poisson's ratio = 0.3 and = 30°:
= 30°
2
3.961
1
2
10.19
2

· M.V. Barton mentions the sensitivity of the result to the order of the mode and the angle.
· This reference solution applies to the thin sections such as: t/a < 0.1.
· Coefficients *I* were established with a limited development of an insufficient nature.

2.2
Results of reference

The first two clean modes given by:
· the formula of M.V. Barton,
· the average of 5 software packages of calculation by the finite element method.

2.3
Uncertainty on the solution

Semi-analytical solution < 2%.

2.4 References
bibliographical

[1]
M.V. BARTON, Vibrations of rectangular and skew cantilever punts. Newspaper of Applied Mechanics, vol. 18, p. 129-134 (1951).

HI-75/96/013 - Ind A

3 Modeling

With

3.1

Characteristics of modeling

DKT

y
111
121
100
110
89
99
78
88
67
77
56
66
45
55
34
44
23
33
12
22
1
2
3
4
5

6
7
8
9
10
11
X
Cutting: 10 on each side of the rhombus 200 meshs TRIA3.
Limiting conditions:
in all the nodes on the side AB:
DDL_IMPO: (GROUP_NO: AB DX: 0. , DY: 0. , DZ: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)
Name of the nodes:
Not A = N1
Not C: N121
Bridge B = N11
Not D = N111

3.2
Characteristics of the grid

A number of nodes:
121
A number of meshs and types:
200 TRIA3

3.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.21.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU

ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“PLUS_PETITE”
NMAX_FREQ

4
Results of modeling A
4.1 Values
tested
Order of the mode
Frequency (Hz)
proper I
Reference
Reference
Aster
% difference
(Barton)
(average of
average codes
5 codes)
1
9.8987

9.7355
9.8402
1.08
2
25.4651
23.2745
23.5790
1.31

4.2 Remarks

Calculations carried out by:
MODE_ITER_SIMULT
METHOD: 'TRI_DIAG
OPTION: “PLUS_PETITE”
NMAX_FREQ: 2

4.3
Contents of the file results

the first 2 Eigen frequencies, clean vectors and modal parameters.

4.4 Parameters
of execution

Version: NEW 3.4
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
4.5 seconds

5
Summary of the results
The results given by Code_Aster are comparable with the results given by other codes of
using calculation of the formulations different for this plate in form from parallélélogramme.

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
V2.03.003 document
SDLS03 - Thin rectangular plate simply
pressed on the edges

Summary:
This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure of type
plate. Two different configurations make it possible to test the modes of vibration in the plan of the plate (behavior out of membrane) with elastic supports on two opposed edges, and the modes of vibration
in inflection of a plate supported on its contour.
This test of mechanics of the structures corresponds to a dynamic analysis of a surface model having one linear behavior. It comprises two modelings (grid in triangle or quadrangle).
This problem makes it possible to test the elements of transverse membrane and flexbeam and the calculation of
frequencies of vibration by the method of Lanczos or the method of Bathe and Wilson.

---

1 Problem of reference

1.1 Geometry

y, v
B
C
has
With
D
.
X, U
Z, W
B

That is to say a plate whose characteristics are as follows:

length: = 1.5 m have
width: B = 1 m
thickness: T = 0.01 m

The points characteristic of the plate have as co-ordinates:

With
B
C
D
X
0.
0.
1.
1.
y
0.
1.5
1.5
0.
Z

0.
0.
0.
0.

1.2
Properties of materials

The parameters characterizing the properties of material are:

E = 2.1 1011 Pa
= 0.3
= 7.800 kg/m3

1.3
Boundary conditions and loadings

1.3.1 Problem of inflection

The plate is in simple support on all its sides: for any point P of the edge one a: W = 0.

1.3.2 Problem of membrane

For all the points of the plate, one blocks displacement in Z and the three degrees of rotation, it be-with to say:

W = 0. X = y = Z = 0.

On sides AD and BC one blocks displacement in y: for y = 0. or y = have one has v = 0.

To points A, B, C, D one attaches springs of stiffness K. The axis of these springs is direction X.

y
B
C
With
D
X

The numerical value of K is as follows: K = 25 N/m.

2
Reference solution
2.1
Method of calculation used for the reference solution
2.1.1 Problem of inflection

The reference solution of the problem of inflection is that given in card SDLS03/89 of the guide VPCS which presents the method of calculation in the following way.

The formulation of M.V. BARTON for a rectangular plate, posed on its four sides led for the modes of inflection with:

I 2

J 2

E 2 *T* 4

F =

ij

2

has +

B

12 (1 2

-

)

with:

I = a number of half-length of wave according to y (dimension has),

J = a number of half-length of wave according to X (dimension b).

2.1.2 Problem of membrane

The problem dealt with out of membrane is equivalent for the research of the first frequency of vibration with the following unidimensional problem:

2 K

2 K

m

X

where:

K is the stiffness of the springs,

m is the mass of the plate.

4k

The sought frequency is thus: *F* = 1

2

m

2.2

Results of reference
For the problem of inflection, one calculates the first six frequencies of vibration and for calculation in membrane, one calculates only the first frequency.
2.3
Uncertainty on the solution
The solutions being analytical, there is no uncertainty.
2.4 References
bibliographical
[1]
M.V. BARTON "Vibrations of rectangular and skew cantilever punts" - Newspaper of Applied Mechanics, vol. 18, p. 129-134 (1951).

---

3 Modeling
With
3.1
Characteristics of modeling
One cut out the plate in 200 meshs TRIA3. Two modelings for the plate are used: DKT
and DST.
For the problem of inflection, the boundary conditions are as follows:
· in all the nodes of the edge: DZ = 0
For the problem of membrane, the boundary conditions are:
· in all the nodes of the grid: DZ = 0 DRX = DRY = DRZ = 0,
· in all the nodes on the sides AB and BC: DY = 0
· at the points A, B, C, D one adds discrete elements of rigidity (direction X).
y
111
113
115

117
119
121
B
C
100
110
89
99
44
34
33
23
22
12
11
1A 2
3
4
5
6
7
8
9
10
D
X

3.2

Characteristics of the grid

A number of nodes: 121

A number of meshs and types: 200 TRIA3

The points characteristic of the grid are as follows:

Not A = N1

Not C = N121

Not B = N111

Not D = N11

3.3 Functionalities

tested

Orders

Keys

AFFE_CARA_ELEM
HULL
ALL

[U4.24.01]
DISCRETE
GROUP_NO
“K_T_D_N”
CARA
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MODELE
“MECHANICAL”
'DKT' or “DST”
ALL
[U4.22.01]
“MECHANICAL”
“DIS_T”
MACRO_MATR_ASSE
MATR_ASSE
OPTION
“RIGI_MECA”
[U4.31.02]
“MASS_MECA”
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“BAND”
CALC_FREQ
OPTION
“PLUS_PETITE”

Author (S):
B. QUINNEZ

4 Results of modeling A

4.1 Values tested

For the modes of inflection:

Number mode	**Frequencies Reference**	**Aster DKT**	**% diff.**	**% tolé.**
4	35.63	35.46	0.477	0.5
5	68.51	67.82	1.003	1.1
6	109.62	108.67	0.867	0.9
7	123.32	121.90	1.150	1.2
8	142.51	139.99	1.761	1.8
9				

197.32
191.70
2.846
2.9
DST aster
% diff.
% tolé.
35.45
0.492
0.5
67.80
1.030
1.1
108.62
0.910
1.
121.84
1.199
1.3
139.92
1.815
1.9
191.57
2.912
3.

For the problem out of membrane:

Reference
Aster DKT
% diff.
% tolé.
0.14714
0.147136
0.002
0.1
DST aster
% diff.
% tolé.
0.147136
0.001
0.1

4.2 Remarks

For the problem in inflection, the modal position of the first mode found in the band (5. , 200.) is fourth, because there are three modes of solid body at frequency zero:

· modes of translation U and v in the plan,
· mode of rotation around axis Z.

4.3 Parameters
of execution

Version: 3.05.18
Machine: CRAY C98
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
25 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

One cut out the plate in 100 meshs QUAD4.
Three modelings for the plate are used: Q4G, DKT (DKQ), DST (DSQ).
Compared to modeling A, the plate was turned in the plan (O, X, y) of an angle of 60°
C121 y
33
x'
22D
11
115
113
y'

B
4
111
3
2
23
1
With
12
X
For the problem of inflection, the boundary conditions are as follows:
· in all the nodes of the edge: DZ = 0
For the problem of membrane, the boundary conditions are:
· in all the nodes of the grid: DZ = 0 DRX = DRY = DRZ = 0,
· with node A, one blocks displacement DY in the reference mark (A, x', y'),
· at the points A, B, C, D one adds discrete elements of rigidity (direction x').

5.2

Characteristics of the grid

A number of nodes: 121
A number of meshs and types: 100 QUAD4
The points characteristic of the grid are as follows:
Not A = N1
Not B = N111
Not C = N121
Not D = N11

5.3 Functionalities

tested

Orders

Keys

AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
DISCRETE
GROUP_NO
CARA
“K_T_D_N”
LOCATE
“LOCAL”
ORIENTATION
“ANGL_NAUT”
AFFE_CHAR_MECA
DDL_IMPO

GROUP_NO
[U4.25.01]
LIAISON_OBLIQUE
NODE
DY
ANGL_NAUT
AFFE_MODELE
“MECHANICAL”
'Q4G' or “DST”
ALL
[U4.22.01]
or “DKT”
“MECHANICAL”
“DIS_T”
MACRO_MATR_ASSE
MATR_ASSE
OPTION
“RIGI_MECA”
[U4.31.02]
“MASS_MECA”
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“BAND” or
“CENTER”
CALC_FREQ
OPTION
“PLUS_PETITE”
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLS03 Plates rectangular thin
Date:
08/01/98
Author (S):

6 Results of modeling B

6.1 Values tested

For the modes of inflection:

Number mode	Frequencies Reference	Aster DKQ	% difference	% tolerance
4	35.63	35.359	0.760	0.8
5	68.51	67.491	1.427	1.5
6	109.62	108.563	0.964	1.
7	123.32	121.144	1.765	1.8
8	142.51	138.402	2.882	2.9
9	197.32			

188.500
4.470
4.5
Aster DSQ
4
35.63
35.351
0.782
0.8
5
68.51
67.464
1.527
1.6
6
109.62
108.494
1.027
1.1
7
123.32
121.060
1.832
1.9
8
142.51
138.291
2.961
3.
9
197.32
188.298
4.572
4.6
Aster Q4G
4
35.63
36.011
1.068
1.1
5
68.51
70.795

3.336
3.5
6
109.62
114.593
4.536
4.6
7
123.32
134.899
9.39
9.4
8
142.51
142.941
4.513
4.6
9
197.32
212.045
7.463
7.5

For the problem out of membrane:

Reference
Aster
% difference
% tolerance
DKQ
0.14714
0.14713
0.003
0.1
DSQ
0.14714
0.14714
0.002
0.1
Q4G
0.14714
0.14714
0.
0.1

6.2 Remarks

For the problem in inflection, the modal position of the first mode found in the band (5. , 200.) is fourth, because there are three modes of solid body at frequency zero:

· modes of translation U and v in the plan,

· mode of rotation around axis Z.

6.3 Parameters
of execution

Version: 3.05.18

Machine: CRAY C98

System:
UNICOS 8.0

Obstruction memory:
8 megawords

Time CPU To use:
40 seconds

---

7 Summary of the results

The precision, for the modes of inflection, remains acceptable on the first six modes. Let us note however that the precision is worse than in the case of the free plate in space (test SDLS01 [V2.03.001]).

It is noticed that the treatment of the modes of solid body is suitable.

For the test out of membrane, the results are very satisfactory.

Author (S):
G. ROUSSEAU, C. VARE

Organization (S): EDF/EP/AMV

Handbook of Validation

V2.03 booklet: Linear dynamics of the hulls and the plates

Document: V2.03.004

SDLS04 - Under-structuring cyclic: Annular thin section embedded in its hub

Summary:

The applicability of this test relates to the dynamics of the structures, and more particularly calculation

modal by cyclic dynamic under-structuring.
It is a question of calculating the clean modes of an axisymmetric structure (annular thin section embedded in sound
hub) by regarding it as a structure with cyclic repetitivity.
The model consists of an angular sector of 20° of the ring, with a grid in triangles to which are affected elements of the type plates: DKT. Two methods of calculation are tested:
· cyclic dynamic Under-structuring of Craig-Bampton
· cyclic dynamic Under-structuring of Mac Neal
The results of reference result from an analytical calculation. They validate the modal computational tools by
cyclic dynamic under-structuring implemented in Code_Aster.
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/98/040 - Ind A

---

1 Problem of reference

1.1 Geometry

Interior ray:
IH = 0.1 m
External ray:
R = 0.2 m
E
Thickness:

T = 0.001 m

1.2 Material properties

E = 2.1011 Pa
= 0.3
= 7.800kg/m3

1.3
Boundary conditions and loadings
Embedding with the hub
For any point R = IH, U = v = W = 0. and X = y = Z = 0.

1.4 Conditions
initial
Without object for the modal analysis.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLS04/89 of the guide VPCS which presents analytical solution in the following way:

The solution of the determinant of the frequencies established starting from the functions of Bessel leads to formulate:

1
E T 2
F
=
2

ij
ij
2
R2
12 1 - 2

E
(
)
With:
· I = a number of nodal diameters
· J = a number of nodal circles
2
and such as:
ij
I
0
1
2
3
J
0
13.0
13.3
14.7
18.5
1
85.1
86.7
91.7
100.
Mode of inflection to 2 nodal diameters and 1 nodal circle: f2,1 = 559,09 Hz

2.2
Results of reference

8 clean modes.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
A.W. LEISSA, Vibration of punts, Document NASA SP160, 1969, p. 19-30.

---

3 Modeling
With

3.1
Characteristics of modeling

This structure with cyclic repetitivity is studied using the method of under-structuring
cyclic dynamics of CRAIG-BAMPTON.

A basic sector, consisted an angular sector of 20°, is with a grid in triangles to which are
affected elements of plate DKT.

The modal base used for the sector is made up of 20 clean modes and the **constrained modes**
associated the interfaces.

3.2
Characteristics of the grid

A number of nodes: 66.

A number of meshs and types: 100 triangles with 3 nodes DKT

3.3 Functionalities
tested

Orders
Keys
DEFI_INTERF_DYNA
NUME_DDL
[U4.55.03]
INTERFACE
NAME
INTERFACE
TYPE
“CRAIGB”
INTERFACE
MASK
DEFI_BASE_MODALE
TRADITIONAL
INTERF_DYNA
[U4.55.04]
TRADITIONAL

MODE_MECA
TRADITIONAL
NMAX_MODE
MODE_ITER_CYCL
BASE_MODALE
[U4.52.03]
NB_MODE
NB_SECTEUR
CONNECTION
RIGHT-HAND SIDE
CONNECTION
LEFT
CALCULATION
NB_DIAM
CALCULATION
NMAX_FREQ
REST_BASE_PHYS
RESU_GENE
[U4.64.01]
SECTOR

---

4 Results of modeling A

4.1 Values tested

Nb of
Nb of
Nume

diameters
circles
Reference
Aster
% difference
order
nodal
nodal
I
J
1
0
0
79.26
79.58
0.4
8
0
1
518.85
519.54
0.1
2.3
1
0
81.09
81.18
0.1
9.10
1
1
528.61
529.50
0.2
4.5
2
0
89.63
89.72
0.1
11.12
2
1

559.09
559.48
0.07
6.7
3
0
112.79
113.16
0.3
13.14
3
1
609.70
609.75
0.01

4.2 Remarks

The modes with more than 1 modal diameter are double modes.

4.3 Parameters of execution

Version: 3.02.15
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CUP To use:
18.17 seconds

---

5 Modeling
B
5.1
Characteristics of modeling

This structure with cyclic repetitivity is studied using the method of under-structuring cyclic dynamics of MAC-NEAL.

A basic sector, consisted an angular sector of 20°, is with a grid in triangles to which are affected elements of plate DKT.

The modal base used for the sector is made up of 20 clean modes and the **modes of fastener** associated the interfaces.

5.2
Characteristics of the grid

A number of nodes: 66.

A number of meshs and types: 100 triangles with 3 nodes DKT

5.3 Functionalities
tested
Orders
Keys

DEFI_INTERF_DYNA
NUME_DDL
[U4.55.03]
INTERFACE
NAME
INTERFACE
TYPE
“MNEAL”
INTERFACE
DDL_ACTIF
DEFI_BASE_MODALE
TRADITIONAL
INTERF_DYNA
[U4.55.04]
TRADITIONAL
MODE_MECA
TRADITIONAL
NMAX_MODE
MODE_ITER_CYCL
BASE_MODALE
[U4.52.03]
NB_MODE
NB_SECTEUR
CONNECTION
RIGHT-HAND SIDE

CONNECTION
LEFT
CALCULATION
NB_DIAM
CALCULATION
FREQ
CALCULATION
OPTION
CALCULATION
NMAX_FREQ
“BAND”
REST_BASE_PHYS
RESU_GENE
[U4.64.01]
SECTOR
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/98/040 - Ind A

6
Results of modeling B
6.1 Values
tested
Nb of
Nb of
Nume
diameter
circles
Reference
Aster
% difference

order
nodal
nodal
I
J
1
0
0
79.26
79.58
0.4
8
0
1
518.85
519.53
0.1
2.3
1
0
81.09
81.18
0.1
9.10
1
1
528.61
529.50
0.2
4.5
2
0
89.63
89.72
0.1
11.12
2
1
559.09
559.48
0.07
6.7
3

0
112.79
113.16
0.3
13.14
3
1
609.70
609.76
0.01

6.2 Remarks

The modes with more than 1 modal diameter are double modes.

6.3 Parameters
of execution

Version: 3.02.15
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CUP To use:
17.50 seconds

7
Summary of the results

The quality of the results seems to be able to be improved by the use of a grid of finer sector.

Code_Aster ®
Version
4.0
Titrate:
SDLS07 clean Modes of a thin spherical envelope
Date:
07/12/98
Author (S):
P. MASSIN, B. QUINNEZ, A. LAULUSA
Key:
V2.03.007-C Page:
1/14
Organization (S): EDF/IMA/MMN, SAMTECH

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
Document: V2.03.007

SDLS07 - Clean modes of an envelope
spherical thin

Summary:

This test from guide VPCS makes it possible to validate the algorithm of search for eigenvalues MODE_ITER_SIMULT [U4.52.02] with the operators of rigidity and mass corresponding to modelings following:

1) Three-dimensional hulls: finite elements DKT (mailllage of one 1/8 of sphere),
2) Elements finished 2D axisymmetric TRIA6 and QUAD8 (grid of a section),
3) Three-dimensional hulls: axisymmetric finite elements isoparametric SEG3 (linear grid of the section),
4) Hulls three-dimensional COQUE_3D: finite element MEC3QU9H (grid 1/8 of sphere),
5) Hulls three-dimensional COQUE_3D: finite element MEC3TR7H.

The results obtained are compared with the analytical solution (HAYEK) and reveal for the six first modes of the lower deviations than:

· 0,45% for the axisymmetric elements continuous mediums,
· 0,20% for the elements of hull DKT,
· 0,17% for the elements of axisymmetric hulls isoparametric,
· 0,17% for elements COQUE_3D.

1 Problem of reference

1.1 Geometry

Rm
T

It is of a thin sphere, average radius Rm = 2.5 m, and about thickness T = 0.1 Mr.

1.2 Properties of materials

The material is homogeneous, isotropic, elastic linear. The elastic coefficients are:
E = 200.000 MPa and = 0.3.
The density is constant and is worth: = 7.800 kg/m3.

1.3 Boundary conditions and loadings

The structure is free in space.

2

Reference solution
2.1
Method of calculation used for the reference solution
For the thin spheres (*i.t* << *R* with *I*, order of the mode), the clean modes with displacement radial and tangential establish by a theory of membrane are given by [bib1] and [bib2]:

E
F
I
=
I
2 *R*
(1-2)
= 1 *B* ± *b2* - 4 1-2
2 + - 2
= 2
with
and

+ +1+
I
(
) (*I I*) *B I I* 3
2
The theory presented by Hayek makes it possible to introduce a correction of the effect of inflection (approximation of
general theory of Wilkinson) who leads to values of *I* function of
= *T* 2 *has*/
R2
12
B = *I* (*I* +)
1
and solution of:
4
2
2
2
2
-
+
-
- +
+

+
+
-
+ -
+ -
-
+
=
I
I [1 3 *A* (1) *B* (1 *A ab*)] *ab* [*B*
B
4
5] (1) [*B* 2 (1 *A*)] 0

2.2
Results of reference

Eigen frequencies:

I	**Eigen frequencies**
2	237.25
3	282.85
4	305.24
5	324.17
6	346.76
7	376.68
8	416.
9	465.75
10	526.20

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Card-index VPCS SDLS 07/89 in the Guide of Validation of the Software packages of Calculation of

Structures/SFM AFNOR TECHNIQUE 1990.
[2]
S. HAYEK: "Vibrations of has spherical Shell in acoustic medium", Journal of the Acoustical Society of America, vol. 40, 2, 1996, p. 342-348

---

3 Modeling With

3.1 Characteristics of modeling

Hulls DKT
Z
2,5
(3 symmetry planes)
0
2,5
2,5
X
y

The discretized geometry is represented above. Elements DKT are plane facets with 3 nodes. The number of the nodes on the meridian line and the equator is: 34.

The boundary conditions applied to the three borders correspond to the conditions of symmetry (displacements and blocked rotations).

3.2 Characteristics of the grid

A number of nodes: 1128
A number of meshs and types: 2125 TRIA3

3.3 Functionalities tested

Orders
Keys
AFFE_MODELE
AFFE
MODELING: “DKT”
[U4.22.01]
AFFE_CARA_ELEM
HULL
THICK: 0.10
[U4.24.01]
CALC_MATR_ELEM
OPTION
“RIGI_MECA”
[U4.41.01]
“MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ: (230. , 530.)
[U4.52.02]

---

4 Results of modeling A

4.1 Values tested

(Frequencies in Hertz)

Value of parameter I of
Reference
Aster

% difference
the reference solution
237.25
237.24
0.005
237.24
0.003
2
3
282.85
not obtained [§4.2]
4
305.24
304.97
0.089
304.99
0.080
305.08
0.054
5
324.17
not obtained [§4.2]
6
346.76
346.11
0.186
346.12
0.185
346.30
0.133
346.38
0.108
7
376.68
not obtained [§4.2]
8
416.00
414.89
0.266
414.92
0.259
415.16
0.201

415.24
0.183
415.33
0.161
9
465.75
not obtained [§4.2]
10
526.20
524.34
0.353
524.43
0.337
524.71
0.283
524.94
0.240
524.97
0.234
525.12
0.205

4.2 Remarks

The reference solution does not give the multiplicity of the modes. One observes with calculations of orders of multiplicity which grow with the value of the frequency.
Modes 3, 5, 7, 9 are not obtained because of the boundary conditions chosen for this model, with the three symmetry planes.

4.3 Parameters of execution

Version: 4.00.02
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
393.7 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

axisymmetric 2D
y
X
No boundary condition.

5.2
Characteristics of the grid

A number of nodes: 365
A number of meshs and types: 40 QUAD8 and 80 TRIA6

5.3 Functionalities
tested

Orders
Keys
AFFE_MODELE
AFFE
MODELING: “AXIS”
[U4.22.01]
CALC_MATR_ELEM
OPTION
“RIGI_MECA”
[U4.41.01]
“MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
“BAND” FREQ: (230. , 530.)
[U4.52.02]

6 Results of modeling B

6.1 Values tested

Frequencies in Hertz

Identification
Reference
Aster
% difference
n° mode
237.25
237.24
0.036
2
3
282.85
282.78
0.023
4
305.24
304.85
0.125
5
324.17
323.32
0.262
6
346.76
345.22
0.443
7
376.68

374.14
0.674
8
416.00
412.03
0.955
9
465.75
459.75
1.286
10
526.20
517.51
1.651

6.2 Parameters
of execution

Version: 4.00.02
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.88 seconds

---

7 Modeling
C
7.1

Characteristics of modeling
Axisymmetric hulls 1D
y
+ 2,50
+ 2,50
X
- 2,50
No boundary condition.
One chooses the model of Coils-Kirchhoff to describe kinematics. With the element chosen, this kinematics is obtained by penalization: one puts a great value for coefficient A_CIS. By elsewhere, one neglects the correction of metric.

7.2
Characteristics of the grid
A number of nodes: 81
A number of meshs and types: 40 SEG3

7.3 Functionalities
tested
Orders
Keys
AFFE_MODELE
AFFE
MODELING: “COQUE_AXIS”
[U4.22.01]
AFFE_CARA_ELEM
HULL
THICK: 0.10,
[U4.24.01]
A_CIS: 1.E6
MODI_METRIQUE: “NOT”
CALC_MATR_ELEM
OPTION
“RIGI_MECA”
[U4.41.01]
“MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
“BAND” FREQ: (220. , 530.)
[U4.52.02]
MODE_ITER_INV
CALC_FREQ
FREQ: (220. , 530.)
[U4.52.01]
Handbook of Validation

8 Results of modeling C

8.1 Values tested

(Frequencies in Hertz)

Identification	Reference	Aster	Aster	% difference
n° mode		ITER_SIMULT	ITER_INV	
2	237.25	237.31	237.32	0.025/0.029
3	282.85	282.77	282.78	0.028/0.025
4	305.24	304.95	304.95	0.096

5
324.17
323.68
323.68
0.150
6
346.76
346.23
346.23
0.154

8.2 Parameters
of execution

Version: 4.00.02
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.0 seconds

8.3 Remarks

The purpose of this test with this modeling is only to test the matrix of mass. A satisfactory variation being observed on the first six frequencies, one chose not to calculate the following ones.

---

9 Modeling
D

9.1
Characteristics of modeling

Hulls 3D MEC3QU9H
Z
2,5
(3 symmetry planes)
0
2,5
2,5
X
y
The boundary conditions applied to the three borders correspond to the conditions of symmetry (displacements and blocked rotations).

9.2

Characteristics of the grid

A number of nodes: 331
A number of meshs and types: 75 QUAD9

9.3 Functionalities
tested

Orders
Keys
AFFE_MODELE
AFFE
MODELING: "COQUE_3D"
[U4.22.01]
AFFE_CARA_ELEM
HULL
THICK: 0.10
[U4.24.01]
CALC_MATR_ELEM
OPTION
"RIGI_MECA"
[U4.41.01]
"MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ: (230. , 530.)
[U4.52.02]

Titrate:
SDLS07 clean Modes of a thin spherical envelope
Date:
07/12/98
Author (S):
P. MASSIN, B. QUINNEZ, A. LAULUSA
Key:
V2.03.007-C Page:
11/14

10 Results of modeling D

10.1 Values tested

(Frequencies in Hertz)

Identification
Reference
Aster
% difference
n° mode
237.25
237.25
0
237.26
0.004
2
3
282.85
not obtained [§10.2]
4
305.24
305.18
0.019
305.19
0.017
305.20
0.011
5
324.17
not obtained [§10.2]
6
346.76
346.17
0.169

346.19
0.165
346.25
0.147
346.36
0.114
7
376.68
not obtained [§10.2]
8
416.00
413.81
0.525
413.84
0.520
413.84
0.518
414.02
0.476
414.09
0.46
9
465.75
not obtained [§10.2]
10
526.20
520.57
1.071
520.62
1.06
520.64
1.056
521.28
0.935
521.29
0.933
521.31
0.929

10.2 Remarks

Modes 3, 5, 7, 9 are not obtained because of the boundary conditions chosen for this model, with the three symmetry planes.

10.3 Parameters of execution

Version: 4.00.14
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
41.3 seconds
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/98/040 - Ind X

---

11 Modeling E

11.1 Characteristics of modeling

Hulls 3D MEC3TR7H
Z
2,5
(3 symmetry planes)
0
2,5
2,5
X
y

11.2 Characteristics of the grid

A number of nodes: 925
A number of meshs and types: 294 TRIA7

11.3 Functionalities tested

Orders
Keys
AFFE_MODELE
AFFE
MODELING: "COQUE_3D"
[U4.22.01]
AFFE_CARA_ELEM
HULL
THICK: 0.10
[U4.24.01]
CALC_MATR_ELEM
OPTION
"RIGI_MECA"
[U4.41.01]

"MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ: (230. , 530.)
[U4.52.02]
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/98/040 - Ind X

12
Results of modeling E
12.1 Values
tested
(Frequencies in Hertz)
Identification
Reference
Aster
% difference
n° mode
237.25
237.25
0.001
237.25
0.001
2
3
282.85
not obtained [§12.2]
4
305.24
305.20

0.011
305.22
0.008
305.22
0.005
5
324.17
not obtained [§12.2]
6
346.76
346.32
0.126
346.43
0.095
346.46
0.086
346.58
0.051
7
376.68
not obtained [§12.2]
8
416.00
413.91
0.502
414.33
0.402
414.36
0.394
414.99
0.241
415.14
0.206
9
465.75
not obtained [§12.2]
10
526.20
520.
1.176
521.02
0.985
521.43

0.907
522.32
0.738
523.03
0.602
523.77
0.461

12.2 Remarks

Modes 3, 5, 7, 9 are not obtained because of the boundary conditions chosen for this model, with the three symmetry planes.

12.3 Parameters of execution

Version: 4.00.14
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
98.64 seconds

---

13 Summary of the results

· Modeling hull DKT, here restricted with the modes having 3 symmetries compared to plans X = 0, y = 0, Z = 0, provide the Eigen frequencies with an error lower than 0.4% on the 20 first modes.

· Modeling continuous medium axisymmetric 2D provides the Eigen frequencies with an error lower than 2%.

· Modeling COQUE_AXIS (quadratic isoparametric elements) provides the frequencies
clean with an error lower than 0.2% on the first 5 modes (space discretization
identical to the trace of the axisymmetric grid 2D).
· Degenerated modeling COQUE_3D (elements of thick hull MEC3QU9H, MEC3TR7H)
to provide the Eigen frequencies with an error lower than 1.2% on the first 10 modes.

Organization (S): EDF/IMA/MMN

Handbook of Validation

V2.03 booklet: Linear dynamics of the hulls and the plates

V2.03.100 document

SDLS100 - Study of grids on a plate square thin

Summary:

This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure composed of a thin square plate embedded on a side. One studies the influence of the distortion of the grid on the results. This test of Mechanics of the Structures corresponds to a dynamic analysis of a model surface having a linear behavior. It comprises three modelings.

This problem makes it possible to test the element of plate DKT in transverse inflection and the calculation of the frequencies clean, either by the method of Lanczos, or by the method of Bathe and Wilson. The first modeling consist in netting finely and regularly the plate by triangles. For the second modeling, it grid is coarser while for the third, it coarse and is distorted.

The first modeling is used as results of reference.

The results obtained are in concord between them and with those of a card NAFEMS. The effect of distortion of grid does not appear on the first frequencies of vibration.

1
Problem of reference

1.1 Geometry

y
8
7
6
has
9
5
1
1
2
3
4
has
Test 1
Test 2
Test 3
Test 4

Square plate:
side has = 10. m
thickness T = 0.05 m

Co-ordinates of the points (in m):

Test 2
Test 4
Node
X

y
Node
X
y
1
4.0
4.0
1
4.0
4.0
2
2.25
2.25
3
4.75
2.5
4
7.25
2.75
5
7.5
4.75
6
7.75
7.25
7
5.25
7.25
8
2.25
7.25
9
2.5
4.75

1.2
Properties of materials

E = 2.1011 Pa
= 0.3
= 8.000. kg/m3

1.3
Boundary conditions and loadings

Any point P such as xp = 0: (U = v = W = 0, y = 0).

1.4 Conditions

initial
Without object for the modal analysis.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution is that given in the card "Test 16" of the tests of reference published by NAFEMS.
Card NAFEMS gives the results of reference as well as computation results carried out in using elements of the mean hull type of Kirchoff based on a formulation of displacement isoparametric quadratic (ddl of rotation and normal translation to the plate).

2.2 Results of reference

the first 6 clean modes.

2.3 References bibliographical

[1] F. ABASSIAN, D.J. DAWSWELL, N.C. KNOWLES. Selected Benchmarks for Natural Frequency Analysis. NAFEMS (1987).

---

3 Modeling
With
3.1
Characteristics of modeling

Fine grid for validation of the reference solution

y
Test 0
121
111
89
67
has
45
23
1
3
5
7
9
11
X
has

Cutting:
10 on each side of the rhombus 200 meshs TRIA3.
has
Twinge of the element
= 20.
10 *T*

Limiting conditions:

in all the nodes P on the Xp side = 0. :
DDL_IMPO: (GROUP_NO: DIMENSION DX: 0. , DY: 0. , DZ: 0. , DRY: 0.)

Name of the nodes:

Point 1 = N1
Point 121 = N121

3.2

Characteristics of the grid

A number of nodes:
121
A number of meshs and types:
200 TRIA3

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION
“PLUS_PETITE”
NMAX_FREQ

---

4 Results of modeling A

4.1 Values tested

Order of the mode	Reference	Aster	% difference
clean	Frequency (Hz)	Frequency (Hz)	
1	0.421	0.4178	0.8
2	1.029	1.0255	0.3
3	2.582	2.5669	0.6
4	3.306	3.2733	-1.
5	3.753	3.7347	0.5

6
6.555
6.5236
0.5
7
7.3756
8
7.7332
9
8.5567
10
11.1199
11
11.6474
12
14.3551

4.2 Remarks

Calculations carried out by:
MODE_ITER_SIMULT
METHOD: “TRI_DIAG”
OPTION: “PLUS_PETITE”
NMAX_FREQ: 12

4.3
Contents of the file results

the first 12 Eigen frequencies, clean vectors and modal parameters.

4.4 Parameters
of execution

Version: 3.03.25
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
7.2 seconds
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

Code_Aster ®
Version
4.0
Titrate:

SDLS100 Study of grids on a thin square plate
Date:
08/01/98
Author (S):
B. QUINNEZ
Key:
V2.03.100-C Page:
6/10

5 Modeling

B

5.1

Characteristics of modeling

Element DKT coarser grid
y
Test 1
21
20
19
18
22
8
7
6
23
17
9
1
5
24
16
has
2
3
4
25
15
10
11
12
13
14
X
has

Twinge of the elements:
= 50.
4 *T*
Limiting conditions:
in all the nodes P on the Xp side = 0. :
DDL_IMPO: (GROUP_NO: DIMENSION DX: 0. , DY: 0. , DZ: 0. , DRY: 0.)
Name of the nodes:
Point 1 = N1
Point 25 = N25
5.2
Characteristics of the grid
A number of nodes:
25
A number of meshs and types:
32 TRIA3
5.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“JACOBI”
[U4.52.02]
CALC_FREQ

OPTION
“PLUS_PETITE”
NMAX_FREQ

6
Results of modeling B
6.1 Values
tested
Frequency (Hz)
Order of the mode
Reference
Test NAFEMS
Aster
% difference
clean
NAFEMS
1
0.421
0.4174
0.4165
1.07
2
1.029
1.020
1.0301
0.11
3
2.582

2.564
2.5793
0.10
4
3.306
3.302
3.2572
1.47
5
3.753
3.769
3.7397
0.35
6
6.555
6.805
6.4544
1.54
Test 0
7
7.3756
7.2821
1.27
8
7.7332
7.6852
0.62
9
8.5567
8.3764
2.11
10
11.1199
10.7209
3.59
11
11.6474
11.2904
3.06
12
14.3531
13.7573
4.16

6.2 Remarks

Calculations carried out by:
MODE_ITER_SIMULT
METHOD: “JACOBI”
OPTION: “PLUS_PETITE”
NMAX_FREQ: 12

6.3
Contents of the file results

the first 12 Eigen frequencies, clean vectors and modal parameters.

6.4 Parameters
of execution

Version: 3.03.25
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5.36 seconds

---

7 Modeling C

7.1 Characteristics of modeling

Element DKT with distorted grid

y
Test 2
21
20
19
18
22
8
23
7
6
17
5
24
1
16
9
3
4
25
15
2
10
11
12
13

14
X
Twinge of the element: between 50 and 75.
Limiting conditions:
in all the nodes P on the Xp side = 0. :
DDL_IMPO: (GROUP_NO: DIMENSION DX: 0. , DY: 0. , DZ: 0. , DRY: 0.)
Name of the nodes:
Point 1 = N1
Point 25 = N25

7.2
Characteristics of the grid

A number of nodes:
25
A number of meshs and types:
32 TRIA3

7.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ

OPTION
“PLUS_PETITE”
NMAX_FREQ
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
HI-75/96/013 - Ind A

8
Results of modeling C
8.1 Values
tested
Frequency (Hz)
Order of the mode
Reference
Test NAFEMS
Aster
% difference
clean
NAFEMS
1
0.421
0.4174
0.4163
1.12
2
1.029
1.020
1.0340
0.49
3
2.582

2.571
2.5644
0.68
4
3.306
3.317
3.2539
1.58
5
3.753
3.780
3.7433
0.26
6
6.555
6.883
6.4898
0.99
Test 0
7
7.3756
7.2119
2.22
8
7.7332
7.6026
1.69
9
8.5567
8.3232
2.73
10
11.1199
10.7735
3.12
11
11.6474
11.2607
3.32
12
14.3531
13.3008
7.34

8.2 Remarks
Calculations carried out by:
MODE_ITER_SIMULT
METHOD: “TRI_DIAG”
OPTION: “PLUS_PETITE”
NMAX_FREQ: 12
8.3
Contents of the file results
the first 12 Eigen frequencies, clean vectors and modal parameters.
8.4 Parameters
of execution
Version: 3.03.25
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5.2 seconds

9
Summary of the results
% differences/reference
Order of
Reference
Aster
Aster
Aster

% diff.
% diff.
% diff.
mode
NAFEMS
Test 0
Test 1
Test 2
Test 0
Test 1
Test 2
clean
1
0.421
0.4178
0.4165
0.4163
0.76
1.07
1.12
2
1.029
1.0255
1.0301
1.0340
0.34
0.11
0.49
3
2.582
2.5669
2.5793
2.5644
0.58
0.10
0.68
4
3.306
3.2733
3.2572
3.2539
0.99
1.47

1.58
5
3.753
3.7347
3.7397
3.7433
0.49
0.35
0.26
6
6.555
6.5236
6.4544
6.4898
0.48
1.54
0.99
% differences/reference
Order of
Reference
Aster
Aster
Aster
% diff.
% diff.
% diff.
mode
NAFEMS
Test 0
Test 1
Test 2
Test 0
Test 1
Test 2
clean
7
7.3756
7.2821
7.2119
1.27
2.22
8
7.7332

7.6852
7.6026
0.62
1.69
9
8.5567
8.3764
8.3232
2.11
2.73
10
11.1199
10.7209
10.7735
3.59
3.12
11
11.6474
11.2904
11.2607
3.07
3.32
12
14.3551
13.7573
13.3008
4.16
7.34

· For tests 1 and 2, the quadrangles of card NAFEMS were cut out in triangles.
· Tests 3 and 4 can be carried out by Aster (not quadratic element of hull).
· Until the 9th mode, the error on the frequency is ² 2.5%.
· The effect of distortion of the grid appears really only on modes 7 and 12.

Author (S):
B. QUINNEZ, L. VIVAN
Key:
V2.03.101-A Page:
1/6
Organization (S): EDF/IMA/MMN, CISI
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
Document: V2.03.101
SDLS101 - Thin rectangular plate on mattress
rubber band
Summary:
This test makes it possible to validate modeling “APPUI_REP” [U4.22.01] for elements of hull. It corresponds
with calculations of frequency of inflection of a thin rectangular plate which rests on an elastic mattress. By
report/ratio with test SDLS03 [V2.03.003], which validates the frequencies of vibrations of a plate pressed on its edge,
this test validates modeling “APPUI_REP” and order CREA_MAILLAGE [U4.12.06]. The plate is with a grid with triangles and quadrangles.

Author (S):
B. QUINNEZ, L. VIVAN

1 Problem of reference

1.1 Geometry

Z, W
B
With
y, v

T
B
D
C
has
X, U
Z

Rectangular plate:

length
= 1.5 m have
width
B = 1. m
thickness
T = 0.01 m

Co-ordinates of the points (in m)

With
B
C
D
X
0.
0.
1.
1.
y
0.
1.5
1.5
0.
Z
0.
0.
0.
0.

1.2

Properties of materials

E = 2.1 E11 Pa
= 0.3
= 7800 kg/m3
Ef = 7th + 5 N/m3

1.3

Boundary conditions and loadings

Simple support on all the sides.

Any point P such as:
xp = 0 or xp = 1 W = 0
YP = 0 or YP = 1 W = 0

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The formulation for a rectangular plate thickness *T* posed on the four sides leads to:

I 2
J 2
And 2
F =

ij
2
has +
B

12 (1-2)
with:

I = a number of half-lengths of wave according to y
J = a number of half-lengths of wave according to X
The formulation for the plate posed on the four sides and resting on a led elastic mattress with:

/
1 2
E

F
F = *F* 2/sans mattress +

ij
ij

2
4 *T*
with *E F*: density of stiffness per unit of area.

2.2
Results of reference

the first 6 clean modes of nonnull frequency (the system comprises 3 modes of rigid body).

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
D. BLEVINS: Formulated for natural frequency and mode shape page 238-239.

---

3 Modeling
With
3.1
Characteristics of modeling
Modeling DKT
Z
y
B
C
With
D
X
Limiting conditions:
in all the nodes located on the edges
DDL_IMPO: (GROUP_NO: EDGE DZ = 0.)
3.2
Characteristics of the grid
A number of nodes: 176
A number of meshs and types: 150 TRIA3, 75 QUAD4
3.3 Functionalities
tested
Orders
Keys
DEFI_GROUP
CREA_GROUP_NO
GROUP_MA
[U4.12.03]
CREA_MAILLAGE
CREA_GROUP_MA
GROUP_MA
[U4.12.06]
DEFI_MATERIAU
APPUI_ELAS
[U4.23.01]
AFFE_MODELE
MODELING: “DKT”
[U4.22.01]
MODELING: “APPUI_REP”
MODELING: “DIS_T”
MODE_ITER_SIMULT
OPTION: “BAND”
[U4.52.02]
METHOD: “TRI_DIAG”

4
Results of modeling A
4.1 Values
tested
Modeling
DKT
Identification
Reference
Aster
% difference
Frequency 4
35.62638
35.5056
0.339
Frequency 5
68.51227
68.0411
0.688
Frequency 6
109.61964
109.0087
0.557
Frequency 7
123.32210
122.1914
0.917
Frequency 8

142.50554
140.6399
1.309
Frequency 9
197.31535
193.3111
2.029
Modeling DKT and APPUI_REP
Identification
Reference
Aster
% difference
Frequency 4
38.68542
38.8710
0.480
Frequency 5
70.15165
69.6943
0.652
Frequency 6
110.65166
110.0539
0.540
Frequency 7
124.24034
123.1200
0.902
Frequency 8
143.30092
141.4473
1.293
Frequency 9
197.89056
193.9004
2.016
Modeling DKT and DIS_T_N (to be able to make comparisons, one replaced the mattress rubber band by discrete springs positioned in each node of the grid).
Identification
Reference
Aster
% difference
Frequency 4

38.68542
38.1366
1.419
Frequency 5
70.15165
69.4507
0.999
Frequency 6
110.65166
109.8944
0.684
Frequency 7
124.24034
122.9824
1.012
Frequency 8
143.30092
141.3281
1.377
Frequency 9
197.89056
193.8133
2.060

4.2 Parameters of execution

Version: 3.06.04
Machine: CRAY C90
System:
Obstruction memory:
8 MW
Time CPU To use:
22 seconds

5

Summary of the results

The results obtained are correct compared to the results of reference.

Author (S):
P. MASSIN, A. LAULUSA

Organization (S): EDF/IMA/MMN, SAMTECH

Handbook of Validation

V2.03 booklet: Linear dynamics of the hulls and the plates

Document: V2.03.102

SDLS102 - Free vibrations of a paddle of compression

Summary:

This test makes it possible to validate the calculation of the Eigen frequencies of a paddle of compression by using the order
MODE_ITER_INV [U4.52.01].
Modelings correspond to the use of elements "COQUE_3D" MEC3QU9H (modeling A) and MEC3TR7H (modeling B).
The reference solutions are experimental results. The variation enters the numerical results and them experimental values does not exceed 4,5% for two modelings.

---

1 Problem of reference

1.1 Geometry

B
D
L
With
C
H
Rm
X
Y

It is about a cylindrical panel:

· Longueur: L = 0.3048 m,
· Average Rayon: Rm = 0.6096,
· Longueur of arc: 0.3042 m,
· Epaisseur: H = 0.003048 Mr.

1.2 Properties of material

The material is homogeneous, isotropic, elastic linear. The elastic coefficients are:

E = 206.850. MPa
= 0.3
Density: = 7857,2 kg/m3
Coefficient of the deformations of shearing action: A_CIS = 0.8333

1.3 Boundary conditions and loadings

The structure is embedded at end data base

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution corresponds to the experimental measurements given in [bib1].

2.2 Results of reference

The first six measured Eigen frequencies.

Number of the mode	Experimental values
1	85.6
2	134.5
3	259
4	351
5	395
6	531

2.3 References bibliographical

[1] J.L. BATOZ, G. DHATT: Modeling of the structures by finite elements - Volume 3 hulls, 1992 HERMES pp 467 to 470.

3 Modeling
With

3.1
Characteristics of modeling

B
Hull 3D MEC3QU9H
With
Z
X
D
C
Y

3.2
Characteristics of the grid

A number of nodes: 169, a Number of meshs and types: 36 QUAD9

3.3 Functionalities
tested

Order
Key word factor
Key word
Argument
Keys
AFFE_MODELE
AFFE
MODELING
“COQUE_3D”
[U4.22.01]
AFFE_CARA_ELEM
HULL
THICK
[U4.24.01]

A_CIS
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
MACRO_MATR_ASSE
MATR_ASSE
[U4.31.02]
MODE_ITER_INV
CALC_FREQ
[U4.52.01]
One seeks the frequencies in the interval (80. , 570.) by using the option “ADJUSTS” under the key word factor CALC_FREQ of order MODE_ITER_INV.

4 Results of modeling A

4.1 Values tested

(Frequencies in Hertz)

Identification	**Reference**	**Aster**	**% difference**
n° mode			
1	85.6	85.85	0.302
2	134.5	138.56	3.021
3	259	246.92	4.664
4	351	342.71	2.361
5	395	386.66	2.112
6			

531
531.59
0.112

4.2 Parameters
of execution

Version: 4.00.14
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
15.8 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

B
Hull 3D MEC3TR7H
With
Z
X
D
C
Y

5.2
Characteristics of the grid

A number of nodes: 913, a Number of meshs and types: 288 TRIA7

5.3 Functionalities
tested

Order
Key word factor
Key word
Argument
Keys
AFFE_MODELE
AFFE
MODELING
“COQUE_3D”
[U4.22.01]
AFFE_CARA_ELEM
HULL
THICK
[U4.24.01]
A_CIS
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
MACRO_MATR_ASSE
MATR_ASSE
[U4.31.02]
MODE_ITER_INV
CALC_FREQ
[U4.52.01]

6
Results of modeling B

6.1 Values
tested

(Frequencies in Hertz)
Identification
Reference
Aster
% difference
n° mode
1
85.6
86.06
0.534
2
134.5

138.68
3.112
3
259
248
4.246
4
351
344.52
1.845
5
395
390.62
1.108
6
531
533.2
0.415

6.2 Parameters of execution

Version: 4.00.14
Machine: C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
108.7 seconds

7

Summary of the results

Resulted are satisfactory. But the grid with elements MEC3TR7H must be fine to have the same level of error as that obtained with elements MEC3QU9H.

Author (S):
***A. ADOBES**, Key Mr. LAINET*
:

Organization (S): EDF/MTI/MFTT, CS IF

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
Document: V2.03.103

SDLS103 - Coaxial hulls under flow annular: inertial coupling between modes

Summary

One considers a hardware configuration made up of two coaxial cylindrical hulls, in interaction with a fluid running out in annular space separating the hulls.

The goal of the case-test is to validate the model of coupling fluid-structure developed in the operator CALC_FLUI_STRU for this type of configuration.

One is interested here more particularly in the taking into account of the inertial coupling between modes, obtained out of water
at rest (mean velocity of flow null). The reference solution is provided by a calculation carried out with
Code_Aster implementing operator CALC_MATR_AJOU.
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-86/01/021/A

Code_Aster ®
Version
5.0

Titrate:
SDLS103 - Coaxial hulls under annular flow

Date:
09/10/01
Author (S):
***A. ADOBES**, Key Mr. LAINET*
:
V2.03.103-A Page:
2/6

1
Problem of reference

1.1 Geometry

The studied configuration consists of two 4 meters height coaxial cylindrical hulls:

2m
4m
0.1m

The internal hull has an average radius of 1 meter and a thickness of 1 centimetre.

The external hull has an average radius of 1,10 meter and a thickness of 1 centimetre.

1.2 Properties

material

The material constituting the two hulls is steel. Its physical characteristics are:

= 7800 kg/m3
E = 2. 1011 Pa
= 0,3

1.3
Boundary conditions and loadings

The conditions of self-supporting quality are the same ones for the two hulls: partly embedded ends lower (Z = 0) and free partly higher (Z = 4 m).
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-86/01/021/A

Code_Aster ®
Version
5.0

Titrate:
SDLS103 - Coaxial hulls under annular flow

Date:
09/10/01
Author (S):
A. ADOBES, Key Mr. LAINET
:

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is provided by a calculation carried out by means of Code_Aster implementing operator CALC_MATR_AJOU.

With this intention, one uses a grid on which the elements of the structure (hulls internal are defined and external), voluminal elements of fluid (annular space) and elements of interface fluid-structure. This method is described completely in [bib1].
On the elements of interface, the condition normal speed limit null is imposed, translating condition of nonpenetration of the fluid in the hulls.
On the sections of entry and exit of annular space, the limiting condition of null potential is imposed, translating the condition of null disturbed pressure at the ends.

One carries out the first modal calculation of the structure in air. Operator CALC_MATR_AJOU allows
then to calculate the matrix of mass added by the fluid, projected on the basis of modal structure in air. One can then recombine this matrix of mass added with the matrix of mass generalized of the structure in air, then to solve a new modal problem which leads to characteristics of the water system at rest. Results obtained for the Eigen frequencies system out of water at rest constitute the reference solution.

Characteristics of the grid 17 nodes on a vertical generator
:

60 nodes on a crown

960 meshs QUAD4 on each hull

=> 1920 meshs for the interface fluid-structure

2880 meshs HEXA8 for the fluid field

180 meshs QUAD4 for the section of entry of annular space

180 meshs QUAD4 for the section of exit of annular space

2.2
Results of reference

N°

mode
1 2 3 4 5 6 7 8 9 10 11
12
Freq
(Hz) 5,65 5,65 6,48 6,48 9,34 9,34 20,82 20,82 28,22 28,22 31,48 31,4
8

2.3
Uncertainty on the solution

In the studied case, the half-thicknesses of hull account for 10% of the dimension of the annular play.
In the calculation of reference realized by operator CALC_MATR_AJOU, the half-thicknesses are
neglected for the definition of the fluid field. One thus awaits a systematic error about
5% on the frequencies, because of this approximation.
Moreover, differences of modeling and resolution between the numerical method implemented
in operator CALC_MATR_AJOU and the analytical model developed in the operator
CALC_FLUI_STRU induce an additional variation.

2.4 References
bibliographical

[1]
G. ROUSSEAU: "Schedule of conditions and principle of realization of the calculation of stiffness
and
of damping added in Code_Aster ", HP-51/96/005/B.
[2]
L. PEROTIN, "Note of principle of model MOCCA_COQUE", HT-32/95/021/A.
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-86/01/021/A

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3 Modeling
With

3.1
Characteristics of modeling

The geometry of the structures and the characteristics of material constituting the hulls were presented before.

Concerning the absolute roughness of wall of the structures, one takes a value of 105 meter.

The surrounding fluid is water. Values taken for the density and viscosity kinematics are respectively

= 106 m2/s.
F = 1000 kg/m3 and
F

One considers the flow not confined upstream and downstream from the structures.

The problem of coupling fluid-structure is solved by analytical model MOCCA_COQUE [bib2] integrated in Code_Aster (operator CALC_FLUI_STRU), for a mean velocity of flow null: one thus obtains the modal characteristics of the water system at rest, by catch in count effects of added mass.

3.2 Characteristics

grid

Compared to the calculation of reference, the characteristics of the grid are similar, with the difference close the fluid field is not represented any more. In order to make the two hulls interdependent one of the other, one adds a group of meshs connecting the nodes to the level of embedding.

One a: 17 nodes on a vertical generator, *60 nodes on a crown,*

960 meshs QUAD4 on each hull,

60 meshs QUAD4 to solidarize the two hulls (bases embedded).

3.3
Stages of calculation

The definition of the characteristics of a hardware configuration made up of two hulls cylindrical coaxial for a calculation of coupling fluid-structure is given via operator DEFI_FLUI_STRU key word factor COQUE_COAX.

The resolution of the coupling fluid-structure for a configuration of the type "coaxial hulls" and it calculation of the modal parameters (reduced frequencies and depreciation) and deformed modal out of water at rest are realized with operator CALC_FLUI_STRU.

3.4 Functionalities
tested

Orders
Key word factor
Key word

DEFI_FLUI_STRU COQUE_COAX
MASS_AJOU
"YES"
CALC_FLUI_STRU BASE_MODALE
MODE_MECA

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-86/01/021/A

Code_Aster ®
Version
5.0

Titrate:
SDLS103 - Coaxial hulls under annular flow

Date:

4
Results of modeling A

4.1 Values tested

The comparisons relate to the water frequencies at rest of the first 12 modes of the system.

Numbers of the modes
CALC_FLUI_STRU
CALC_MATR_AJOU
variation
(H = 9cm)
(H = 10cm)
1 and 2
5,30 Hz
5,65 Hz
6,2 %
3 and 4
6,12 Hz
6,48 Hz
5,5 %
5 and 6
8,69 Hz
9,34 Hz
6,9 %
7 and 8
21,96 Hz
20,82 Hz
-5,5 %
9 and 10
29,34 Hz
28,22 Hz
-3,9 %
11 and 12
33,75 Hz

31,48 Hz
-7,2 %

One gives, for information, the values of the frequencies of these modes in air:

Numbers of
Hull in mvt
Order of hull
Order of beam
Frequency
modes
1 and 2
external
3
1
25,15 Hz
3 and 4
intern
3
1
26,12 Hz
5 and 6
external
4
1
31,91 Hz
7 and 8
intern
2
1
36,85 Hz
9 and 10
intern
4
1
37,42 Hz
11 and 12
external
2
1
39,49 Hz

4.2 Remarks

The results are in conformity so that one could wait. One observes indeed:

· a systematic error of about 5%, because of not taken into account thicknesses of hull for the definition of the fluid field in the calculation of reference;
· a residual variation due to the differences of modeling and resolution between the two operators CALC_MATR_AJOU and CALC_FLUI_STRU.

Modes 1 to 6 are modes for which the structure is strongly coupled with the fluid. In practical, these modes correspond to movements of the hulls internal and external overall in opposition of phase. For these modes, the terms of added mass are theoretically proportional
3
F
R
with
, where R indicates the average radius and H the thickness of annular space.
H

For these the first six modes, the results provided by CALC_FLUI_STRU lead to frequencies clean lower than those calculated by CALC_MATR_AJOU. Indeed, H being weaker, them terms of added mass are larger.

Modes 7 to 12 are modes for which the structure is slightly coupled with the fluid. In practical, these modes correspond to movements of the hulls internal and external almost in phase. Thus, the terms of added mass are theoretically proportional to the water mass involved, i.e. with
F
RH.

In this case, it is normal that the results provided by CALC_FLUI_STRU lead to Eigen frequencies higher than those calculated by CALC_MATR_AJOU. Indeed, H being more weak, the terms of added mass are smaller.

4.3 Parameters of execution

Version: NEW 5.02.20

Machine: SGI ORIGIN 2000

Obstruction memory: 64 Mo
Time CPU To use: 50,63 seconds

5 Summary of the results

The comparison of the water frequencies at rest calculated with operators CALC_FLUI_STRU and CALC_MATR_AJOU is satisfactory. The variations met between these two operators are explained by the fact that they use a different modeling.

Titrate:
SDLS106 - Modal calculation of plate in under-structuring

Date:
01/03/04
Author (S):
***E. BOYERE** Key*
:
V2.03.106-A Page:
1/4

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and the plates
Document: V2.03.106

SDLS106 - Modal calculation of plate in
under-structuring with base of Ritz

Summary:

This test of the field of the modal analysis implements the calculation of Eigen frequencies of inflection in
under-structuring of a plate pressed on its edges. The interface is of type CRAIG-BAMPTON.

The reference solution is analytical.

1
Problem of reference

1.1 Geometry

plate
L
SS1
substructure 1
SS2
I
interface
simple support

L = 2 m

L = 1,5 m

1.2
Properties of the structure

= 7800 kg/m3

E = 2.1011 Pa
= 0.3
thickness 1 Misters.
S

1.3
Boundary conditions and loadings

The plate is in simple support on its four edges. The interface of each substructure is embedded.

2
Reference solution

2.1
Reference solution of each substructure

Each substructure is a plate length 1,5 m and width 1 m, supported on three dimensioned and embedded on the fourth, vibrating in inflection.

It is shown [bib1] that the Eigen frequencies are worth:

1

2
2
ij

Eh
2
fij =

2 L2 12 1
(- 2)

with 2
=
53
,
42
2

=
00
,
69
2

=
30
,
116
2

=
00
,
121
,
11
21
31
12

what gives for the first frequencies

F =

,

47 26Hz,

11

F

=

57

,

76

Hz,

21

F

=

,

129 24Hz,

31

F

=

,

134 47

.

12

Hz

2.2
Reference solution of the assembled problem

According to [bib1], one has for the Eigen frequencies of vibration of a supported plate

2

2

=

L

2

2

2

ij

I
+
J

L

That is to say

F =
12
,
17
Hz,
11
F
=
61
,
35
Hz,
21
F
=
99
,
49
Hz,
12

F
=
,
66 42Hz,
31
F
= ,
68 48
.
22

Hz

2.3 Reference bibliographical

[1]
BLEVINS R.D: Formulated for natural frequency and shape mode. ED. Krieger 1984.

---

3 Modeling With

3.1 Characteristics of modeling

For each substructure: 600 meshs QUAD4.

3.2 Functionalities tested

Orders

DEFI_BASE_MODALE OPTION RITZ

MODE_STATIQUE
FREQ

MODE_ITER_SIMULT
“REAL”

4
Results of modeling A

4.1
Values tested on the complete structure

Identification Reference
Aster %
difference
N°11 mode

frequency
17.12 Hz
17.12 Hz
0.00
N°21 mode

frequency
35.61 Hz
35.59 Hz
0.05
N°12 mode

frequency
49.99 Hz
50.03 Hz
0.08

N°31 mode

frequency 66.42
Hz
66.57 Hz
0.2

N°22 mode

frequency 68.48
Hz
68.36 Hz
0.01

5
Summary of the results

Calculation in under-structuring with modal base of type "Ritz" was validated on the modes of inflection
of a plate pressed on its four edges.

Organization (S): EDF/RNE/AMV, SAMTECH-France

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
V2.03.108 document

SDLS108 - Use of option RIGI_PARASOL
within the framework of a study EPR

Summary:

The goal of the test is to test the option RIGI_PARASOL which makes it possible to distribute stiffnesses of floor under a foundation raft of
building. This option is called successively in orders AFFE_CARA_ELEM and CALC_AMOR_MODAL.

In order AFFE_CARA_ELEM, it makes it possible to calculate then to affect by a modeling DIS_TR them
specific stiffnesses of a carpet of springs of floor under the foundation raft of building. In the order CALC_AMOR_MODAL, these values make it possible to calculate modal potential energy in the ground which contributes
with the calculation of modal depreciation according to the rule of the RCC-G [bib1].

The studied case is an industrial structure of the nuclear small island of EPR. It includes/understands only one modeling. It

case test is thus used to test nonthe regression of the code as much as it constitutes documentation on its use
in oneself. The model of approximately 40000 degrees of freedom consists of 6700 nodes and 10300 elements approximately:
9500 elements DKT, 100 elements of beam and 700 discrete elements of connection.

This industrial case-test is representative of the studies led by SEPTEN/MS on modelings 3D of civil engineering subjected to the seism and makes it possible to reabsorb the tools used within this framework. The comparison relates to
frequencies and depreciation for the first modes calculated on carpet of springs of ground.
The values of reference for a ground of the type SA (soft ground) are given in note E.N.T.MS 96.052 A
[bib2].
The 6 values of total stiffnesses of ground to be distributed under the foundation raft are determined by PARASOL for
modulate ground of the type SA (444 MPa).
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-62/01/012/A

1
Problem of reference

1.1 Geometry

The studied case is the industrial structure of the nuclear small island of EPR. It includes/ understands only one modeling
composed primarily of elements of hull. The connection of the foundation with the ground is

modelled
by specific discrete elements.

A number of nodes: 6732
A number of triangular meshs (TRIA3): 1848
A number of rectangular meshs (QUAD4): 7677
A number of POI1: 1119
A number of SEG2: 9047

1.2
Material properties

Reinforced concrete:

E =
35000.
MPa
Naked =
0.2
AMOR_ALPHA = 4.95E-04
AMOR_BETA =
3.91

Various distributions of the densities of reinforced concrete following the components:

To erase

RHO = 2500 kg/m3
External walls
RHO = 2500 kg/m3
Floors of the boxes RHO = 2500 kg/m3
Internal structures
RHO = 2500, 12500, 9700, 5850, 5290, 4500, 4180, 3900, 3680, 620 kg/m3
External enclosure
RHO = 2500 kg/m3
Division 0
RHO = 2500, 5000, 4500, 4180, 3750 kg/m3
Division 1
RHO = 2500, 4500, 3410 kg/m3
Division 2-3
RHO = 2500, 4500, 4180, 3900 kg/m3
Division 4
RHO = 42500, 500, 3410 kg/m3

Concrete prestressed:

E =
40000
MPa
Naked =
0.2
RHO =
2500
kg/m3
AMOR_ALPHA = 3.54
E-04
AMOR_BETA =
2.79

Used for the internal enclosure.

1.3 Characteristics
elementary

To erase
thicknesses of hull 8, 4.5, 4 m
External enclosure
thickness 1.3 m
Internal enclosure
thicknesses 2.5, 1.3, 0.9 m
External walls

thicknesses 1.3, 0.9 m
Floors of the boxes thickness 0.6 m
Internal structures
thicknesses 7.5, 2.8, 1.9, 1.5, 1.2, 1.0, 0.8, 0.6, 0.5 m
Division 0
thicknesses 3, 2.5, 2.0, 1.5, 1, 0.8, 0.6, 0.5, 0.4, 0.3 m
Division 2-3
thicknesses 0.8, 0.7, 0.6, 0.5, 0.4, 0.3 m

Beams squares dig height = 0.5 m, thickness = 0.25 m
Division 1
thicknesses 1.1, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3 m

Beams squares dig height = 0.5 m, thickness = 0.25 m
Division 4
thicknesses 1.1, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3 m

Beams squares dig height = 0.5 m, thickness = 0.25 m

Stiffnesses of ground resulting from PARASOL:

Stiffnesses of the foundation raft:

Kx = 3.3 E10 N/m
Ky = 3.3 E10 N/m
Kz = 3.3 E10 N/m
Krx = 6.01 E13 N.m
Kry = 5.76 E13 N.m
Krz = 5.76 E13 N.m

Co-ordinates of the center: 0. 0. 11.6 m
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-62/01/012/A

Code_Aster ®
Version
5.0

Titrate:
SDLS108 Use of RIGI_PARASOL within the framework of a study EPR
Date:
30/08/01
Author (S):
G. DEVESA, Key P. LATRUBESSE

2
Reference solution

2.1
Method of calculation used for the reference solution

The modal damping coefficients are calculated according to the rule of the RCC-G [bib1]. They are obtained by summoning depreciation of the substructures constitutive of a building and them depreciation structural and geometrical of the ground balanced by their respective rates of energy potential compared to total potential energy, and that for each mode. There are 2 methods and two key words of CALC_AMOR_MODAL to estimate the contribution of the ground with the potential energy according to
that one average modal efforts (key word "RIGI_PARASOL") or modal displacements
(key word "DEPL") with the nodes of the foundation raft.

2.2
Results of reference

The results of reference, frequencies, masses effective and modal depreciation are provided
in the note bench-mark datum [bib2]. They were calculated by Code_Aster.
It should be noted that modal depreciation was also calculated by affecting a stiffness to
each node of the foundation raft (instead of RIGI_PARASOL).

2.3
Uncertainty on the solution

Results of the industrial study. The case-test is thus included/understood like a test of not-regression of
code.

2.4 References
bibliographical

[1]
RCC-G Rules of design and construction of the nuclear small islands REFERENCE MARK - EDF - Direction
equipment - Edition July 1988
[2]
EPR BASIC Design dynamic analyses - modal Modelling and analysis of NR. I. buildings - note E.N.T.MS 96.052 A

3 Modeling
With

3.1
Characteristics of modeling

PHENOMENON formulation: “MECHANICAL”, MODELING: DKT.

3.2
Characteristics of the grid

A number of nodes: 6732
A number of meshs and type: 7677 QUAD4 and 1848 TRIA3

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM RIGI_PARASOL
CARA

VALE

MODE_ITER_INV
CALC_FREQ FREQ

OPTION
“NEAR”
POST_ELEM ENER_POT

CALC_AMOR_MODAL ENERSOL
METHOD
“RIGI_PARASOL”
AMOR_INTERNE

“DEPL”
AMOR_SOL

Handbook of Validation

4
Results of modeling A

4.1 Depreciation

Frequencies modes
Depreciation (%)
Results of
Variations reference -
(Hz)
with RIGI_PARASOL
reference (%)
calculation with
threshold = 30%
Code_Aster (%)
1 1.17453
20.905
20.905
0
2
1.17782
21.052
21.052
0
3 1.35640
30.000

30.000
0
4 2.16990
30.000

30.000
0
5
2.27813
29.925
29.925
0

Modes Frequencies Depreciation (%)
Results of
Variations reference -
(Hz)
with RIGI_PARASOL
reference (%)
calculation with
without threshold
Code_Aster (%)
1 1.17453
20.905
20.905 0
2
1.17782
21.052
21.052
0
3 1.35640
54.970
54.970
0
4 2.16990
30.223
30.223
0
5
2.27813
29.925

29.925
0

Modes Frequencies Depreciation (%)
Results of
Variations reference -
(Hz)
with DEPL
reference (%)
calculation with
threshold = 30%
Code_Aster (%)
1 1.17453
21.033
21.033
0
2 1.17782
21.183
21.183
0

3 1.35640
30.000
30.000
0
4 2.16990
30.000
30.000
0
5 2.27813
30.000
30.000
0

4.2 Parameters
of execution

Version: 5.02

Machine: SGI ORIGIN 2000

Obstruction memory:
400 megawords
Time CPU to use:
258 seconds
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-62/01/012/A

5
Summary of the results

Results of the depreciation obtained by CALC_AMOR_MODAL with the method of the forces (key word "RIGI_PARASOL") with or without truncation of threshold to 30% are exactly the same ones as those given in the reference [bib2]. They are very close to those obtained by CALC_AMOR_MODAL with the method of displacements (key word "DEPL"), also identical to those given in reference [bib2].

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
Document: V2.03.109

SDLS109 - Eigen frequencies of a ring cylindrical thick

Summary:

This test is inspired by a vibratory study carried out on collector VVP of the N4 sections. This collector is thick and a maximum report/ratio thickness presents on average radius of 0,13. This value, being able to be typical of an industrial structure, is slightly higher than the limiting value of usually recognized validity for the plates and hulls. In this study, the modeling of the collector in hulls is then evaluated by comparison with a voluminal model on a ring.

This test makes it possible to evaluate the algorithm of search for eigenvalues MODE_ITER_SIMULT [U4.52.03] with operators of rigidity and mass corresponding to following modelings:

1) plates of the type DKQ (finite element MEDKQU4) and DSQ (finite element MEDSQU4),
2) plates of the type DKT (finite element MEDKTR3) and DST (finite element MEDSTR3) with an ear grid and in star grid,
3) three-dimensional hulls of type COQUE_3D (finite elements MEC3QU9H and MEC3TR7H),

4) sections of hull in plane constraints of type COQUE_C_PLAN (finite element METCSE3),
5) telegraphic elements with kinematics of beam and modes of Fourier PIPE (finite element METUSEG3) and
TUYAU_6M (finite element MET6SEG3).

The results obtained are compared with the solution resulting from a voluminal modeling of the ring (element
finished MECA_HEXA8) revealing the modes of Fourier of order 2 (ovalization) and 3 (trifoliate) like 2
modes except plan. The variations on the frequencies of the modes of ovalization and trifoliate are close to:

·
0.4% in DSQ and COQUE_3D in QUAD9,
·
0.7% in COQUE_3D in TRIA7, COQUE_C_PLAN, PIPE and TUYAU_6M,
·
1% for the DKQ, DKT and DST.

1
Problem of reference

1.1 Geometry

Rm
L

T

It is of a cylindrical ring, average radius Rm = 0.369 m, about thickness T = 0.048 m and of length L = 0.05 Mr.

1.2
Properties of material

The material is homogeneous, isotropic, elastic linear. The elastic coefficients are:
E = 185.000 MPa and = 0.3.
The density is constant and is worth: = 7800 kg.m3.

1.3
Boundary conditions and loadings

The structure is free in space.

1.4
Order of magnitude of the Eigen frequencies

The required clean modes correspond to the modes of Fourier of order 2 and 3 of the ring. frequencies of a ring can be estimated starting from an analytical model of curved beam of Euler [bib1]. For a mode of Fourier of order N, the frequency is worth:

N (N2 -)
1
E I
F
y
=
N
2

R2
2
m
m (N +)
1

Lt3
where: I =
=
y
and m

Lt
12

For the modes of ovalization (N = 2) and trifoliate (N = 3), the corresponding frequencies are worth respectively 211.65 Hz and 598.64 Hz. The search for clean modes is carried out on the tape 200 - 800 Hz in order to collect these 2 modes of Fourier.

1.5 Reference bibliographical

[1]
Blevins R.D., Formulated for natural frequency and shape mode, N.Y.: Van Nostrand Reynhold Company, 1979, 492 p.

---

2 Modeling of reference

2.1 Characteristics of the modeling of reference

Voluminal elements 3D

The discretized geometry is represented above. The elements 3D are voluminal with 8 nodes of type HEXA8. The number of nodes on the circumference is 600, on thickness 9 and length 9.

2.2
Characteristics of the grid

A number of nodes: 48600
A number of meshs and type: 38400 HEXA8

2.3 Functionalities
tested

Orders
AFFE_MODELE
AFFE
MODELING = "3D"
CALC_MATR_ELEM OPTION "RIGI_MECA"
"MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)

3
Results of the modeling of reference

3.1
Values of reference tested

Frequencies of the clean modes of ovalization, trifoliate and except plan.

Mode
Eigen frequencies (Hz)
ovalization 210.55
210.55
trifoliate 587.92
587.92
except plan
205.89
205.89
588.88
588.88

3.2 Remarks

The axisymmetric problem has double modes in the plan and except plan.
The modes except plan have the following deformations:

205.89 Hz:
588.88 Hz:

3.3 Uncertainties

Uncertainty results from the analysis of convergence of the grid where Eigen frequencies with grid of reference 600x8x8 are compared with those of the grids 500x7x9.

A number of elements
Eigen frequencies (Hz)
Circumference Thickness
Length
Ovalization Trifoliate
100
3
3
232.03
648.62
200
3
3
225.20
628.74
400
5

8
221.02
616.34
500
7
9
210.64
588.18
600
8
8
210.55
587.92

Uncertainty is 0.05% on the frequency.

---

4 Modeling With

4.1 Characteristics of modeling

Plates DKQ and DSQ.

The discretized geometry is represented above. Elements DKQ and DSQ are facets plane with four nodes of the type QUAD4. The number of nodes on the circumference is 100 and on length 5.

4.2
Characteristics of the grid

A number of nodes: 500
A number of meshs and type: 400 QUAD4

4.3 Functionalities tested

Orders

AFFE_MODELE
AFFE
MODELING = "DKT" or "DST"
AFFE_CARA_ELEM
HULL
THICK = 0.048
CALC_MATR_ELEM OPTION
"RIGI_MECA"
"MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)

5
Results of modeling A

5.1 Values tested

(Frequencies in Hertz)

Reference mode
Aster
DKQ %
difference Aster
DSQ %
difference
ovalization 210.55 211.48
0.44
209.57
-0.46
210.55
211.48
0.44
209.57
-0.46
trifoliate 587.92
598.23
1.75
586.30
-0.27
587.92
598.23
1.75
586.30
-0.27
except plan
205.89
234.70
13.99

205.89
234.70
13.99

588.88
646.34
9.75
533.02
-9.49
588.88
646.34
9.75
533.02
-9.49

5.2 Remarks

Modelings in plates DKQ and DSQ do not make it possible to represent the modes correctly except plan. One can think that that is due to the number of meshs over the too low length (4 with the place from 8 in the modeling of reference). The first frequency except plan in plates DSQ must be lower than 200 Hz.

---

6 Modeling B

Plates DKT and DST - ear grid

The geometry discretized on the average radius Rm = 0.369 m is represented above. Elements DKT and DST are plane facets with three nodes of the type TRIA3 laid out out of ears. The number of nodes on the circumference is 100 and over length 5.

6.1
Characteristics of the grid

A number of nodes: 500
A number of meshs and type: 800 TRIA3

6.2 Functionalities
tested

Orders

AFFE_MODELE
AFFE
MODELING = "DKT" or "DST"
AFFE_CARA_ELEM
HULL
THICK = 0.048
CALC_MATR_ELEM OPTION
"RIGI_MECA"
"MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)
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SDLS109 - Eigen frequencies of a thick cylindrical ring
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7
Results of modeling B

7.1 Values
tested

(Frequencies in Hertz)

Reference mode
Aster
DKT %
difference Aster
DST %
difference
ovalization 210.55 211.54
0.47
203.69
-3.25
210.55
211.54
0.47
203.69
-3.25
trifoliate 587.92
598.64
1.82
568.70
-3.27
587.92
598.64
1.82
568.70
-3.27
except plan
205.89
254.89
23.80

202.38
-1.70
205.89
254.89
23.80
202.38
-1.70
588.88
707.53
20.14
617.18
4.81
588.88
707.53
20.14
617.18
4.81

7.2 Remarks

Modeling in plates DKT does not make it possible to represent the modes except plan correctly.
The errors on the frequencies in DST plates are relatively important.

---

8 Modeling

C

Plates DKT and DST - star grid

The geometry discretized on the average radius Rm = 0.369 m is represented above. Elements DKT and DST are plane facets with three nodes of the type TRIA3 laid out out of stars. The number nodes on the circumference is 100 and over length 5.

8.1
Characteristics of the grid

A number of nodes: 500
A number of meshs and type: 800 TRIA3

8.2 Functionalities tested

Orders

AFFE_MODELE
AFFE
MODELING = "DKT" or "DST"
AFFE_CARA_ELEM
HULL
THICK = 0.048
CALC_MATR_ELEM OPTION
"RIGI_MECA"
"MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)

9
Results of modeling C

9.1 Values tested

(Frequencies in Hertz)

Reference mode
Aster
DKT %
difference Aster
DST %
difference
ovalization 210.55 211.54
0.47
208.20
-1.11
210.55
211.54
0.47
208.20
-1.11
trifoliate 587.92
598.58
1.81
581.00
-1.18
587.92

598.58
1.81
581.00
-1.18
except plan
205.89
284.38
38.12
225.23
9.39
205.89
284.38
38.12
225.23
9.39
588.88
797.24
35.38
690.73
17.29
588.88
797.24
35.38
690.73
17.29

9.2 Remarks

Modelings in plates DKT and DST do not make it possible to represent the modes correctly except plan.

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10 Modeling D

10.1 Characteristics of modeling

COQUE_3D grid in QUAD9.

The geometry discretized on the average radius Rm = 0.369 m is represented above. Elements COQUE_3D are meshs with 9 nodes of the type QUAD9 making it possible to take into account the ray of curve of the ring. The nodes mediums are well on the average circumference. The number of nodes on the circumference is 40 and over length 5.

10.2 Characteristics of the grid

A number of nodes: 200
A number of meshs and type: 40 QUAD9

10.3 Functionalities tested

Orders

CREA_MAILLAGE
MODI_MAILLAGE
OPTION = "QUAD8_9"
AFFE_MODELE
AFFE
MODELING = "COQUE_3D"
AFFE_CARA_ELEM
HULL
A_CIS = 0.833333
COEF_RIGI_DRZ = 1.E-5
THICK = 0.048
CALC_MATR_ELEM OPTION
"RIGI_MECA"
"MASS_MECA"

MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)

11
Results of modeling D

11.1 Values
tested

(Frequencies in Hertz)

Reference mode
Code_Aster %
difference
ovalization 210.55
209.91
-0.30
210.55
209.91
-0.30
trifoliate 587.92
586.51
-0.24
587.92
586.51

-0.24
except plan
205.89
205.14
-0.36
205.89
205.14
-0.36
588.88
587.55
-0.23
588.88
587.55
-0.23

11.2 Remarks

All the frequencies are correctly estimated.

---

12 Modeling
E

12.1 Characteristics of modeling

COQUE_3D grid in TRIA7.

The geometry discretized on the average radius Rm = 0.369 m is represented above. Elements COQUE_3D are meshs with 7 nodes of the type TRIA7 making it possible to take into account the ray of
curve of the ring. The nodes mediums are well on the average circumference. The number of nodes on the circumference is 40 and over length 5.

12.2 Characteristics of the grid

A number of nodes: 280
A number of meshs and type: 160 TRIA7

12.3 Functionalities tested

Orders

CREA_MAILLAGE
MODI_MAILLAGE
OPTION = “TRIA6_7”
AFFE_MODELE
AFFE
MODELING = “COQUE_3D”
AFFE_CARA_ELEM
HULL
A_CIS = 0.833333
COEF_RIGI_DRZ = 1.E-5
THICK = 0.048
CALC_MATR_ELEM OPTION
“RIGI_MECA”
“MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)
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Titrate:

13
Results of modeling E

13.1 Values
tested

(Frequencies in Hertz)

Reference mode
***Code_Aster** %*
difference
ovalization 210.55 211.19
0.30
210.55
211.19
0.30
trifoliate 587.92
590.98
0.52
587.92
590.98
0.52
except plan
205.89
205.81
-0.04
205.89
205.81
-0.04
588.88
595.38
1.10
588.88
595.38

1.10

13.2 Remarks

The frequencies are less better estimated that with elements QUAD9.

14 Modeling
F

14.1 Characteristics of modeling

COQUE_C_PLAN.

The geometry discretized on the average radius Rm = 0.369 m is represented above. Elements COQUE_C_PLAN are meshs with 3 nodes of the type SEG3 making it possible to take into account the ray
of curve of the ring. The nodes mediums are well on the average circumference. The number of nodes on the circumference is 100.

14.2 Characteristics of the grid

A number of nodes: 100
A number of meshs and type: 50 SEG3

14.3 Functionalities
tested

Orders

AFFE_MODELE
AFFE
MODELING = “COQUE_C_PLAN”
AFFE_CARA_ELEM
HULL
A_CIS = 0.833333
MODI_METRIQUE = “NOT”
THICK = 0.048
CALC_MATR_ELEM OPTION
“RIGI_MECA”
“MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)

15
Results of modeling F

15.1 Values
tested

(Frequencies in Hertz)

Reference mode
Code_Aster %
difference
ovalization 210.55
209.14
-0.67
210.55
209.14
-0.67
trifoliate 587.92
583.28
-0.79
587.92
583.28
-0.79
except plan
205.89

205.89
588.88
588.88

15.2 Remarks

Modeling in plane constraints does not make it possible to reveal the modes except plan of the ring.

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SDLS109 - Eigen frequencies of a thick cylindrical ring
Date:
06/02/04
Author (S):

16 Modeling G

16.1 Characteristics of modeling

PIPE and TUYAU_6M.

CENTER in SEG3

The geometry discretized on the axis of the ring is represented above. The elements PIPE and TUYAU_6M are meshs with 3 nodes of the type SEG3 representing the axis of the ring. The number of nodes on the axis is 5.

16.2 Characteristics of the grid

A number of nodes: 5
A number of meshs and type: 2 SEG3

16.3 Functionalities tested

Orders

AFFE_MODELE
AFFE
MODELING = "PIPE" or "TUYAU_6M"
AFFE_CARA_ELEM
BEAM
SECTION = "CIRCLE"
MODI_METRIQUE = "NOT"
CARA = ("R" "EP")
VALE = (0.395, 0.048)
CALC_MATR_ELEM OPTION
"RIGI_MECA"
"MASS_MECA"

MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)

17
Results of modeling G

17.1 Values
tested

(Frequencies in Hertz)

Reference mode
Aster
PIPE %
difference Aster
TUYAU_6M %
difference
ovalization 210.55 209.02
-0.72
209.02
-0.72
210.55
209.02
-0.72

209.02
-0.72
trifoliate 587.92
591.00
0.52
591.00
0.52
587.92
591.00
0.52
591.00
0.52
except plan
205.89
259.74
26.15
259.74
26.15
205.89
259.74
26.15
259.74
26.15
588.88
649.57
10.31
649.57
10.31
588.88
649.57
10.31
649.57
10.31

17.2 Remarks

Modelings in PIPE (limited by construction to 3 modes of Fourier) and TUYAU_6M do not allow to represent the modes except plan correctly. On the other hand, they provide them same results on the outline views, close to the reference.

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18 Modeling H

18.1 Characteristics of modeling

Modeling SHB8

The discretized geometry is represented above. Elements SHB8 are pressed on meshs HEXA8. The number of elements on the circumference is 100 and over length 5.

18.2 Characteristics of the grid

A number of nodes: 1000
A number of meshs and type: 400 HEXA8, 400 QUAD4

18.3 Functionalities tested

Orders

AFFE_MODELE
AFFE
MODELING = "SHB8"
CALC_MATR_ELEM OPTION
"RIGI_MECA"
"MASS_MECA"

MODE_ITER_SIMULT
CALC_FREQ
BANDAGE FREQ = (200. , 800.)
CREA_MAILLAGE COQU_VOLU

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19
Results of modeling H

19.1 Values tested

(Frequencies in Hertz)

Reference mode
Aster
DKQ %
difference
ovalization 210.55 210.71
0.08
210.55
210.71
0.08
trifoliate 587.92
590.84
0.5
587.92
590.84
0.5
except plan
205.89
208.05
1.05
205.89
208.05

1.05
588.88
595.3
1.09
588.88
595.3
1.09

20
Summary of the results

.

Even if the results obtained are honourable, models DKQ, DSQ, DKT, DST, COQUE_C_PLAN, PIPE and TUYAU_6M do not make it possible to estimate the modes except plan of the ring. Only model COQUE_3D with a grid in QUAD9 provides a good estimate frequential of these modes with an error lower than 0.4%.

.

Models DSQ and COQUE_3D in QUAD9 give an error close to 0.3% for the modes of ovalization and trifoliate. For models COQUE_3D in TRIA7, COQUE_C_PLAN, PIPE and TUYAU_6M, this error border 0.7% and are higher than 1% for the DKQ, DKT and DST.

.

The best results of the DSQ compared to the DKQ confirm than the effect of shearing transverse is not negligible in the hulls notable thickness.

.

On a developable geometry like that of the cylinder studied here, finite elements quadrangular provide better results which triangular finite elements. DST, tested on an ear grid and a symmetrical star grid, are much less goods that DSQ. The same remark is also valid for the COQUE_3D in TRIA7 by report/ratio with the COQUE_3D in QUAD9.

.

The performances of the COQUE_3D are good quantitatively and in computing times. richness of the interpolation, the taking into account of the curve of the cylinder in the elements and metric correction carried out in the thickness of the hull seem to explain these good results.

.

Elements SHB8 make it possible to about obtain all the modes with a maximum change 1%.

Code_Aster ®
Version
8.2

Titrate:
SDLS114 Calculation of the modal stress intensity factors
Date:
07/11/05
Author (S):
***E. GALENNE**, Key S. DI DOMIZIO*
:
V2.03.114-A Page:
1/10

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
Document: V2.03.114

SDLS114 Calculation of the factors of intensity of constraint of a plate fissured by recombination modal

Summary

This test aims at validating the calculation of the factors of intensity of a plate fissured by modal recombination.
modal factors of intensity, i.e associated each clean mode of vibration of the structure, are calculated with
operators CALC_G_THETA_T (option K_G_MODA) in 2D and CALC_G_LOCAL_T (option K_G_MODA) in 3D.

This test contains a modeling 2D and a modeling 3D. The reference solution results from one direct temporal resolution of the transitory problem.

Two modelings illustrate the possibility of recombining the modal factors of intensity directly in the command file by instructions python.
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1
Problem of reference

1.1 Geometry

One considers a plate height H = 0,1 m, dispatcher L = 0,05 m and thickness E = 0.005 Mr. Une *crack is positioned in the middle of the height of the beam, with a depth of 0,1 L.*

F
y
X

Z

1.2
Material properties

One considers the traditional properties of a steel:

Young modulus:
E = 2.10+5 MPa
Poisson's ratio:
= 0.3
Density
= 7800 kg/m3

1.3
Boundary conditions and loadings

The plate is:

· embedded on S1 surface;
*· subjected to a force **F** (T) on S2 surface.*

*The evolution of the standard of **F** (T) is traced on the figure above. One takes = 0,001 S. the direction of*
*the force **F** (T) is as follows:*

*· **F** (T) **=** F (T) .ex for modeling A;*
*· **F** (T) = (aex + bey +cez) F (T) for modeling B, with B = 2a and C = 0.4 A.*

For modeling A, one blocks displacements in direction Z (plane problem).

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that obtained by a direct temporal resolution of the problem transient. Operator DYNA_TRAN_EXPLI is used to identify the fields of displacement, with a diagram of integration in times of Newmark.
The evolution of the stress intensity factors according to time is then calculated by interpolation of the jumps of displacements (operator POST_K1_K2_K3).

2.2
Result of reference Modeling A

For modeling A, the plate is requested by a force in the plan (O, X, y) and displacements in direction Z are blocked. The result of reference, calculated by direct temporal resolution on a grid 2D, is traced on the following figure. The horizontal displacement top of the plate and it factor of intensity of the constraints oscillate with a frequency corresponding to the first clean mode structure.

2.3
Result of reference Modeling B

The evolution of the three factors of intensity of the constraints is traced on the following figure for the node
located in the middle of the bottom of crack. The oscillations of the factors of intensity of the constraints show
dominating contribution of the first mode of inflection of the plate in direction X and the first mode of inflection in direction Z.
1,6E+06
KI
1,4E+06
KII
1,2E+06
KIII
1,0E+06

8,0E+05
6,0E+05
4,0E+05
2,0E+05
0,0E+00
0
0,001
0,002
0,003
0,004
0,005
Time (S)

2.4 Uncertainty on the solution

The explicit direct resolution of the transitory problem can be regarded as exact. Uncertainty on the identification of the factors of intensity of the constraints by interpolation of the jumps of displacements is about 5%.

2.5 References bibliographical

[1]

E. GALENNE, S. DI DOMIZIO: Method theta in breaking process: development bilinear form G in 3D and application to the case of dynamics low frequency, Note EDF HT-65/05/024/A, 2005
Handbook of Validation
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---

3 Modeling With

3.1 Characteristics of modeling

It is about a modeling 2D plane deformations. The calculation of the evolution of the factors of intensity constraints according to time is carried out in several stages:

· calculation of the first 15 clean modes of the structure;
· calculation of the modal factors of intensity of the constraints associated these modes by two methods;
· resolution of the transitory dynamic problem by projection on modal basis;
· recombination of K modal.

3.2 Characteristics of the grid

The grid is composed of quadratic elements. It comprises 2000 nodes and 700 meshs and is refined around the bottom of crack.

3.3 Functionalities
tested

Orders
MODE_ITER_SIMULT
POST_K1_K2_K3
CALC_G_THETA_T
Option K_G_MODA
DYNA_TRAN_MODA

4
Results of modeling A

4.1 Values
tested

Modal values: case test of not-regression

Number of
KI *(POST_K1_K2_K3)*
KI *(K_G_MODA)*
% difference
mode

1 -1,921.E+10 -1,898.E+10 1,2
2 -1,166.E+11 -1,152.E+11 1,3
3 8,039.E+10
7,948.E+10 1,1
4 -1,188.E+11 -1,174.E+11 1,2
5 1,723.E+11
1,705.E+11 1,1

Temporal values K1 (T): comparison with the explicit resolution

Moment Reference Aster
% difference
0,0005 24055,6
24337,0
1,2
0,001 44676,8
45159,3
1,1
0,002 90592,3
91679,4
1,2
0,003 134065,3
135633,9
1,2
0,004 181113,3
183286,7
1,2

4.2 Notice

The difference between the modal values calculated by interpolation of the jumps of displacement or by
method theta is weak and coherent with that observed on the static problems.

The value of K I (T) is calculated starting from K I modal (method K_G_MODA) and of the coefficients of
the resolution about modal base directly in the case test by lines of order in python:

M
K (T) = (T). I
K
I

I
I
I 1
=

where the coefficients (T
I) are the coefficients of modal participation, extracted the result from
the operator DYNA_TRAN_MODA, and I
K are the modal factors of intensity of the constraints.
I

The precision obtained is satisfactory taking into account the number of elements retained in the base modal. The precision increases quickly with the number of modes [bib1].

---

5 Modeling
B

5.1
Characteristics of modeling

It is about a modeling 3D. The calculation of the evolution of the factors of intensity of the constraints in
function of time is fulfilled in several stages:

· calculation of the first 50 clean modes of the structure;
· calculation of the modal factors of intensity of the constraints associated these modes by two

methods;
· resolution of the transitory dynamic problem by projection on modal basis;
· recombination of K modal.

5.2
Characteristics of the grid

The grid is composed of linear elements. It comprises 8200 nodes and 8900 meshs and is refined around the bottom of crack.

5.3 Functionalities
tested

Orders
MODE_ITER_SIMULT
DEFI_FOND_FISS
POST_K1_K2_K3
DEFI_FISS_XFEM
CALC_G_LOCAL_T
Option K_G_MODA
DYNA_TRAN_MODA
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6

Results of modeling B

6.1 Values tested

The values indicated are those found with the node which is in the middle of the bottom of crack.

Modal values: case test of not-regression

Number of mode	KI (POST_K1_K2_K3)	KI (K_G_MODA)	% difference
1	5,631E+09	4,790E+09	14,9
2	8,599E+09	7,291E+09	15,2
3	6,940E+10	5,897E+10	15,0
4	-2,702E+11	-2,897E+11	-7,2
5	-9,637E+10	-8,165E+10	15,3

Temporal values KI (T): comparison with the explicit resolution

Moment (S)	Reference (Pa.m)	Aster (Pa.m)	% difference
0.0005	696752,4	721825,9	3,6
0.001	1153703,3	1239061,8	7,4
0.002	997675,6	1110569,6	

11,3
0.003 1305429,9
1364524,8
4,5
0.004 870347,2
1004735,2
15,4

6.2 Notice

The difference between the modal values calculated by interpolation of the jumps of displacement or by
method theta is high: that is explained by the linear grid very little refined in the thickness of the plate.

The value of K I (T) is calculated starting from K I modal (method K_G_MODA) and of the coefficients of
the resolution about modal base directly in the case test by lines of order in python:

M
K (S, T) = (T). I
K (S)
I
I
I
I 1
=

where the coefficients (T
I) are the coefficients of modal participation, extracted the result from
the operator DYNA_TRAN_MODA, and I
K (S) are the modal factors of intensity of the constraints.
I

The precision obtained is satisfactory taking into account the number of elements retained in the base modal (50) and cuts it grid. The precision increases quickly with the number of modes
[bib1].

7
Summary of the results

This test makes it possible to validate the calculation of the modal factors of intensity by the operators CALC_G_LOCAL_T and CALC_G_THETA_T (option K_G_MODA) and illustrate their use for the resolution
of a problem of breaking process in dynamics low frequency by modal recombination.
The relationship between the computing times of the resolution clarifies and of the resolution about modal base are
ranging between 10 and 50 according to the type of grid, and the precision of the method of recombination
modal is fully satisfactory.

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Titrate:
SDLS300 - Air cooler subjected to an excitation ground

Date
:

25/10/04
Author (S):
E. BOYERE, *G. ROBERT, F. SOULIE Key*
:
V2.03.300-A Page:
1/8

Organization (S): EDF-R & D /AMA, SAMTECH

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
V2.03.300 document

SDLS300 - Air cooler subjected to an excitation
ground

Summary:

The applicability of this test is the seismic analysis. The studied structure is an air cooler subjected to an excitation ground.
Displacements are calculated along meridian in plan XZ.
The objective is to test axial, tangential and normal displacements for modal recombinations CQC and SRSS, for elements hull 3D.
Displacements of reference come from results obtained by several computer codes.

One is interested more particularly in calculation of the Eigen frequencies of this system. Values of reference
are obtained on a model of Fourier with the computation software of structures the SAMCEF software.

1
Problem of reference

1.1 Geometry

Rb
Z
h1
rc

H2
ep
X
With
ruffle

The structure is defined by two arcs of hyperbole.

Dimensions:

ruffle = 55.587 m
Rb = 37.515 m
rc = 35.532 m
h1 = 30.16 m
H2 = 107.01 m
ep = 0.305 m

1.2
Properties of materials

E = 2.76E10 Pa
= 0.166
= 2244 Kg/m3

1.3
Boundary conditions and loading

Boundary conditions

Embedding of the air cooler on the level of the ground.

Loading:

The air cooler is subjected to an excitation in direction X on the level of embedding. Calculation is realized starting from the spectrum of answer of speed [Figure 1.3-a].

Appear 1.3-a: Spectrum of answer of speed

2
Reference solution

2.1
Method of calculation used for the reference solution

The spectral analysis is carried out with code CASTEM 2000.

2.2
Results of reference

· Fréquences calculated with the SAMCEF software.
· Axial, tangential and normal Déplacements along the wall located in the xOz plan (X and Z positive) for modal recombinations CQC and SRSS. (Calculated while taking into account 4 modes).

In order to improve the identification of the modes, one evaluates the spectrum with a model of Fourier. This modeling was carried out with software the SAMCEF software. The spectrum being very dense, the following table present that the frequencies lower than 4Hz.

Harmonic N°	Frequencies
4	1,14
5	1,17
3	1,24
4	1,35
6	1,45
5	1,50
2	1,53
6	1,62
7	1,70
3	1,73
5	1,93
8	1,96
7	2,03
6	2,09
9	2,26
7	2,28
6	2,42
8	2,45
4	2,47
7	2,55
10	2,60
8	2,67
1	2,80

9 2,82
11 2,98
5 3,01
8 3,04
8 3,10
7 3,10
2 3,20
10 3,21
9 3,29
9 3,37
12 3,40
6 3,56
11 3,65
9 3,70
10 3,80
3 3,81
8 3,83
13 3,86
9 3,91

2.3
Uncertainty on the solution

Comparisons between codes.

2.4 References
bibliographical

The case test is inspired by the following reference:

[1]
P.L. GOULD and S.H. ABU SITTA: Dynamic response of structures to wind and earthquake loading PENTECH PRESS
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/04/005/A

Code_Aster ®
Version
7.3

Titrate:
SDLS300 - Air cooler subjected to an excitation ground

3 Modeling With

3.1 Characteristics of modeling

3.2
Characteristics of the grid

The grid consists of 1860 nodes and 1800 elements hull DKT.

3.3
Functionalities tested

Orders

AFFE_MODELE AFFE MODELING
"DKT"
AFFE_CHAR_MECA DDL_IMPO

THICK AFFE_CARA_ELEM

POST_ELEM MASS_INER

MODE_ITER_SIMULT
METHOD
"TRI_DIAG"

CALC_FREQ
OPTION
"BAND"
NORM_MODE NORMALIZES
"TRAN_ROTA"

Titrate:

SDLS300 - Air cooler subjected to an excitation ground

Date
:

25/10/04
Author (S):
E. BOYERE, G. ROBERT, F. SOULIE Key
:
V2.03.300-A Page:
6/8

4
Results of modeling A

4.1 Values tested

Eigen frequencies (Hz)

Only the effective frequencies having a mass higher than 0.1% are indicated in the table below.

Number of the mode
Réf
Code_Aster
Difference between the SAMCEF software and
(The SAMCEF software)
Code_Aster in %
1 2.80058
2.80065 0.003
2 2.80058
2.80065 0.003
3 5.92549
5.92490 -0.010
4 5.92549
5.92490 -0.010

These four modes make it possible to obtain a good representation of the mass in the direction of excitation since the effective mass according to X amounts to 83.2%

Horizontal displacement X (m):

Altitude CASTEM

2000
Code_Aster
Variation (%)
(m) CQC SRSS CQC SRSS CQC
SRSS
13.3 1.318E-03
1.316E-03
1.538
E-03 1.432
E-03 16.653 8.740
26.8 1.484E-03
1.485E-03
2.853
E-03 2.669
E-03 92.155 79.744
40.3 1.898E-03
1.898E-03
4.456
E-03 4.249
E-03 134.714 123.819
49.4 2.4448E-03
2.442E-03 5.693
E-03 5.495
E-03 132.872 124.948
63.08 3.278E-03 3.275E-03 7.822
E-03 7.657
E-03 138.603 133.751
76.8 4.570E-03
4.568E-03
1.026
E-02 1.014
E-02 124.510 121.860
90.7 5.918E-03
5.918E-03
1.293
E-02 1.283
E-02 118.516 116.802
100 7.023E-03
7.024E-03
1.477
E-02 1.467
E-02 110.294 108.862
109.3 7.677E-03 7.677E-03 1.658

E-02 1.648
E-02 115.998 114.614
127.9 9.053E-03 9.054E-03 1.990
E-02 1.975
E-02 119.818 118.117

Vertical displacement Z (m):

Altitude CASTEM
2000
Code_Aster
Variation (%)
(m) CQC SRSS CQC SRSS CQC
SRSS
13.3 4.534E-04
4.540E-04
8.297
E-04 8.101
E-04 82.955 78.407
26.8 6.832E-04
6.832E-04
1.712
E-03 1.674
E-03 150.528 145.025
40.3 1.091E-03
1.091E-03
2.464
E-03 2.408
E-03 125.872 120.680
49.4 1.510E-03
1.510E-03
2.892
E-03 2.823
E-03 91.521 86.877
63.08 1.794E-03 1.795E-03 3.424
E-03 3.337
E-03 90.769 85.848
76.8 1.944E-03
1.945E-03
3.840
E-03 3.737
E-03 97.437 92.035
90.7 2.024E-03

2.025E-03
4.173
E-03 4.056
E-03 106.143 100.213
100 2.114E-03
2.115E-03
4.372
E-03 4.244
E-03 106.767 100.630
109.3 2.187E-03 2.188E-03 4.564
E-03 4.427
E-03 108.645 102.266
127.9 2.356E-03 2.358E-03 4.959
E-03 4.803
E-03 110.427 103.663

4.2 Remarks

These four modes make it possible to obtain a good representation of the mass in the direction of excitation since the effective mass according to X amounts to 83.2%.
Calculation is carried out without the taking into account of the neglected modes.

5

Summary of the results

One is interested in two the first hundred modes of the structure: those are located in band 0 - 7Hz.
One finds well these frequencies with Code_Aster with a maximum change compared to the solution of reference of 1.7%.

Four modes make it possible to obtain an effective mass cumulated according to X and there of 83.2%. Mass
effective cumulated according to Z is null. These effective weight breakdowns are identical to those obtained
with the SAMCEF software.

For seismic calculation, displacements obtained are far away from the reference solution.
However, one can express some doubts on the validity of these results of reference, being
data the bad representation of the mass: indeed, for this calculation of reference, the mass
effective cumulated in direction X accounts for 43% of the total mass. This is why this part of
calculation was put in comment in the case-test.

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Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/04/005/A

Code_Aster ®
Version
5.0

Titrate:
SDLS501 - Free vibrations of a corrugated sheet

Date:
29/10/01
Author (S):
P. MASSIN, F. LEBOUVIER *Key*
:
V2.03.501-A Page:
1/6

Organization (S): EDF/MTI/MMN, DeltaCAD

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
Document: V2.03.501

SDLS501 - Free vibrations of a corrugated sheet

Summary:

This test represents a calculation in dynamic modal analysis of an iron corrugated into free-free. This test allows
to validate modeling finite elements COQUE_D_PLAN. There is a test of the same structure in statics non-linear material (SSNV115) [V6.04.115].

The frequencies and the modes obtained are compared with a reference solution obtained with Code_Aster
starting from a modeling D_PLAN.

1
Problem of reference

1.1 Geometry

y
B
D
With
C
X
X
Z
y
sight of "crosses"

R
R
With
C
X
X
R
R

Characteristics of the hull:

· thickness H = 0.05m,
· radius of curvature R = 1.m
· width = AB = CD = 0.1m,
· the angle is selected so that the surface upper of the hull than item X is with
(y = 0), i.e. aligned with A and C.
1 H
cos = 1

4 R

1.2 Properties

material

The properties of material constituting the plate are:

E = 2.E+11 Pa
Young modulus
= 0.3
Poisson's ratio
= 7800. Kg/m3 Masses
voluminal

1.3
Boundary conditions and loadings

No boundary condition: analyze dynamic into free-free

1.4 Conditions
initial

Without object
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SDLS501 - Free vibrations of a corrugated sheet

2
Reference solution

2.1
Method of calculation used for the reference solution

Modeling A (D_PLAN) is used as reference for modeling COQUE_D_PLAN.

2.2
Results of reference

The first three nonnull Eigen frequencies.

Frequency mode 4:
658.24 Hz
Frequency mode 5:
1749.35 Hz
Frequency mode 6:
3225.42 Hz

2.3
Uncertainties on the solution

· not regression for modeling A
· < 2% for modeling B

2.4 References bibliographical

None.

3 Modeling
With

3.1
Characteristics of modeling

Modeling D_PLAN
y
4
0
X
20

3.2 Characteristics

grid

A number of nodes: 289

A number of meshs and types: 80 QUAD8

3.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING: “D_PLAN”
CALC_MATR_ELEM

OPTION: “RIGI_MECA”
OPTION: “MASS_MECA”
MODE_ITER_SIMULT CALC_FREQ
METHOD:
“TRI_DIAG”
OPTION: “BAND”
FREQ: (500. 5000.)

4
Results of modeling A

4.1 Values tested

Identification Moments Reference
Aster %
difference
Frequency mode 4
658.24
658.24
0.
Frequency mode 5
1749.35
1749.35
0.
Frequency mode 6
3225.42
3225.42
0.

4.2 Remarks

4.3 Parameters of execution

Version:

NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 2.19 seconds
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SDLS501 - Free vibrations of a corrugated sheet

Date:
29/10/01
Author (S):
P. MASSIN, F. LEBOUVIER Key
:
V2.03.501-A Page:
5/6

5 Modeling
B

5.1
Characteristics of modeling

Modeling COQUE_D_PLAN
With
5
C
5
5
5

5.2
Characteristics of the grid

A number of nodes: 41

A number of meshs and types: 20 SEG3

5.3 Functionalities
tested

Orders Key word
factor Key word
AFFE_MODELE AFFE
MODELING
:
“COQUE_D_PLAN”
AFFE_CARA_ELEM HULL
THICK
MODI_METRIQUE: “YES”
CALC_MATR_ELEM

OPTION: “RIGI_MECA”
OPTION: “MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
OPTION: “BAND”
FREQ: (500. 5000.)

6
Results of modeling B

6.1 Values
tested

Identification Moments Reference
Aster %
difference
Frequency mode 4
658.24
660.51
0.345
Frequency mode 5
1749.35
1759.09
0.557
Frequency mode 6

3225.42
3222.28
-0.097

6.2 Remarks

6.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 1.68 seconds

---

7 Summary of the results

This case-test made it possible to test modeling COQUE_D_PLAN. The results obtained compared

has
a solution resulting from a modeling D_PLAN are very good, the maximum change observed is 0.5%.

Code_Aster ®
Version
5.0

Titrate:
SDLS502 - Square plate "solid" simply supported

Date:
04/09/02
Author (S):
P. MASSIN, F. LEBOUVIER Key
:
V2.03.502-A Page:
1/18

Organization (S): EDF/AMA, DeltaCAD

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
Document: V2.03.502

SDLS502 - Square plate "solid" simply
supported

Summary:

This test simply represents a calculation in dynamic modal analysis of a thick square plate supported. This test makes it possible to validate:

· modelings finite elements DST, DKT, COQUE_3D with meshs QUAD4 and TRIA3, QUAD8 and TRIA6, and 3D with meshs HEXA20,
· the taking into account of rigidity in transverse shearing.

The frequencies and the modes obtained are compared with a reference solution, suggested by NAFEMS,
obtained with a calculation finite elements of voluminal type.

1
Problem of reference

1.1 Geometry

B
C
H

Z, W
L
y, v
L = 10.0 m
H = 1.0m
With
D
X, U

1.2 Properties of material

The properties of material constituting the plate are:

E = 2. 1011
Pa Modulus Young
= 0.3
Poisson's ratio
= 8000. Kg/m3 Masses
voluminal

1.3 Boundary conditions and loadings

- C.L. : plate simply supported on its contour

1.4 Conditions initial

Without object

2
Reference solution

2.1
Method of calculation used for the reference solution

the reference solution suggested by NAFEMS [bib1] was obtained to leave a calculation finite elements
3D with elements bricks with 20 nodes and with a grid 4x4 (xy plan) and 1 following element the thickness.

2.2
Results of reference

the first 7 nonnull frequencies and the associated clean modes, the first three modes are those of rigid bodies:

· Fréquence (mode 4 except plan)
: 44.762
Hz
· Fréquence (modes 5 & 6 except plan)
: 110.52
Hz
· Fréquence (mode 7 except plan)
: 169.08
Hz
· Fréquence (Mode 8 in the plan)
: 193.93
Hz
· Fréquence (mode 9 & 10 in the plan): 206.64
Hz

mode 4 except plan
5&6 mode except plan

mode 7 except plan

mode 8 in the plan

9&10 mode in the plan

2.3
Uncertainties on the solution

< 2% for a grid identical to that of [§2.1], i.e. with few elements.

2.4 References
bibliographical

[1]
NAFEMS: Standard The NAFEMS Benchmarks, TNSB, rev. October 3, 1990.

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SDLS502 - Square plate "solid" simply supported

3 Modeling
With

3.1
Characteristics of modeling

Y
C
Modeling DST (TRIA3)
- The plate is located in the plan Z= 2.3
B
- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
- To validate modeling in
a reference mark different from the reference mark
total, the plate is turned of
15,5 degrees. This does not have
D
to change the Eigen frequencies
obtained.
With

3.2
Characteristics of the grid

A number of nodes: 122
A number of meshs and types: 200 TRIA3

3.3 Functionalities

tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING: `DST
AFFE_CARA_ELEM
HULL
THICK
CALC_MATR_ELEM
OPTION: "RIGI_MECA"
OPTION: "MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
METHOD:
"SORENSEN"
OPTION: "BAND"

4
Results of modeling A

4.1 Values
tested

Identification Moments
Reference Aster %
difference
Frequency
44.762
44.989
0.507
(mode 4 except plan)
Frequency
110.52
107.608
-2.634
(modes 5 & 6 except plan)
107.880
-2.388
Frequency

169.08 165.454 -2.144
(mode 7 except plan)
Frequency
193.93
196.089
1.114
(Mode 8 in the plan)
Frequency
206.64
211.658
2.428
(mode 9 & 10 in the plan)
212.000
2.594

4.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection enters modes 8 and 9 of reference: these modes are them modes 6 and 7 of Code_Aster.

In the table below we deferred the first 14 found Eigen frequencies.

N° mode
Frequency (Hz)
1 44,98
2 107.61
3 107.88
4 165.45
5 196.09
6 202.80
7 203.54
8 211.66
9 212.00
10 222.53
11 254.74
12 255.62
13 264.73
14 289.85

4.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 4.62 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/02/001/A

---

5 Modeling B

5.1 Characteristics of modeling

Y
C
Modeling DST (QUAD4)
- The plate is located in the plan Z= 2.3
B
- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
- To validate modeling in
a reference mark different from the reference mark
total, the plate is turned of
D
15,5 degrees. This does not have
to change the Eigen frequencies
obtained.
With

5.2

Characteristics of the grid

A number of nodes: 122
A number of meshs and types: 100 QUAD4

5.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING: `DST
AFFE_CARA_ELEM
HULL
THICK
CALC_MATR_ELEM
OPTION: "RIGI_MECA"
OPTION: "MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
METHOD:
"SORENSEN"
OPTION: "BAND"

6
Results of modeling B

6.1 Values
tested

Identification Moments
Reference
***Aster** %*
difference
Frequency
44.762
44.64
-0.273
(mode 4 except plan)
Frequency

110.52
108.04
-2.247
(modes 5 & 6 except plan)
108.26
-2.041
Frequency
169.08
162.86
-3.681
(mode 7 except plan)
Frequency
193.93
195.70
0.912
(Mode 8 in the plan)
Frequency
206.64
208.89
1.088
(mode 9 & 10 in the plan)
208.89

6.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection enters modes 8 and 9 of reference: these modes are them modes 6 and 7 of Code_Aster.

In the table below we deferred the first 14 found Eigen frequencies.

N° mode	Frequency (Hz)
1	44.64
2	108.04
3	108.26
4	162.86
5	195.70
6	203.97
7	206.08
8	208.89
9	208.89
10	220.92
11	248.12
12	250.10
13	252.49
14	289.79

6.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 4.81 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/02/001/A

Code_Aster ®
Version
5.0

7 Modeling C

7.1 Characteristics of modeling

Y
C
Modeling DKT (TRIA6)
- The plate is located in the plan Z= 2.3
B
- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
- To validate modeling cf page4
D
With

7.2 Characteristics of the grid

A number of nodes: 122
A number of meshs and types: 200 TRIA3

7.3 Functionalities tested

Orders Key word factor

Key word

AFFE_MODELE
AFFE
MODELING: "DKT"
AFFE_CARA_ELEM
HULL
THICK
CALC_MATR_ELEM
OPTION: "RIGI_MECA"
OPTION: "MASS_MECA"
MODE_ITER_SIMULT
CALC_FREQ
METHOD:
"SORENSEN"
OPTION: "BAND"

8
Results of modeling C

8.1 Values
tested

Identification Moments
Reference
Aster *%*
difference
Frequency
44.762
47.358
5.799
(mode 4 except plan)
Frequency
110.52
118.029
6.795
(modes 5 & 6 except plan)
118.059
6.822
Frequency
169.08
187.504
10.897

(mode 7 except plan)
Frequency
193.93
196.089
1.114
(Mode 8 in the plan)
Frequency
206.64
211.658
2.428
(mode 9 & 10 in the plan)
212.000
2.594

8.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection after mode 11 of reference (mode 8 of Code_Aster), of the same form as those appeared in DST modeling enters modes 8 and 9 of reference (modes 6 and 7 of Code_Aster).

In the table below we deferred the first 14 found Eigen frequencies.

N° mode

Frequency (Hz)
1 47.358
2 118.03
3 118.06
4 187.50
5 196.09
6 211.66
7 212.00
8 222.53
9 235.41
10 235.56
11 264.73
12 289.85
13 302.84
14 303.15

8.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 3.97 seconds

---

9 Modeling
D

9.1
Characteristics of modeling

Y
C
Modeling DKT (QUAD4)
- The plate is located in the plan Z= 2.3
B
- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
- To validate modeling in
a reference mark different from the reference mark
total, the plate is turned of
D
15,5 degrees. This does not have
to change the Eigen frequencies
obtained.
With

9.2
Characteristics of the grid

A number of nodes: 122
A number of meshs and types: 100 QUAD4

9.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING: “DKT”
AFFE_CARA_ELEM
HULL
THICK
CALC_MATR_ELEM
OPTION: “RIGI_MECA”
OPTION: “MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
METHOD:
“SORENSEN”
OPTION: “BAND”

10 Results of modeling D

10.1 Values
tested

Identification Moments
Reference
Aster %
difference
Frequency
44.762
47.182
5.408
(mode 4 except plan)
Frequency
110.52
117.463
6.283
(modes 5 & 6 except plan)
Frequency
169.08
184.746
9.266
(mode 7 except plan)
Frequency
193.93
195.699
0.912

(Mode 8 in the plan)
Frequency
206.64
208.887
1.088
(mode 9 & 10 in the plan)

10.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection after mode 11 of reference (mode 8 of Code_Aster), of the same form as those appeared in DST modeling enters modes 8 and 9 of reference (modes 6 and 7 of Code_Aster).

In the table below we deferred the first 14 found Eigen frequencies.

N° mode
Frequency (Hz)
1 47.183
2 117.46
3 117.46
4 184.75
5 195.70
6 208.89

7 208.89
8 220.92
9 234.74
10 234.74
11 252.49
12 289.79
13 297.27
14 297.27

10.3 Parameters
of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 4.02 seconds

---

11 Modeling
E

11.1 Characteristics of modeling

Y
C
Modeling COQUE_3D (TRIA6)
- The plate is located in the plan Z= 2.3
B
- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
- To validate modeling in
a reference mark different from the reference mark
total, the plate is turned of
D
15,5 degrees. This does not have
to change the Eigen frequencies
obtained.
With

11.2 Characteristics of the grid

A number of nodes: 122
A number of meshs and types: 200 TRIA6

11.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING:
"COQUE-3D"
AFFE_CARA_ELEM
HULL
THICK
CALC_MATR_ELEM
OPTION: "RIGI_MECA"
OPTION: "MASS_MECA"

MODE_ITER_SIMULT
CALC_FREQ
METHOD:
"SORENSEN"
OPTION: "BAND"

12 Results of modeling E

12.1 Values
tested

Identification Moments
Reference
Aster %
difference
Frequency
44.762
43.867
2.00
(mode 4 except plan)
Frequency
110.52
106.058
-4.037
(modes 5 & 6 except plan)
106.066
-4.029
Frequency
169.08
160.010
-5.305
(mode 7 except plan)
Frequency
193.93
193.600
-0.170
(Mode 8 in the plan)
Frequency
206.64
206.209
0.208
(mode 9 & 10 in the plan)
206.211

12.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection enters modes 8 and 9 of reference: they are modes 6 and 7 of Code_Aster.

In the table below we deferred the first 14 found Eigen frequencies.

N° mode	*Frequency (Hz)*
1	*43,867*
2	*106.06*
3	*106.07*
4	*160.11*
5	*186,72*
6	*193.60*
7	*199.76*
8	*200.23*
9	*206.21*
10	*206.21*
11	*219.28*
12	*245.91*

13 245.94
14 249.27

12.3 Parameters
of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 10.97 seconds

---

13 Modeling
F

13.1 Characteristics of modeling

Y
C
Modeling COQUE_3D (QUAD8)
- The plate is located in the plan Z= 2.3
B

- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
- To validate modeling in
a reference mark different from the reference mark
total, the plate is turned of
15,5 degrees. This does not have
D
to change the Eigen frequencies
obtained.
With

13.2 Characteristics of the grid

A number of nodes: 122
A number of meshs and types: 100 QUAD8

13.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING:
“COQUE_3D”
AFFE_CARA_ELEM
HULL
THICK
CALC_MATR_ELEM
OPTION: “RIGI_MECA”
OPTION: “MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
METHOD:
“SORENSEN”
OPTION: “BAND”

14 Results of modeling F

14.1 Values tested

Identification Moments
Reference
Aster %
difference
Frequency
44.762
43.870
-1.993
(mode 4 except plan)
Frequency
110.52
106.041
-4.052
(modes 5 & 6 except plan)
Frequency
169.08
160.055
-5.337
(mode 7 except plan)
Frequency
193.93
193.588
-0.176
(Mode 8 in the plan)
Frequency
206.64
206.192
-0.216
(mode 9 & 10 in the plan)

14.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection enters modes 8 and 9 of reference: they are modes 6 and 7 of Code_Aster.

In the table below we deferred the first 14 found Eigen frequencies.

N° mode	Frequency (Hz)
1	43.87
2	106.04
3	106.04
4	160.06
5	193.59
6	199.64
7	200.13
8	206.19
9	206.19
10	219.26
11	245.68
12	245.68
13	249.20
14	287.99

14.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 9.99 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/02/001/A

---

15 Modeling
G

15.1 Characteristics of modeling

Y
C
Modeling 3D (HEXA20)
- The average plan of the plate is located in the plan Z= 2.3
B
- Not O: (0. ; 0. ; 2.3)
Boundary conditions:
15°5
O
X
- Dimensioned AB, BC, CD, DA: w=0
Z
D
X
With
O

15.2 Characteristics of the grid

A number of nodes: 1266
A number of meshs and types: 200 HEXA20

15.3 Functionalities

tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
MODELING: “3D”
CALC_MATR_ELEM
OPTION: “RIGI_MECA”
OPTION: “MASS_MECA”
MODE_ITER_SIMULT
CALC_FREQ
METHOD:
“SORENSEN”
OPTION: “BAND”

16 Results of modeling G

16.1 Values
tested

Identification Moments
Reference
Aster %
difference
Frequency
44.762
43.862
-2.009
(mode 4 except plan)
Frequency
110.52
105.953
-4.132
(modes 5 & 6 except plan)
Frequency
169.08
159.749
-5.518
(mode 7 except plan)
Frequency

193.93
193.590
-0.175
(Mode 8 in the plan)
Frequency
206.64
199.410
-3.498
(mode 9 & 10 in the plan)
199.903
-3.260

16.2 Remarks

· In Aster, the calculated modes are those of rigid body: the fourth mode of reference is it first mode calculated by Code_Aster.
· Apparition of two modes of inflection enters modes 8 and 9 of reference: they are modes 6 and 7 of Code_Aster.

In the table below we deferred the first 14 found Eigen frequencies.

N° mode
Frequency (Hz)
1 43.86

2 105.95
3 105.95
4 159.75
5 193.59
6 199.41
7 199.90
8 206.16
9 206.16
10 219.27
11 245.07
12 245.07
13 249.13
14 287.75

16.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000
Obstruction memory: 16 megabytes
Time CPU To use: 24.77 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HT-66/02/001/A

---

17 Summary of the results

Taking into account the nature of the numerical solution (voluminal finite elements), the results obtained
are satisfactory for:

· modeling A and B (DST) the maximum change is less than 4% for the first 5 modes,
· modeling E and F (COQUE_3D), the maximum change is approximately 5% for the 5 first modes,
· modeling G (3D), the maximum change is approximately 5% for the first 5 modes,
· the modes of reference 5&6 except plan have symmetry different from those
met in modelings E, F and G, but they are equivalent because it is about
modal recombinations.

Modelings C and D (DKT) are less satisfactory with relative variations reaching 10% on
mode 7 except plan, this due to is not taken into account of transverse shearing for this plate relatively thick.
Moreover one observes the appearance of modes of inflection and membrane for all these modelings, y
included/understood voluminal modeling 3D G. When one refines sufficiently the grids, this
tendency is confirmed and the relative variations regress. Calculation 3D in addition showed that in on this side
of a grid 6x6 in plan (XY), the modes of inflection and membrane were not detected.

Author (S):
P. MASSIN, F. LEBOUVIER

Organization (S): EDF/MTI/MMN, DeltaCAD

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
Document: V2.03.503

SDLS503 - Vibrations of inflection of a beam sandwich

Summary:

This test represents a calculation in modal analysis of a sandwich beam simply supported. This test allows to validate:

- ***modeling finite elements DKT with meshs QUAD4 and TRIA3,***
- ***modeling finite elements DST with meshs QUAD4 and TRIA3,***
- ***the taking into account of rigidity in transverse shearing,***
- ***the taking into composite material account.***

The frequencies and the modes obtained are compared with an analytical reference solution.
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates

1
Problem of reference

1.1 Geometry

Z, W
y, v
L
D
X, U
C
B
Heart
h1
H2
L = 1.0 m
D = 0.1m
With
H = 0.1m
1
D
H = 0.05m
2

1.2

Properties of material

Coatings:
E = 4. 1010 Pa
G = 4. 109 Pa
= 0.3
= 2000 kg/m3
X
xz
xz
1
Heart:
E = 4. 107 Pa
G = 1.5. 107 Pa
= 0.3
= 50 kg/m3
X
xz
xz
2
Coefficient of shearing K: 1/K=110.8

The Poisson's ratios are identical: = =
xz
xy
yz

1.3
Boundary conditions and loadings

C.L. : the beam rests simply on the with dimensions AB and CD.

1.4 Conditions
initial

Without object

5.0

Titrate:
SDLS503 - Vibrations of inflection of a sandwich beam

Date:
01/10/01
Author (S):
P. MASSIN, F. LEBOUVIER Key
:
V2.03.503-A Page:
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2
Reference solution

2.1
Method of calculation used for the reference solution

Calculation is carried out starting from the relations of dynamic balance and behavior [bib2] pointed out
hereafter:
M
2
T
2
X

y
v
+ T =
=

I
S

X
y
T 2 X
T 2

v
M
I.E.(internal excitation)

Z
=
=
-
Z
T
K GS
X
y
X
Z

These relations make it possible to write the equation of the movement of dynamic inflection transverse v (X, T). One
the equation at the Eigen frequencies obtains after having associated the boundary conditions.
The equation at the Eigen frequencies is written:
1

(+ has)

1 - has 2
2
1

1
sin (X) = 0 with X
2
2
2
=
+

2
2
2

2 + r2

and

I 2 2l
I
S I.E.(INTERNAL EXCITATION)
2 =
; R 2 =
; has =

I.E.(internal excitation)
S l2
K I GS
The solutions of the equation at the Eigen frequencies are written then: X = N (n=1,2,3,…)
2

2.2
Results of reference

the first 5 frequencies and clean modes of inflection associated.

.
Frequency mode 1:
64.476 Hz

.
Frequency mode 2:
131.918 Hz

.
Frequency mode 3:
198.734 Hz

.
Frequency mode 4:
265.383 Hz

.
Frequency mode 5:
331.963 Hz

2.3
Uncertainties on the solution

The reference solution is calculated within the framework of the assumptions of the theory of the beams [bib2]:
= = 0 .

y
Z

2.4 References bibliographical

[1]
VPCS: Software package of composite structural analysis; Examples of validation. Review of composites and of advanced materials, Volume 5 - number except series 1995 - Hermes Edition.
[2]
CIEAUX J.M.: Dynamic inflection of the composite beams with orthotropic phases; Validity of quasi-static field, thesis of the university Paul Sabatier Toulouse III, 1988.
Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-75/01/010/A

---

3 Modeling With

3.1 Characteristics of modeling

Z, W
Modeling DKT (TRIA3)
C
B
D
y, v
With

9.48°
X, U
- Plate located in the plan x= 0.33
- Boundary conditions: Dimensioned AB and CD: u=0

3.2
Characteristics of the grid

A number of nodes: 22
A number of meshs and type: 20 TRIA3

3.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING: "DKT"
AFFE_CARA_ELEM HULL
THICK
DEFI_MATERIAU
ELAS_ORTH
E_L E_T G_LT G_LN
NU_LT NU_LN RHO
CALC_MATR_ELEM OPTION

"RIGI_MECA"
"MASS_MECA"
MODE_ITER_INV CALC_FREQ
OPTION
: "ADJUSTS"
FREQ: (5. 8500.)

Titrate:
SDLS503 - Vibrations of inflection of a sandwich beam

Date:
01/10/01
Author (S):
P. MASSIN, F. LEBOUVIER Key
:
V2.03.503-A Page:
5/12

4
Results of modeling A

4.1 Values tested

Identification	*Reference*	*Aster*	*% difference*
Frequency mode 1	*64.476*	*277.449*	*330.*
Frequency mode 2	*131.918*	*1105.83*	*738.*
Frequency mode 3	*198.734*	*2473.80*	*1.14E3*
Frequency mode 4	*265.383*	*4363.97*	*1.54E3*
Frequency mode 5	*331.963*	*6753.904*	*1.93E3*

4.2 Remarks

In the table of results, we deferred the frequencies whose modes are identical to modes of reference.

.

the effects of transverse shearing are neglected in modeling "DKT",

.

the Aster results are much higher than the results of reference,

.

appearance of a mode of membrane enters modes 2 and 3 and between modes 5 and 6 of reference.

4.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 3.37 seconds

---

5 Modeling
B

5.1
Characteristics of modeling
Z, W
Modeling DKT (QUAD4)
C
B
D
y, v
With
9.48°
X, U
- Plate located in the plan x= 0.33
- Boundary conditions: Dimensioned AB and CD: u=0

5.2
Characteristics of the grid

A number of nodes: 22
A number of meshs and type: 10 QUAD4

5.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING: "DKT"
AFFE_CARA_ELEM HULL
THICK
DEFI_MATERIAU
ELAS_ORTH
E_L E_T G_LT G_LN
NU_LT NU_LN RHO
CALC_MATR_ELEM OPTION

"RIGI_MECA"
"MASS_MECA"

MODE_ITER_INV CALC_FREQ OPTION
: “ADJUSTS”
FREQ: (5. 8500.)

6
Results of modeling B

6.1 Values
tested

Identification	Reference	Aster	% difference
Frequency mode 1	64.476	277.788	331
Frequency mode 2	131.918	1111.225	742.
Frequency mode 3	198.734	2500.930	1.16E3

Frequency mode 4
265.383
4449.073
1.52E3
Frequency mode 5
331.963
6960.324
2.00E3

6.2 Remarks

In the table of results, we deferred the frequencies whose modes are identical to modes of reference.

- *the effects of transverse shearing are neglected in modeling "DKT",*
- *the Aster results are much higher than the results of reference,*
- *appearance of a mode of membrane enters modes 2 and 3 and between modes 5 and 6 of reference.*

6.3 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 3.53 seconds

---

7 Modeling C

7.1 Characteristics of modeling

Modeling DST (TRIA3)
Z, W
C
B
D
y, v
With
9.48°
X, U
- Plate located in the plan x= 0.33
- Boundary conditions: Dimensioned AB and CD: u=0

7.2 Characteristics of the grid

A number of nodes: 22
A number of meshs and type: 20 TRIA3

7.3 Functionalities tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING: “DST”
AFFE_CARA_ELEM HULL
THICK
DEFI_MATERIAU
ELAS_ORTH
E_L E_T
G_LT G_LN
NU_LT NU_LN
RHO
CALC_MATR_ELEM OPTION

“RIGI_MECA”
“MASS_MECA”
MODE_ITER_INV CALC_FREQ OPTION
: “ADJUSTS”
FREQ: (5. 500.)

---

8 *Results of modeling C*

8.1 Values tested

Identification	***Reference***	***Aster***	***% difference***
Frequency mode 1	*64.476*	*64.573*	*0.150*
Frequency mode 2	*131.918*	*133.987*	*1.568*
Frequency mode 3	*198.734*	*206.046*	*3.679*
Frequency mode 4	*265.383*	*282.875*	*6.591*
Frequency mode 5	*331.963*	*365.919*	*10.229*

8.2 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 2.84 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-75/01/010/A

9 Modeling D

9.1 Characteristics of modeling

Modeling DST (QUAD4)
Z, W
C
B
D
y, v
With
9.48°
X, U
- Plate located in the plan x= 0.33
- Boundary conditions: Dimensioned AB and CD: u=0

9.2 Characteristics of the grid

A number of nodes: 22
A number of meshs and type: 10 QUAD4

9.3 Functionalities tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING: “DST”
AFFE_CARA_ELEM HULL
THICK
DEFI_MATERIAU
ELAS_ORTH
E_L E_T
G_LT G_LN
NU_LT NU_LN
RHO
CALC_MATR_ELEM OPTION

“RIGI_MECA”
“MASS_MECA”
MODE_ITER_INV CALC_FREQ
OPTION
: “ADJUSTS”
FREQ: (5. 500.)

---

10 Results of modeling D

10.1 Values tested

Identification Reference Aster** % **difference
Frequency mode 1
64.476
64.595
0.184
Frequency mode 2
131.918
131.495
-0.320
Frequency mode 3
198.734
196.861
-0.942
Frequency mode 4
265.383
260.247
-1.935
Frequency mode 5
331.963
320.409
-3.480

10.2 Parameters of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 3.21 seconds

Handbook of Validation
V2.03 booklet: Linear dynamics of the hulls and plates
HI-75/01/010/A

---

11 Summary of the results

Modeling DKT is not adapted to model this case-test, the errors are very important. Formulation DKT does not take into account transverse shearing contrary to modeling DST. For this type of example, where the structure makes up of a composite material and relatively thick (h/L =0.1), it is preferable to use DST modeling.

The results obtained with DST are:

- ***satisfactory for the first 3 frequencies with mesh TRIA3 and for the 5 first frequencies for mesh QUAD4 with a better precision for mesh QUAD4,***
- ***the error of 10% for 4th and 5th frequency with mesh TRIA3 is significant. One finer grid should make it possible to improve the results by having the best representation of the last modes.***

D. Key GIRARDOT
:

Organization (S): EDF/EP/AMV

Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
Document: V2.04.100

SDLV100 - Vibration of a slim beam
of variable rectangular section (embed-free)

Summary:

The studied structure is a beam out of free steel embedded with rectangular variable section modelled by voluminal elements. One is interested in his Eigen frequencies in inflection. The same problem is dealt with in modeling beam in the case test SDLL09.

This problem makes it possible to test voluminal elements MECA_HEXA20 and MECA_PENTA15 in modal analysis.
It also makes it possible to test option MASS_MECA_DIAG of calculation of the matrices of mass diagonalized for voluminal modelings.

The reference solution is a numerical solution obtained using the computer code by finite elements The SAMCEF software for similar modelings. The results obtained are also in concord with semi-analytical results given in guide VPCS.

1
Problem of reference

1.1 Geometry

y, v
L
y
y
bo
b1
B
H
H
O
h1
H
With
1
Z

O
X, U
Z
Z, W
b1
bo
Rectangular sections

Length of the beam:

L = 1 m

Rectangular section:

Initial cross-section
Final cross-section
height:
Ho = 0.04 m
h1 = 0.01 m
width:
bo = 0.04 m
b1 = 0.01 m
surface:
Ao = 1.6 103 m2
A1 = 1.104 m2
inertia:
lzo = 2.1333 107 m4 Iz1 = 8.3333 1010 m4

Co-ordinates of the points (in meters)

WITH B
X
0. 1.
y
0. 0.
Z
0. 0.

1.2
Properties of steel

E = 2.1011 Pa

= 7.800 kg/m3

1.3
Boundary conditions and loadings

Not a: embedded U = v = Z = 0

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is obtained using the computation software by finite elements the SAMCEF software for
identical modelings but with elementary matrices of mass coherent.

One points out the analytical solution given in card SDLL09/89 of guide VPCS. The equation differential in inflection of the beam considered, in theory of Euler-Bernoulli is written (Theory of Euler-Bernoulli):

2

2
v
E I

Z

2
X
2 v
= - A

2
X
2
T

where Iz and A vary with the X-coordinate.

The Eigen frequencies are then of the form:

1
H
E
F
1
I
=
I
(,)

2
L2

12

H
B
with
=
0
= 4
and
=
0
= 4.

H
B
1
1

For this value of and, the first values of the continuation (I) are:

1
2
3
4
5
= 4
23.289 73.9 165.23 299.7 478.1

2.2
Results of reference

The results of reference selected are the first 5 Eigen frequencies of the modes of inflection.

2.3
Uncertainty on the solution

Analytical solution in theory of beam of Bernoulli, and numerical solution the SAMCEF software.

2.4 References
bibliographical

[1]
H.H. MABIE, C.B. ROGERS, Transverse vibrations of double-tapered cantilever beams - Newspaper of the Acoustical Society of America, n° 51, p. 1771-1774 (1972).

---

3 Modeling With

3.1 Characteristics of modeling

Elements of volume MECA_HEXA20

Discretization:
beam AB: 30 meshs HEXA20
(1 mesh in the section)

Boundary conditions:

.
in all the nodes
DDL_IMPO: (ALL: "YES" DZ: 0.)
.
at end A (group of G_1 nodes) (GROUP_NO: G_1 DX: 0. , DY: 0)

3.2 Characteristics of the grid

Grid:
A number of nodes: 368
A number of meshs and type: 30 HEXA20

3.3 Functionalities tested

Orders

Keys
AFFE_CHAR_MECA DDL_IMPO

[U4.25.01]
"MECHANICAL" AFFE_MODELE
"3D"

[U4.22.01]
DEFI_MATERIAU ELAS

[U4.23.01]
CALC_MATR_ELEM OPTION
"MASS_MECA_DIAG"

[U4.41.01]
MODE_ITER_INV

[U4.52.01]

4
Results of modeling A

4.1 Values
tested

Identification Solution
beam
Reference
Aster %
difference
analytical
The SAMCEF software
The Aster-SAMCEF software

frequency
in HZ
in HZ

coherent matrix

inflection 1
54.18
56.84
56.85
0.0176%
inflection 2
171.94
180.0
180.08
0.0444%
inflection 3
384.40
401.0
401.23
0.0574%
inflection 4
697.24
723.2

724.02
0.1134%
inflection 5
1112.28
1145.41
1147.51
0.1833%

stamp diagonal

inflection 1
54.18
56.84
56.78
-0.1033%
inflection 2
171.94
180.00
179.57
-0.2419%
inflection 3
384.40
401.00
399.24
-0.4408%
inflection 4
697.24
723.20
718.69
-0.6273%
inflection 5
1112.28
1145.41

1136.01
-0.8273%

4.2 Parameters of execution

Version: NEW4.03.06

Machine: CRAY C90

Obstruction memory: 8 MW,
time CPU To use: 32.08 seconds.

Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

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5 Modeling B

5.1 Characteristics of modeling

Elements of volume MECA_PENTA15

Discretization:
beam AB: 60 meshs PENTA15
(2 meshs in the section)

Boundary conditions:

.
in all the nodes
DDL_IMPO: (ALL: "YES" DZ: 0.)
.
at end A (group of G_1 nodes) (GROUP_NO: G_1 DX: 0. , DY: 0)

5.2 Characteristics of the grid

Grid:
A number of nodes: 368
A number of meshs and type: 60 PENTA15

5.3 Functionalities tested

Orders

Keys
AFFE_CHAR_MECA DDL_IMPO

[U4.25.01]
"MECHANICAL" AFFE_MODELE
"3D"

[U4.22.01]
DEFI_MATERIAU ELAS

[U4.23.01]
CALC_MATR_ELEM OPTION
"MASS_MECA_DIAG"

[U4.41.01]
MODE_ITER_INV

[U4.52.01]

6
Results of modeling B

6.1 Values
tested

Identification Solution
beam
Reference
***Aster** %*
difference
semi-analytical
The SAMCEF software
ASTER-SAMCEF

frequency
in HZ
in HZ

consistent matrix

inflection 1
54.18
56.84
56.82
-0.038%
inflection 2
171.94
180.00
179.96
-0.022%
inflection 3
384.40

401.00
400.93
-0.018%
inflection 4
697.24
723.20
723.41
0.029%
inflection 5
1112.28
1145.41
1146.41
0.088%

stamp diagonal

inflection 1
54.18
56.84
56.76
-0.149%
inflection 2
171.94
180.00
179.51
-0.272%
inflection 3
384.40
401.00
399.25
-0.437%
inflection 4
697.24

723.20
719.
-0.583%
inflection 5
1112.28
1145.41
1140.
-0.740%

6.2 Parameters of execution

Version: NEW4.03.06
Machine: CRAY C90
Obstruction memory: 8 MW,
time CPU To use: 47.09 seconds.

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7 Summary of the results

The differences between the results of calculations Aster and the SAMCEF software with coherent masses are lower than 0.2%.

Differences between the computation results Aster with diagonal masses and the SAMCEF software with masses
coherent remain lower than 1%.

These results are in conformity so that one could wait, and validate in a reliable way them calculations of Eigen frequencies in Aster by MODE_ITER_INV and operator CALC_MATR_ELEM in coherent masses as in diagonal masses.

Organization (S): EDF/IMA/MMN
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
V2.04.111 document
SDLV111 - Homogenisation of a network
beams in an incompressible fluid
Summary:
Test in modal analysis, being used to validate the elements of modeling 3D_FAISCEAU: héxaèdre with 8 nodes
or héxaèdre with 20 nodes. These elements represent the homogenized medium of a bathing network of beams
in an incompressible fluid, initially at rest.
One tests the Eigen frequencies of the beams of the medium homogenized without or with fluid.

1
Problem of reference

1.1 Geometry

One considers a periodic network of 4 X 4 beams [1.1-a]. The period of the field is Y.
appear [1.1-b] represents an enlarging of 1 of the period. Each beam is right of
square section.

Surface top: HS
L
Z
y
Surface bottom: Sb
X

Appear 1.1-a: Geometry of the heterogeneous medium - Beams without fluid

E
Y2
Y1
has
1

Appear 1.1-b: Cell of reference Y - Enlarging from = 10

· Caractéristiques of the period:
- Dimensions
:
Y = (0.21 m, 0.21 m)
= 1.5 m have
E = 0.3 m

· Caractéristiques of each beam:
- Section
:
With = (X has) 2 = (0.1 X 1.5) 2 = 0.0225 m2
- Length
:
L = 4.1 m
-
Moment of inertia of inflection:
Ix = Iy = (X has) 4/12 m4

1.2
Material properties

Isotropic linear elastic material:
E = 109 Pa
NAKED = 0.3
Densities:
Beam:
Rho = 7641 kg/m3
Fluid:
Rho = 0 kg/m3 (case without fluid)
Rho = 1000 kg/m3 (case with fluid)

1.3 Terms
correctors

The correct terms are calculated on the cell of reference Y [1.1-b].
B_T
=
0.79 m2
B_N
=
0.79 m2
B_TN
=
0 m2
A_FLUI
=
2.16 m2

A_CELL
=
2.25 m2
COEF_ECHELLE
=
10

1.4
Boundary conditions and loadings

Case without fluid:

Surface low Sb: embedding
All the DDL are blocked.
Surface high HS: embedding
All the DDL are blocked.

Case with fluid:

Surface low Sb: embedding
All the DDL are blocked.
Surface high HS: plane support (bilateral connection)
All rotations are blocked.
Longitudinal displacement DZ is blocked.
All the nodes of HS have same transverse displacement DX and same normal displacement DY.

2
Reference solution

2.1
Method of calculation used for the reference solution

Case without fluid:

Let us consider the heterogeneous field described with [§1] in absence of the fluid. It is supposed that

the beams
respect the assumptions of modeling of a right beam of Euler Bernoulli. Since conditions
in extreme cases applied to the whole of the beams are the same ones as for each one of them, one
can bring back the research of the Eigen frequencies of the unit to that of only one beam.
The following problem is thus studied:
That is to say a beam Bi embedded [2.1-a] in the same way characteristic geometrical and material that them
beams of the heterogeneous medium. One notes A the surface of the section, L his length, and I the moment of inertia of
inflection.
By the method of rigidity dynamic one shows that such a beam admits frequencies double
the form:
1
2 I.E.(internal excitation) 2
F =
I

I
2 L2
With
=
I
(2i + 1)/2 I = 1, 2,… for the second case of boundary conditions: [2.1-a].
Embedding
Z
L
X
Embedding
Appear 2.1-a
The field contains NR beams independent between them (not of boundary conditions which couples
displacements of two different beams), It results from it that the multiplicity of the frequencies is equal
with 2N (2 modes of inflections by beams).
For the homogenized medium discretized by the finite elements héxaèdre with 8 nodes or héxaèdre with 20
nodes, the number NR must be replaced by the number of straight lines parallel with the axis of the beams.
Case with fluid:
The case with fluid is more difficult to solve analytically: no analytical result was found
until the drafting of this case test. The results of reference which one has benches thus come from one
numerical resolution by finite elements of the complete heterogeneous problem. One used for this fact
version 3.6.2 of Code_Aster.
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures

Each beam is represented in the grid by its average fibre modelled by POU_D_E (beam right-hand side of Euler). For all the beams, one binds each node of average fibre to the nodes of side surface, located in the same transverse section as the node in question, by LIAISON_SOLIDE. The fluid interface beam is modelled by FLUI_STRU which translates the continuity of normal speeds with the walls. The fluid, was to be perfect incompressible, one deduced his modeling of that of the compressible true fluid 3D_FLUIDE by removing the contribution of the pressure.
Boundary conditions imposed on the fields [§1.3], and especially the relation which couples it displacement of all the beams on the level of HS, reveal two kinds of clean modes of the structure:
Modes of sets: all the beams become deformed in the same way and top surfaces it a displacement not no one admits.
Local modes: they correspond to modes of embed-embedded beams.
surfaces top thus admits a null displacement. None of these modes can correspond to an overall mode.
The action of the fluid results in an effect of added mass and thus a lowering of the frequencies by report/ratio with the case without fluid. It also causes, in the case of the local modes, to spread out the spectrum of associated frequencies. In the case without fluid one saw that this spectrum was concentrated in only one frequency of vibration.

2.2 Results of reference

Value of the Eigen frequencies.

2.3 References bibliographical

[1]
Walter D. Pilkey: "Formulated for Stress, Strain and Structural Matrices", A Wiley-Interscience Publication JOHN WILEY & SOUNDS, Inc. Edition 1994.

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3 Modeling
With

3.1
Characteristics of modeling

Modeling 3D_FAISCEAU
Boundary conditions:

Case without fluid:

DDL_IMPO: (
GROUP_MA: Sb DX: 0
DY: 0
DZ: 0
DRX: 0 DRY: 0 DRZ: 0
GROUP_MA: HS DX: 0
DY: 0
DZ: 0
DRX: 0 DRY: 0 DRZ: 0
N1 NODE: PHI: 0
)

Case with fluid:

DDL_IMPO: (
GROUP_MA: Sb DX: 0
DY: 0
DZ: 0
DRX: 0 DRY: 0 DRZ: 0
GROUP_MA: HS DZ: 0
DRX: 0 DRY: 0 DRZ: 0
N1 NODE: PHI: 0
)

LIAISON_UNIF: (GROUP_MA: HS
DDL: “DX”)
LIAISON_UNIF: (GROUP_MA: HS
DDL: “DY”)

3.2
Characteristics of the grid

Grid of the homogenized medium used, for the two cases of figure: with or without fluid, is represented by [3.2-a].
It comprises 48 meshs HEXA8.
The grid contains 9 straight lines parallel with average fibre of each beam.
4 meshs in cross section
HS
12
meshs
in
height
Sb

Appear 3.2-a: grid

3.3 Functionalities
tested

Case without fluid:

Orders
Keys
AFFE_MODELE
3D_FAISCEAU
[U4.22.01]
AFFE_CHAR_MECA

DDL_IMPO
[U4.25.05]
AFFE_CARA_ELEM
BEAM
SECTION:
“RIGHT-ANGLED”
[U4.24.01]
ORIENTATION
ANGL_NAUT
POUTRE_FLUI
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION:
“BAND”
Case with fluid:
Orders
Keys
AFFE_MODELE
3D_FAISCEAU
[U4.22.01]
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
LIAISON_UNIF
AFFE_CARA_ELEM
BEAM
SECTION:
“RIGHT-ANGLED”
[U4.24.01]
ORIENTATION
ANGL_NAUT
POUTRE_FLUI
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION:
“BAND”
4

Results of modeling A
4.1 Values
tested
Case without fluid:
Number
Size and
Reference
Aster
% difference
of order
unit
1, 2 and 6
frequency (Hz)
3.3333
3.3183
-0.45%
19 and 20
frequency (Hz)
9.2584
9.1480
-1.19%
Case with fluid:
Number
Size and
Reference
Aster
% difference
of order
unit
1 and 2
frequency (Hz)
0.6908
0.6932
0.35%
19 and 20
frequency (Hz)
3.7871
3.7984
0.30%
4.2 Parameters
of execution
Version: 3.6.2
Machine: CRAY C90

Obstruction memory:
16 MW
Time CPU To use:
100 S
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HI-75/96/052 - Ind A

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5 Modeling B

5.1 Characteristics of modeling

Modeling 3D_FAISCEAU
Boundary conditions:
Case with fluid:
DDL_IMPO: (
GROUP_MA: Sb DX: 0
DY: 0
DZ: 0
DRX: 0 DRY: 0 DRZ: 0
GROUP_MA: HS DZ: 0
DRX: 0 DRY: 0 DRZ: 0
N1 NODE: PHI: 0
)
LIAISON_UNIF: (GROUP_MA: HS
DDL: “DX”)
LIAISON_UNIF: (GROUP_MA: HS
DDL: “DY”)

5.2 Characteristics of the grid

Grid of the homogenized medium used, for the two cases of figures: with or without fluid, is represented by [5.2-a].
It comprises 48 meshs HEXA20.
The grid contains 9 straight lines parallel with average fibre of each beam.
4 meshs in section
HS
12
meshs
in

height
Sb
Appear 5.2-a: grid
5.3 Functionalities
tested
Case with fluid:
Orders
Keys
AFFE_MODELE
3D_FAISCEAU
[U4.22.01]
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
LIAISON_UNIF
AFFE_CARA_ELEM
BEAM
SECTION:
“RIGHT-ANGLED”
[U4.24.01]
ORIENTATION
ANGL_NAUT
POUTRE_FLUI
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.02]
CALC_FREQ
OPTION:
“BAND”

6
Results of modeling B
6.1 Values
tested
Case with fluid:
Number
Size and
Reference
Aster
% difference
of order
unit
1 and 2
frequency (Hz)
0.6908
0.6932
0.35%
19 and 20
frequency (Hz)
3.7871
3.7984
0.23%
6.2 Parameters
of execution
Version: 3.6.2
Machine: CRAY C90
Obstruction memory:
16 MW
Time CPU To use:
100 S

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7 Summary of the results

The results show the good modal behavior of the elements of modeling 3D_FAISCEAU in inflection, absence of the fluid. It show also a very good agreement of the frequencies of the modes overall with calculation Aster into heterogeneous, when there is fluid.

For the frequencies of the overall modes, one does not observe differences between a grid HEXA8 and HEXA20 (this is not true for the other modes).

Organization (S): EDF/RNE/AMV

Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
Document: V2.04.120

SDLV120 - Absorption of a wave of compression
in an elastic bar

Summary

One tests the elastic paraxial elements of order 0 intended to apply conditions absorbing to
border of a grid finite elements to simulate the infinite one in direct transitory calculations.
Are used they to model an infinite elastic bar, in 3D or 2D, in which one creates a wave of
pressure by imposing a displacement on the one of the ends. One is interested in nonthe reflexion of the wave in
the "infinite" end of the bar.
One tests successively the two direct transitory operators of Code_Aster, namely DYNA_LINE_TRAN and
DYNA_NON_LINE.

1
Problem of reference

1.1 Geometry

The system considered in the case 3D is that of an elastic bar with square section. One is imposed displacement according to X on one of the vertical faces and one observes the propagation of a wave of
compression. The side surface of the bar is left free. One places the elements absorbents on face opposed to the face of excitation to simulate the infinite character of the bar in this direction. In the case 2D, the principle is identical with a very broad supposed bar which one does not model that a vertical section (see diagram).

Z

X

Imposed displacement
Elastic solid
Surface absorbing

section

Section case 3D:
Section case 2D:

Z

y

1.2 Properties

materials

Bar: concrete

Density:

2400 kg.m3
Young modulus:
3,6.1010 Pa
Poisson's ratio: 0,48

1.3
Boundary conditions and loadings

One imposes on all the nodes of the face of the piston in contact with the fluid a displacement according to X
with the function of following temporal excitation:
Displacement of the piston according to X
10 -3
1,00E+00
9,00E-01
8,00E-01
7,00E-01
6,00E-01
5,00E-01
4,00E-01
3,00E-01
Displacement (m) 2,00E-01
1,00E-01
0,00E+00
-0,1
0,1

0,3
0,5
0,7
0,9
1,1
1,3
1,5
Time (S)

1.4 Conditions
initial

Displacement is null in all the bar at the initial moment.

2
Reference solution

The solution must show the absorption of a wave of compression by absorbing surface.
imposed displacement is a uniform translation according to the x axis. One must obtain a field of identical displacement according to this direction in all the plans X = Cte. Moreover, the border absorbing is orthogonal with this axis. One thus studies the absorption of plane waves of compression under normal incidence. The theory [bib1] known as that with a solid paraxial border of order 0, this absorption is perfect. It is what one must check with this reference solution.

One thus goes, by observing the evolution of displacement in a given point of the grid, to stick to to find in the signal obtained the duration of excitation and the return at rest after the passage of the wave,
characteristic of its absorption.

2.1
Results of reference

One gives in this paragraph the results obtained with Code_Aster in this configuration. One check that they are satisfactory and one takes them as reference for the future.
They concern, for the case 3D, the bar being 200 m length, the evolution of displacement in X in a point of the bar located at 150 m of the face excited in direction X and at the center of the section in the yz plan. For the case 2D, the bar being 50 m length, the point is located at 40 m of face according to X and in the middle of the section in the direction y (in 2D, one takes a shorter grid and
refined).

Displacement in X in the bar - case 3D
1,00E-03
9,00E-04
8,00E-04
7,00E-04
6,00E-04
5,00E-04
4,00E-04
3,00E-04
Displacement (m) 2,00E-04
1,00E-04
0,00E+00
-1,00E
-1,
-04
00E-01 1,00E-01 3,00E-01 5,00E-01 7,00E-01 9,00E-01 1,10E+00 1,30E+00 1,50E+00
Time (S)

Displacement in the bar - case 2D
1,00E-03
9,00E-04
8,00E-04
7,00E-04
6,00E-04
5,00E-04
4,00E-04
3,00E-04

Displacement (m) 2,00E-04
1,00E-04
0,00E+00
-1,00E
-1,
-04
00E-01 1,00E-01 3,00E-01 5,00E-01 7,00E-01 9,00E-01 1,10E+00 1,30E+00 1,50E+00
Time (S)

As envisaged, the width of the signal measured in both cases is identical to that of the function of excitation. Physically, one observes the wave propagation well of compression. The signal is little modified in its propagation and one thus finds well the maximum amplitude of 1 Misters One notes
also clearly the return at rest immediately after the passage of the wave and the absence of signal thought of the end of the grid.

2.2 Uncertainties

It is about a numerical result of the study. The qualitative forecasts are found. Values numerical are related to the precision of calculation. Only the return at rest is precisely given by analysis.

2.3 References
bibliographical

[1]
H. MODARESSI "numerical Modeling of the wave propagation in the mediums porous rubber bands. "Thesis doctor-engineer, Central School of Paris (1987).

5/8

3 Modeling a: case 3D

3.1 Characteristics of modeling

Bar: PHENOMENON: “MECHANICAL”
MODELING: “3D”

3.2 Characteristics

grid

A number of nodes: 45
A number of meshs and types: 16 HEXA8
8 QUA4 (faces of HEXA8)
Node 43
200 m
Node 16
50 m

Node 18

3.3 Functionalities tested

Orders

AFFE_MODELE AFFE
MODELING
3D_ABSO
DYNA_LINE_TRAN

DYNA_NON_LINE

3.4 Values tested

One tests the values of displacement in X to nodes 16, 18 and 43 (see grid). For node 16,

one tests the maximum and the return at rest. For nodes 18 and 43, one tests the maximum.
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

· DYNA_LINE_TRAN:

Node
Moment (S)
Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement
in m)
in m)
Code_Aster (%)
N16 5.39500E-01
9.91869E-04
1.00000E-03 0.81
RELATIVE
1.20000E+00
1.7E-8
0. 1.7E-6
ABSOLUTE
N18 5.40000E-01
9.91393E-04

1.00000E-03 0.86
RELATIVE
N43 5.00000E-01
1.00000E-03
1.00000E-03 0.
RELATIVE

· DYNA_NON_LINE:

Node
Moment (S)
Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement
in m)
in m)
Code_Aster (%)
N16 5.40000E-01
9.92640E-04
9.92640E-04 0.74
RELATIVE
1.20000E+00
3.0E-8
0. 3.0E-6
ABSOLUTE
N18 5.40000E-01
9.92182E-04
9.92182E-04 0.78
RELATIVE
N43 5.00000E-01
1.00000E-03
1.00000E-03 0.
RELATIVE

3.5 Parameters
of execution

Version: 5.2.16

Machine: SGI ORIGIN 2000

Time CPU: 600
Memory: 64 Mo
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

4
Modeling b: case 2D

4.1
Characteristics of modeling

Bar: PHENOMENON: "MECHANICAL"
MODELING: "D_PLAN"

4.2 Characteristics

grid

25 m

Node 3
50 m
Node 14
Node 32

A number of nodes: 36

A number of meshs and types: 30 QUA4

12 SEG2 (faces of QUA4)

4.3 Functionalities tested

Orders

AFFE_MODELE AFFE
MODELING
D_PLAN_ABSO
DYNA_LINE_TRAN

DYNA_NON_LINE

4.4 Values tested

One tests the values of displacement in X to nodes 32, 14 and 3 (see grid). For node 32, one tests the maximum and the return at rest. For nodes 14 and 3, one tests the maximum.

Note:

Node 3 is on vis-a-vis imposed displacement. One thus has exactly the values of excitation in this point.

· DYNA_LINE_TRAN:

Node
Moment (S)
Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement in m)
in m)
Code_Aster *(%)*
N32 5.09500E-01
9.99536E-04 1.00000E-03 0.046
RELATIVE
1.20000E+00
6.3E-10
0.
6.3E-8
ABSOLUTE
N14 5.09500E-01
9.99536E-04 1.00000E-03 0.046
RELATIVE
N3 5.00000E-01
1.00000E-03 1.00000E-03 0.
RELATIVE

· DYNA_NON_LINE:

Node
Moment (S)
Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement in m)
in m)
***Code_Aster** (%)*
N32 5.09500E-01
9.99867E-04 9.99867E-04 0.013
RELATIVE
1.20000E+00
-3.8E-9
0.
3.8E-7
ABSOLUTE
N14 5.09500E-01
9.99867E-04 9.99867E-04 0.013
RELATIVE
N3 5.00000E-01
1.00000E-03 1.00000E-03 0.
RELATIVE

4.5 Parameters of execution

Version: 5.2.16

Machine: SGI ORIGIN 2000

Time CPU: 1200
Memory: 300 Mo

5 Summary of the results

One finds by calculation with two modelings quantitatively, the maximum of displacement equal to the maximum amplitude of the signal and qualitatively, the return at rest after the passage of the wave.
The results obtained with operators DYNA_LINE_TRAN and DYNA_NON_LINE are very close.
The difference comes from obtaining to each step in time from the state from balance from the efforts from the second member with operator DYNA_NON_LINE, which explains why its results are a little bit better even with a step of larger time. This difference remains however tiny because the step time used with DYNA_LINE_TRAN is sufficiently small.

V2.04 booklet: Linear dynamics of the voluminal structures
Document: V2.04.121

SDLV121 - Wave planes shearing in one
elastic column

Summary

One tests the application of a loading in transient in the form of a plane wave thanks to the elements paraxial rubber bands of order 0, in 3D and 2D. One applies this loading to an elastic solid mass occupying one
half space and which one models a column. This column is supposed to be infinite in its lower part and
level in its part higher than the level of the surface of the free half space left. One observes propagation of the incidental wave, its reflexion on the free face of the solid mass and its absorption by the elements
paraxial at the lower end of the column.
One tests successively the two direct transitory operators of Code_Aster, namely DYNA_LINE_TRAN and
DYNA_NON_LINE.

1
Problem of reference

1.1 Geometry

The system considered in the case 3D is that of a homogeneous elastic ground occupying the half space
Z < 0. The plan Z = 0 is left free. One models of this ground a vertical column, presumedly infinite in its lower part and levelling than the free face at its higher end. The elements are placed paraxial on lower surface, to translate the infinite character of the column and to apply it loading by plane wave. In the case 2D, the principle is identical, with a very broad column which one models only one vertical section (see diagram).
Moreover, the direction of vibration is the y axis in the case 3D. It is about the x axis in the case 2D.

Locate:
Z
Case 3D
Free face
y
(Z = 0)
X
50 m
y
Case 2D
Elastic solid
X
Paraxial surface
Section case 3D:
Section case 2D:
X
y
y

1.2 Properties

materials

Elastic solid mass: floor covering

Density:
1900 kg.m3
Young modulus:
4,44.108 Pa

Poisson's ratio:
0,2

1.3
Boundary conditions and loadings

One is interested in the movement 1D of the column under the exiting action of a wave planes vertical.
To identify this movement, one forces all the nodes of the same horizontal section to have it even displacement.
In this configuration, the loading by plane wave comprises the following characteristics:

Direction: (0. 0. 1.)
Type_d' wave: "HS"
Outdistance initial origin: 150 m
Signal: function given below (with its derivative which is used as entry with calculation):

Signal of the incidental wave
1,00E-03
9,00E-04
8,00E-04
7,00E-04
6,00E-04
5,00E-04
4,00E-04
3,00E-04

2,00E-04
Displacement tranversal (m) 1,00E-04
0,00E+00
0,00E+00
2,00E+01
4,00E+01
6,00E+01
8,00E+01
1,00E+02
1,20E+02
-1,00E-04
length in the direction of the wave (m)

The maximum is obtained for a value of 49,5 m of the parameter.

Derived from the signal
8,00E-05
6,00E-05
4,00E-05
2,00E-05
0,00E+00
0,00E+00
2,00E+01
4,00E+01
6,00E+01
8,00E+01
1,00E+02
1,20E+02
-2,00E-05
Derived (without dimension) -4,00E-05
-6,00E-05
-8,00E-05
Length in the direction of the wave (m)

1.4 Conditions
initial

Displacement is null in all the column at the initial moment.
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

2
Reference solution

The propagation 1D of the signal of the incidental wave in the column is known analytically [bib1]. One
can for example determine the moment of passage of the maximum of the incidental wave with middle height, that is to say with
a 25 m depth, and that of the maximum of the wave thought of the same point.

Taking into account the signal given previously and position of its source to Z = 150 m, the maximum signal is Z = 105.5 m (i.e. 150 - value of 49,5 m of the parameter corresponding) that is to say
to 50,5 m of the paraxial surface (Z = -50 m) of the column in direction Z (that of the wave) with
the initial moment. To arrive to 25 m, it will thus have to traverse 75,5 Mr. the speed of the waves of shearing being of 281 m.s1 for the ground considered, one can thus await the maximum of
displacement with middle height in the column for time 0,27 S. Moreover, at the time of the passage of the wave
reflected, the signal will have traversed 50 m moreover, therefore one can await it for time 0,44 S. the value
maximum measured at these moments must be 1 Misters Ce are these analytical values which one will test
in calculation.

2.1
Results of reference

One gives in this paragraph the results obtained with Code_Aster in this configuration. One
check that they are satisfactory qualitatively and quantitatively.
They concern, for the case 3D, the evolution of displacement in the three directions in a point of
column located at middle height, is to 25 m of the free face in direction Z. The measurement of

displacement is identical in the case 2D.
Moreover, the direction of vibration is the y axis in the case 3D. It is about the x axis in the case 2D.

Transverse displacement in the column - case 3D
1,20E-03
1,00E-03
8,00E-04
6,00E-04
4,00E-04
2,00E-04
Displacement according to y (m)
0,00E+00
0,00E+00 1,00E-01 2,00E-01 3,00E-01 4,00E-01 5,00E-01 6,00E-01 7,00E-01 8,00E-01
-2,00E-04
Time (S)

Transverse displacement in the column - case 2D
2,00E-04
0,00E+00
0,00E+0 1,00E-
2,00E-
3,00E-
4,00E-
5,00E-

6,00E-
7,00E-
8,00E-
-2,00E-04 0
01
01
01
01
01
01
01
01
-4,00E-04
-6,00E-04
Displacement (m) -8,00E-04
-1,00E-03
-1,20E-03
Time (S)

It is checked first of all that displacements is null according to X and Z in the case 3D and according to y in the case 2D.
The celerity of the waves of shearing in a floor covering is of 280 m.s1 approximately. The length of signal is approximately 80 m. It is thus checked that the width of the peaks is well 0,3 S at the base.
One also observes at the moments envisaged the presence of the two identical peaks due to the reflexion without change of sign on the free face. Their amplitude of 1 mm also finds the signal imposed.
The inversion of the sign of displacement in the case 2D is due only to the orientation of the reference mark.

2.2 Uncertainties

It is about a numerical result of the study. One finds the qualitative and quantitative forecasts. numerical values are related to the precision of calculation.

2.3 References bibliographical

[1]
H. MODARESSI "numerical Modeling of the wave propagation in the mediums

porous rubber bands. "Thesis doctor-engineer, Central School of Paris (1987)
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

3
Modeling a: case 3D

3.1
Characteristics of modeling

Bar: PHENOMENON: "MECHANICAL"
MODELING: "3D"

3.2 Characteristics

grid

A number of nodes: 44
A number of meshs and types: 10 HEXA8
2 QUA4 (faces
Z
HEXA8)
50 m
y
.
X
Not measurement of
displacement (node 22)

5 m

3.3 Functionalities
tested

Orders

AFFE_MODELE AFFE MODELING
3D_ABSO
AFFE_CHAR_MECA_F ONDE_PLANE

DYNA_LINE_TRAN

DYNA_NON_LINE

3.4 Values
tested

One tests the values of displacement in the three directions with the node 22 (see grid). For direction y, one tests the value of the two maximum ones and the return at rest after the passage of the wave. For
the two other directions, one tests the nullity of displacement, for example at the moment of the first maximum in Y.

· DYNA_LINE_TRAN:

Direction Moment
(S) Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement
in m)
in m)
Code_Aster (%)
Y 2.65600E01

1.00410E03
1.E03 0.41
RELATIVE
4.38400E01
9.94716E04
1.E03 0.53
RELATIVE
8.00000E01
-5.8E6
0. 5.8E4
ABSOLUTE
X 2.65600E01 0.
0.
0.
ABSOLUTE
Z 2.65600E01 0.
0.
0.
ABSOLUTE

· DYNA_NON_LINE:

Direction Moment
(S) Calculation with
Results of
Variations reference -

Code_Aster
reference
calculation with
(displacement
(displacement in
in m)
m)
Code_Aster (%)
Y 2.67200E01
1.00396E04
1.E03 0.40
RELATIVE
4.40000E01
9.94928E04
1.E03 0.51
RELATIVE
7.20000E01
5.1E6
0. 5.1E4
ABSOLUTE
X 2.67200E01 0.
0.
0.
ABSOLUTE
Z 2.67200E01 0.
0.
0.
ABSOLUTE

3.5 Parameters
of execution

Version:
5.2.16

Machine:
SGI ORIGIN 2000

Time CPU:
300
Memory:
64 Mo

4
Modeling b: case 2D

4.1
Characteristics of modeling

Bar: PHENOMENON: “MECHANICAL”
MODELING: “D_PLAN”

4.2 Characteristics

grid

A number of nodes: 22
A number of meshs and types: 10 QUA4
2 SEG2 (faces of QUA4)
y
X
.
50 m
Not measurement of
displacement (node 11)

5 m

4.3 Functionalities
tested

Orders

AFFE_MODELE AFFE
MODELING
D_PLAN_ABSO
AFFE_CHAR_MECA_F ONDE_PLANE

DYNA_LINE_TRAN

DYNA_NON_LINE

4.4 Values
tested

One tests the values of displacement in the three directions with node 11 (see grid). For
direction X, one tests the value of the two maximum ones and the return at rest after the passage of the wave. For
the direction y, one tests the nullity of displacement, for example at the moment of the first maximum in Y.

· DYNA_LINE_TRAN:

Direction Moment
(S) Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement
in m)
in m)
Code_Aster (%)
X 2.65600E01

1.00410E04
1.E03 0.41
RELATIVE
4.38400E01
9.94716E04
1.E03 0.53
RELATIVE
8.00000E01
5.8E6
0. 5.8E4
ABSOLUTE
Y 2.65600E01 0.
0.
0.
ABSOLUTE

· DYNA_NON_LINE:

Direction Moment
(S) Calculation with
Results of
Variations reference -
Code_Aster
reference
calculation with
(displacement
(displacement
in m)
in m)
Code_Aster (%)
X 2.65600E01
1.00319E03
1.E03 0.32
RELATIVE
4.38400E01
9.93554E04
1.E03 0.64
RELATIVE
8.00000E01
3.0E6
0. 3.0E4
ABSOLUTE
Y 2.65600E01 0.

0.
0.
ABSOLUTE

4.5 Parameters of execution

Version:
5.2.16

Machine:
SGI ORIGIN 2000

Time CPU:
300
Memory:
64 Mo

5 Summary of the results

One finds by calculation with two modelings quantitatively, the values of maximum of displacement equal to the maximum amplitude of the signal and the values of the corresponding moments and qualitatively, the return at rest after the passage of the considered wave.
The results obtained with operators DYNA_LINE_TRAN and DYNA_NON_LINE are very close. The difference comes from obtaining to each step in time from the state from balance from the efforts from the second member with operator DYNA_NON_LINE, which explains why its results are in general small not very better even with a step larger time. This difference remains however tiny because it no the time used with DYNA_LINE_TRAN is sufficiently small.

SDLV122- Extrapolation of local measurements on a complete model (3D)
Date:
04/03/02
Author (S):
S. AUDEBERT, Key P. HERMAN
:
V2.04.122-A Page:
1/8

Organization (S): EDF/RNE/AMV, CS IF

Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
V2.04.122 document

SDLV122 - Extrapolation of local measurements
on a complete model (3D)

Summary:

It is about a linear test of dynamics 3D.

The goal is to test order PROJ_MESU_MODAL in the case of a system 3D. This order allows to project experimental dynamic transitory answers in a certain number of points on a basis modal of a numerical modeling.

This test contains 2 modelings:

•
projection (of constraints) is done on a basic concept modal of type [mode_meca],
•
projection (of constraints) is done on a basic concept modal of type [base_modale].

For 2 modelings, provided experimental measurements are identical and make it possible to test seek nodes in opposite and the taking into account of a local orientation.

In both cases, the reference solution is obtained by a direct calculation with Code_Aster; projection is realized in the successful outcome where the number of modes is equal to the number of measurements. Answers in
constraint obtained after projection are identical to the constraints of reference provided in data.

For modeling A, the answers in displacements and deformation obtained after projection are in perfect adequacy with the reference solutions. Values speeds and the accelerations deduced from identified modal contributions are close to those obtained by direct calculation. Weak variations noted are due to the errors of approximation generated by the determination via a linear diagram in time speeds and accelerations.

1
Problem of reference

1.1 Geometry

Let us consider the embed-free slim cylindrical bar described below:

P (T)

R

L
Length
: L = 4 m
Ray
: R = 0.1 m
End 1: embedded (x=0)
End 2: free (x=l)

1.2
Properties of materials

The characteristics of material are as follows:
Young modulus: E = 2.1 1011 Pa
Poisson's ratio: = 0.3
Density: = 7800 kg/m3

1.3
Boundary conditions and loading

The boundary condition is the embedding of end 1 of the bar. This embedding is of type beam to allow the effects Poisson on the section.

The loading applied for the calculation of answer is a thrust load, constant in traction, distributed on the section of end 2:

P (T) = 0
if T < 0
P = 106 NR
if T 0
0

2
Reference solutions

2.1
Method of calculation used for the reference solution

.
Analytical solution:
An analytical solution of this problem exists. It is described in:

In this case, the solution by modal superposition of this problem is written:

s-1
(
P
8P I

0
0
- 1

X

C

U X, T)
( )
=
X - 2

sin (2s -)
1
cos (2s
)
1
T
EA
EA
(2s -) 2

1
2I
-

2I
s=1

EA
with: C =

: propagation velocity of wave in the bar
m

.
Adopted reference solution:
The analytical solution utilizing an infinite sum on the modes, it is preferable that reference solution and the solution with projection corresponds to the same configuration, with the same number of modes.
Moreover, to avoid problems involved in the discretization of the numerical grid, the solution of reference selected is the answer provided by the direct calculation carried out with Code_Aster with order DYNA_TRAN_MODAL.

2.2
Results of reference

For modeling A, the comparison of the results relates to displacements, speeds, accelerations, strains and stresses along axis X, of the nodes N2 and NR 4 to 3 moments different. NR 4 corresponds to a node of measurement and N2 is not one.
For modeling B, the comparison of the results relates to the constraints of the nodes NR 3 and NR 4 at 3 different moments.

2.3
Uncertainty on the solution

The selected reference makes it possible to draw aside uncertainties related to the discretization of the numerical grid.
The number of modes of the base of projection is equal to the number of measurements, therefore the solution of
the inversion is exact (in opposition to an approximate solution of a generalized opposite problem).

If projection is done on a concept of the type [mode_meca], modal bases of reference solution and solution obtained by projection are identical, the answers in displacements, strains and stresses obtained must thus be similar to the answers of reference. Some errors of approximation can appear on speeds and accelerations which are determined by a linear diagram in time.
If projection is done on a concept of the type [base_modale], modal bases of reference solution and solution obtained by projection contain the same number of modes but are different. The calculation of reference not being possible on a concept of the type [base_modale], the comparison of the results relates only to answers corresponding to provided measurements.

2.4 Bibliography

[1]

Mr. GERADIN, D. RIXEN: Theory of the vibrations - Application to the dynamics of the structures - Edition MASSON 1993
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

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3 Modeling
With

3.1
Characteristics of modeling and the grids

.
Numerical grid:
The numerical grid is carried out with I-DEAS version Master Series 5. It comprises 2667 nodes and 3328 meshs of the linear type 3D.

.
Experimental grid:
The grid of measurement includes/understands only 5 specific elements and 5 nodes positioned like indicates the following figure:

N1 (0. 0. 0.)
N2 (l/4=1. 0. 0.)
N3 (l/2=2. 0. 0.)
N4 (3l/4=3. 0. 0.)
N5 (l=4. 0. 0.)

P (T)

3.2
Characteristics of measurements

Provided experimental measurements are:

.
With the nodes NR 3, NR 4 and NR 5:
The data are the axial stresses, applied in direction X.
The sampling of time is constant: initial time is 0 S, the step of times is 105 S and it
a many moments are 1001 (i.e until a final time of 0.01 S).

The values result from the direct calculation carried out with Code_Aster.

3.3
Characteristics of the modal base

The modes are stored in a concept of the type [mode_meca], containing the first three modes
dynamic of traction. These modes are obtained by blocking transverse displacements
(i.e according to DY and DZ) of the nodes of fibre of neutral and the nodes of the higher line (X =0.
to 4.
y =0.1 and Z =0.). Their Eigen frequencies (326.5 Hz, 980.0 Hz and 1634.5 Hz) are close to
Eigen frequencies of traction analytically calculated (324.3 Hz, 972.9 Hz and 1621.5 Hz).

4
Results of modeling A

4.1 Values
tested

Identification Reference
Code_Aster difference

with T = 9. 104s
2.686 10-4 2.686
10-4 0.00
%
DEPL_X
with the node N2 with
T = 17. 104s
3.074 10-4 3.074
10-4 0.00
%
(m)
with T = 25. 104s
1.446 10-5 1.446
10-5 0.01
%

with T = 9. 104s
5.793 10-4 5.793
10-4 0.00
%
DEPL_X
with the N4 node with
T = 17. 104s
9.160 10-4 9.160
10-4 0.00
%
(m)
with T = 25. 104s
3.095 10-4 3.095
10-4 0.00
%

with T = 9. 104s
6.221 10-1 5.855
10-1 -5.88
%
VITE_X
with the node N2 with
T = 17. 104s
-4.683 10-2 -4.094
10-2 -12.59
%
(m/s)
with T = 25. 104s
-3.542 10-1 -3.168
10-1 -10.56
%

with T = 9. 104s
8.056 10-1 8.140
10-1 1.04
%
VITE_X
with the N4 node with
T = 17. 104s
-3.556 10-1 -3.800
10-1 6.87
%
(m/s)
with T = 25. 104s
-8.638 10-1 -8.708
10-1 0.82
%

with T = 9. 104s
-3.633 10+3 -3.653
10+3 0.55
%
ACCE_X
with the node N2 with
T = 17. 104s
6.337 10+2 7.550
10+2 19.14
%

(m/s2)
with T = 25. 104s
3.801 10+3 3.778
10+3 -0.62
%

with T = 9. 104s
8.655 10+2 9.636
10+2 11.34
%
ACCE_X
with the N4 node with
T = 17. 104s
-2.387 10+3 -2.371
10+3 -0.69
%
(m/s2)
with T = 25. 104s
-6.355 10+2 -5.019
10+2 -21.02
%

with T = 9. 104s
1.957 10-4 1.957
10-4 0.00
%
EPXX
with the node N2 with
T = 17. 104s
3.015 10-4 3.015
10-4 0.00
%
(m)
with T = 25. 104s
5.422 10-5 5.422
10-5 0.00
%

with T = 9. 104s
1.822 10-4 1.822
10-4 0.00

%
EPXX
with the N4 node with
T = 17. 104s
2.611 10-4 2.611
10-4 0.00
%
(m)
with T = 25. 104s
1.681 10-4 1.681
10-4 0.00
%

with T = 9. 104s
5.012 10+7 5.012
10+7 0.00
%
SIXX
with the node N2 with
T = 17. 104s
7.717 10+7 7.717
10+7 0.00
%
(Pa)
with T = 25. 104s
1.390 10+7 1.390
10+7 0.00
%

with T = 9. 104s
4.650 10+7 4.650
10+7 0.00
%
SIXX
with the N4 node with
T = 17. 104s
6.671 10+7 6.671
10+7 0.00
%
(Pa)
with T = 25. 104s
4.293 10+7 4.293

10+7 0.00
%

4.2 Parameters
of execution

Version: NEW5 (5.04)

Machine: CLASTER

Obstruction memory: 300 Mo
Time CPU To use: 146.84 seconds
Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
HT-62/01/012/A

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5 Modeling
B

5.1
Characteristics of modeling and the grids

.
Numerical grid:
The numerical grid is identical to that used in the preceding case. It is carried out with I-DEAS version Master Series 5 and comprises 2667 nodes and 3328 meshs of the linear type 3D. One group comprising only one node is added to be used as interface.

.

Experimental grid:
The grid of measurement includes/understands only 5 specific elements and 5 nodes positioned like indicates the following figure:

N1 (0. 0.1 0.)
N2 (l/4=1. 0.1 0.)
N3 (l/2=2. 0.1 0.)
N4 (3l/4=3. 0.1 0.)
N5 (l=4. 0.1 0.)

P (T)
N3INF (3l/4=3. -0.1 0.)

5.2
Characteristic of measurements

Provided experimental measurements are:

.

With the nodes NR 3, NR 4 and N5:
The data are the axial stresses, applied in direction X.
The sampling of time is constant: initial time is 0 S, the step of times is 105 S and it a many moments are 1001 (i.e until a final time of 0.01 S).

The values result from the direct calculation carried out with Code_Aster.

5.3
Characteristics of the modal base

The modes are stored in a concept of the type [base_modale], containing the two first dynamic modes of traction and static mode with the node NR 3INF for the degree of freedom DX. The interface is of Craig-Bampton type. The base thus contains on the whole 3 modes.

Note:

The number of modes being very reduced, the solution depends on the modal base. However, modes determined for this modeling are not the same ones as those of the modal base of reference, and it is not possible to carry out direct calculation with Code_Aster on one concept [base_modale]. Only the answers corresponding to provided measurements can *thus to be validated. No comparison can be carried out on the other answers.*

6
Results of modeling B

6.1 Values
tested

Identification Reference
Code_Aster difference

with T = 9. 104s
3.416 10+7 3.416
10+7 0.00
%
SIXX
with the N3 node with
T = 17. 104s
8.046 10+7 8.046
10+7 0.00
%
(Pa)
with T = 25. 104s
4.251 10+7 4.251
10+7 0.00

%

with T = 9. 104s
4.650 10+7 4.650
10+7 0.00
%
SIXX
with the N4 node with
T = 17. 104s
6.671 10+7 6.671
10+7 0.00
%
(Pa)
with T = 25. 104s
4.293 10+7 4.293
10+7 0.00
%

6.2 Parameters of execution

Version: NEW5 (5.04)

Machine: CLASTER

Obstruction memory: 300 Mo
Time CPU To use: 147.42 seconds

7
Summary of the results

For two modelings, the answers in constraints obtained after projection are identical with the constraints of reference obtained by direct calculation with Code_Aster and provided in data.

For modeling A, the answers in displacements and deformation are in perfect adequacy with the reference solutions. Values speeds and accelerations obtained afterwards projection are close to those obtained by direct calculation. The weak noted variations are due with the errors of approximation generated by the determination by a linear diagram in time of speeds and accelerations.

The cases where the number of modes is not equal to the number of measurements are not tested (problem opposite generalized); in particular, the method of regularization of Tikhonov is not tested.

Author (S):
E. BOYERE, G. ROBERT, F. SOULIE Key

Organization (S): EDF-R & D /AMA, SAMTECH

Handbook of Validation
V2.04 booklet: Linear dynamics of the voluminal structures
Document: V2.04.401

SDLV401 - Free-free full sphere

Summary:

This three-dimensional test of modal analysis consists in calculating the Eigen frequencies of a full sphere in
free-free.
The interest of this test is to evaluate the robustness and the performance of Code_Aster in the detection of the modes
rigid and of the multiple frequencies, during the use of voluminal elements.

The reference solution is numerical and is obtained using the computation software of structures by elements
stop the SAMCEF software.
In this test, one compares the results obtained with two types D `elements:

· element HEXA8 (modeling A)
· element HEXA20 (modeling B).

In order to determine the clean elements of this system, the method known as of SORENSEN is used.

1
Problem of reference

1.1 Geometry

Full sphere:

R

Interior ray R = 0.01 m

1.2
Material properties

The presumedly elastic material linear A following characteristics:

E = 1.E8 Pa
= 0.3
= 10000 kg/m3

1.3
Boundary conditions and loadings

The studied structure is free in space.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is numerical: it is obtained with the computation software of structures by finite elements the SAMCEF software.
The method of calculation of the Eigen frequencies is the method known as of SORENSEN (method by
defect in operator MODE_ITER_SIMULT).

2.2 Results of reference

The structure presenting six rigid modes, one is interested in the first 10 Eigen frequencies not null.
The following table shows the values of the frequencies obtained (in Hz) according to the degree of the elements voluminal.

Mode	Degree 1	Degree 2
1	2.54231 E3	2.47035 E3
2	2.54231 E3	2.47035 E3
3	2.60747 E3	2.47101 E3
4	2.60747 E3	2.47101 E3
5	2.60747 E3	2.47101 E3
6	2.74095 E3	2.61296 E3
7	2.74095 E3	2.61296 E3
8	2.74095 E3	2.61430 E3
9	2.76313 E3	2.61430 E3
10	2.76313 E3	2.61430 E3

3 Modeling
With

3.1

Characteristics of modeling A

Grid made up of elements HEXA8

3.2
Characteristics of the grid

A number of nodes: 417
A number of meshs and type: 160 HEXA8

3.3 Functionalities
tested

Orders

AFFE_MODELE AFFE MODELING
“3D”
CALC_MATR_ELEM OPTION
“RIGI_MECA”

“MASS_MECA”
MODE_ITER_SIMULT METHOD
“SORENSEN”
CALC_FREQ
OPTION
BANDAGE
FREQ
(1, 3000 Hz)

---

4 Results of modeling A

4.1 Values tested

(Frequencies in Hertz)

Identification	**Reference**	**Code_Aster**	**% difference**
n° mode			
1	2.54231 E3	2.54231 E3	~ 1 E -6
2	2.54231 E3	2.54231 E3	~ 1 E -6
3	2.60747 E3	2.60747 E3	~ 1 E -6
4	2.60747 E3	2.60747 E3	~ 1 E -6
5	2.60747 E3	2.60747 E3	~ 1 E -6
6			

2.74095 E3
2.74095 E3
~ 1 E -6
7
2.74095 E3
2.74095 E3
~ 1 E -6
8
2.74095 E3
2.74095 E3
~ 1 E -6
9
2.76313 E3
2.76313 E3
~ 1 E -6
10
2.76313 E3
2.76313 E3
~ 1 E -6

4.2 Remarks

Code_Aster detects well the 6 modes of rigid body.

6/8

5 Modeling
B

5.1
Characteristics of modeling B

Grid made up of elements HEXA20

5.2
Characteristics of the grid

A number of nodes: 815
A number of meshs and type: 160 HEXA20

5.3 Functionalities
tested

Orders

AFFE_MODELE AFFE
MODELING
“3D”
CALC_MATR_ELEM OPTION
“RIGI_MECA”

“MASS_MECA”
MODE_ITER_SIMULT METHOD
“SORENSEN”
CALC_FREQ
OPTION
BANDAGE
FREQ
(1 , 3000)

6
Results of modeling B

6.1 Values
tested

(Frequencies in Hertz)

Identification	*Reference*	*Code_Aster*	*% difference*
n° mode			
1	*2.47035 E3*	*2.46964*	*-0.029*
2	*2.47035 E3*	*2.46964*	*-0.029*
3	*2.47101 E3*	*2.47084*	*-0.007*
4	*2.47101 E3*	*2.47084*	*-0.007*
5	*2.47101 E3*	*2.47084*	*-0.007*
6	*2.61296 E3*	*2.61344*	*0.019*
7	*2.61296 E3*	*2.61344*	*0.019*
8	*2.61430 E3*	*2.61345*	*-0.033*
9	*2.61430 E3*	*2.61364*	*-0.025*
10	*2.61430 E3*	*2.61364*	*-0.025*

6.2 Remarks

Code_Aster detects well the 6 modes of rigid body.

7
Summary of the results

The results obtained are excellent since the instantaneous frequency deviations with the reference solution
are lower than 0.03%. Moreover, Code_Aster detects well the 6 modes of rigid body, which one does not have
not asked to calculate.

To calculate the rigid modes indeed, two possibilities exist. With the option "BANDAGES" on frequency band (0, 3000 Hz), one can employ either the method of "SORENSEN", or the method LANCZOS ("TRI_DIAG") by specifying option "MODE_RIGIDE".

Titrate:
SDLX01 Inflection of a symmetrical gantry
Date:
09/01/98
Author (S):
B. QUINNEZ
Key:
V2.05.001-C Page:
1/6
Organization (S): EDF/IMA/MMN
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
V2.05.001 document
SDLX01 - Inflection of a symmetrical gantry
Summary:
This plane problem consists in seeking the frequencies of vibration of a mechanical structure made up of one assembly of beams with rectangular section (symmetrical gantry). This test of mechanics of the structures corresponds to a dynamic analysis of an assembled structure having a linear behavior. It includes/understands only one modeling.
Via this problem, one tests the element of beam of Timoshenko as well as the calculation of frequencies of vibration by the method of the iterations opposite.
The results obtained are in very good agreement with those of guide VPCS. The error on the thirteen first frequencies of vibration is lower than 0,2%.
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/96/004 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLX01 Inflection of a symmetrical gantry
Date:
09/01/98
Author (S):
B. QUINNEZ
Key:
V2.05.001-C Page:
2/6

1
Problem of reference
1.1 Geometry
E
F
Rectangular cross-sections:
thickness
H = 0.0048 m
y, v
C
D
width
B = 0.029 m
surface

To = 1.392 10-4 m2

inertia
lz = 2.673 10-10 m4
With
B
X, U
y'
z'
section:
z'
H
B
y'
B
posts
cross-pieces
H
Co-ordinates of the points (in meters):
With
B
C
D
E
F
X
0.30
0.30

0.30
0.30
0.30
0.30
y
0.
0.
0.36
0.36
0.81
0.81
1.2
Material properties
E = 2.1 1011 Pa
= 0.3
= 7.800. kg/m3
1.3
Boundary conditions and loadings
Embedded points A and b: (U = v = 0, = 0).
1.4 Conditions
initial
Without object for the modal analysis.
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/96/004 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SDLX01 Inflection of a symmetrical gantry
Date:
09/01/98
Author (S):
B. QUINNEZ
Key:
V2.05.001-C Page:
3/6
2
Reference solution
2.1
Method of calculation used for the reference solution
The reference solution is that given in card SDLX01/89 of the guide VPCS which presents

method of calculation in the following way:
Method of the dynamic stiffness (Theory of the slim beams)
2.2
Results of reference
the first 13 Eigen frequencies.
2.3
Uncertainty on the solution
(f/f) < 0.5%.
2.4 References
bibliographical
[1]
J. PIRANDA. Run and Directed Work of vibrations of the structures. Mechanical option. School Higher main road of Mechanics and Micromechanics. Laboratory of Mechanics Applied. Besancon (France) (1983).

---

3 Modeling
With
3.1
Characteristics of modeling
POU_D_T
y
E
F
C
D
With
B
X

Cutting:
AC and data base
6 meshs SEG2
EC and DF
9 meshs SEG2
CD and EF
10 meshs SEG2
Limiting conditions:
plane problem
DDL_IMPO:
(ALL: "YES" DZ: 0. , DRX: 0. , DRY: 0.)
embedded nodes A and B
(GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0.)
Name of the nodes:
Not A = N100
Not B = N600
Not C = N200
Not D = N500
Not E = N300
Not F = N400
3.2
Characteristics of the grid
A number of nodes:
50
A number of meshs and types:
50 SEG2
3.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
BEAM
"RIGHT-ANGLED"
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
ALL
[U4.25.01]
GROUP_NO
AFFE_MATERIAU
ALL
[U4.23.02]

AFFE_MODELE
"MECHANICAL"
"POU_D_T"
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
MODE_ITER_INV
CALC_FREQ
OPTION
"ADJUSTS"
[U4.52.01]
FREQ
NMAX_FREQ

4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference
1 anti
8.8
8.7802
0.23

2 anti
29.4
29.4341
0.12
3 sym
43.8
43.8385
0.09
4 sym
56.3
56.2826
0.03
5 anti
96.2
96.1506
0.05
6 sym
102.6
102.6408
0.04
7 anti
147.1
147.0437
0.04
8 sym
174.8
174.8118
0.01
9 anti
178.8
178.7979
0.00
10 anti
206.0
206.0614
0.03
11 sym
266.4
266.4698
0.03
12 anti
320.0
320.1142

0.03
13 sym
335.0
335.2300
0.07

4.2 Remarks

Calculations carried out by:
MODE_ITER_INV
OPTION: LIST_FREQ "ADJUSTS": (5. , 350.) NMAX_FREQ: 13

4.3
Contents of the file results

the first 13 Eigen frequencies (clean vectors and modal parameters).

4.4 Parameters
of execution

Version: 3.4.10
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.7 seconds

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/96/004 - Ind A

---

5 Summary of the results

Precision < 0.2% on all the Eigen frequencies until the 13th mode.

Organization (S): EDF/IMA/MMN, CISI

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
Document: V2.05.002

SDLX02 - Piping: Problem of Hovgaard. Spectral analysis

Summary:

The three-dimensional problem consists *firstly*, to seek the modes of vibration of a mechanical structure composed of a curved beam embed-embedded (problem of Hovgaard), *secondly*, to analyze the answer of this structure subjected to a spectrum of acceleration. This test of mechanics of the structures corresponds to one
analyze dynamic of a linear model (assembled structure) having a linear behavior. It includes/

understands
three modelings.
Via this problem, one tests the element of beam of Timoshenko (right beam or curve) in inflection, the calculation of the clean modes by the method of Lanczos, the calculation of the static modes and calculation of a spectral response of a structure subjected to a spectrum of acceleration (one tests also the interpolation of spectrum).
The results obtained are in concord with the results of reference (compilation of results obtained by other software packages).

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/96/004 - Ind A

---

1 Problem of reference

1.1 Geometry

- 0.
- 0.922
2.75
With - 1.828
B - 0.922
=
Z
- 0.922
- 0.
=
4
3 5
=
6
=

=
With
7
8
9
3.69
B
10
2
12
11
y
13
=
=
14
=
15
=
=
1.96
X
1
· diameter external of the pipe: 0.185 m
· thickness of the pipe: 6.12 m
· radius of curvature of the elbows: 0.922 m

1.2 Material properties

E = 1.658 E + 11 Pa
= 0.3
= 13404.106 kg/m3 (pipe full of water)

1.3 Boundary conditions and loadings

Items 1 and 15 embedded (U = v = W = X = y = Z = 0).
Loading: without object for the modal analysis.
For the spectral analysis: definition of a spectrum of acceleration to the supports for a damping of 2%.
Frequency (Hz)
1
10
30
100
10000
Acceleration (G)
0.2

2.
2.
0.2
0.2
according to X and y
Acceleration (G)
0.1
1.
1.
0.1
0.1
according to Z

---

2 Reference solution

2.1 Method of calculation used for the reference solution

Averages of codes: Lice, ADL, TITUS-T.
Guide validation of the Software packages of structural analysis - AFNOR - 1990 (for modal calculation).
values provided in the card under are estimated and were corrected thereafter in 1992. However, they were preserved for calculations with matrix of diagonal mass.

2.2 Results of reference

Modal calculation:
the first 9 Eigen frequencies.
Spectral answer:
displacement of the nodes N3 N5 and N7, N9, N11.
Reaction of supports to the nodes N1, N15.
Generalized efforts of the nodes N3, N7, N11.

2.3 Uncertainty on the solution

About 1% on the first 5 modes.
Between 1 and 2,5% for modes 6 to 9.

2.4 Bibliographical references

[1] Guide Technical VPCS AFNOR - 1990
[2] W. HOVGAARD "dimensional Stress in three pipe bens", Trans of ASME vol. 57, FSP 75-12 P 401-416.

---

3 Modeling A

3.1 Characteristics of modeling

The curved elements are modelled by elements "POU_C_T" (2 elements per elbow).
The right elements are modelled by elements "POU_D_T".
2.75
=
Z
=
N400
N500
=
N600
N300
=
=
With
N700N800
N900
3.69
B N1000
N200

N1100
N1200
y
=
N1300
=
N1400
=
N1500
=
=
1.96
X
N100

3.2 Functionalities tested

Orders
Keys
AFFE_MODELE
GROUP_MA
“MECHANICAL”
“POU_D_T”
[U4.22.01]
“POU_C_T”
CALC_MATR_ELEM
OPTION
“MASS_MECA_DIAG”
[U4.41.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.01]
CALC_FREQ
DIM_SOUS_ESPACE
NMAX_FREQ
NORM_MODE
NORMALIZES
“TRAN_ROTA”
[U4.64.02]
CALC_ELEM
OPTION
“SIELF_ELGA_DEP”
[U4.61.02]
“EFGE_ELNO_DEPL”

CALC_NO
OPTION
“REAC_NODA”
[U4.61.03]
MODE_STATIQUE
ACCE_UNIF
[U4.52.04]
COMB_SISM_MODAL
EXCIT
MONO_APPUI
[U4.54.04]
TRI_SPEC
SPEC_OSCI
CORR_FREQ

3.3 Characteristics of the grid

A number of nodes:
15
A number of meshs and types:
10 POU_D_T
4 POU_C_T

3.4 Remarks

The modes are normalized in the following way: larger component (degree of freedom of translation or rotation) with one.

The total answer is obtained by quadratic combination of the directions of the excitations.

---

4 Results of modeling A

4.1 Values tested

Frequencies of the structure (matrix of complete mass).

Eigen frequencies	**Reference**	***Aster***	**% difference**
Mode 1	10.39	10.4488	0.566
2	20.02	19.9067	0.566
3	25.45	25.3369	0.444
4	48.32	46.8806	2.979
5	52.60	51.7708	1.576
6	84.81	82.4334	2.802
7	87.16	84.1737	3.426
8	129.31	130.138	0.640
9	131.69	131.691	0

Frequencies of the structure (matrix of mass diagnonale).

Eigen frequency
Reference

Aster

% difference

10.18
10.198
0.18
2
19.54
19.544
0.02
3
25.47
25.368
0.40
4
48.09
74.763
0.68
5
52.86
52.509
0.66
6
75.94
75.131
1.07
7
80.11
79.512
0.75
8
122.34
120.785
1.27
9
123.15
121.480
1.36

Spectral answer: one does not take account of the correction of the frequencies due to damping (option CORR_FREQ with not in operator COMB_SISM_MODAL)

Displacement

Identification

Reference

Aster

% difference
DEPL
N300
DX
4.847 103
4.8449 103
0.04
DY
2.192 103
2.1914 103
0.03
DZ
2,735 106
2.7341 106
0.03
N500
DX
4.808 103
4.8062 103
0.04
DY
2.914 103
2.131 103
0.03
DZ
6.507 104
6.5048 104
0.03
N700
DX
3.588 103
3.5866 103
0.04
DY
2.914 103
2.9124 103
0.05
DZ
8.599 104
8.5959 104
0.03
N900
DX

2.342 103
2.3415 103
0.02
DY
2.913 103
2.9114 103
0.05
DZ
1.027 103
1.0261 103
0.08
N1100
DX
3.009 106
3.007 106
0.05
DY
9.375 104
9.3711 104
0.04
DZ
3.364 104
3.3621 104
0.06

Nodal reaction
Identification
Reference

Aster
% difference
REAC
N100
DX
2132
2130.81
0.06
DY
1241
1240.24
0.06
DZ
564.6
564.33
0.05
DRX
2352
2351.27
0.03
DRY
4746
4744.27
0.04
DRZ
937.3
936.92
0.04
N1500
DX
1653
1652.24
0.05
DY
3354
3352.19
0.05
DZ
893.7
893.34
0.04
DRX
170.8

170.74
0.03
DRY
1668
1667.71
0.02
DRZ
4903
4900.62
0.05
Generalized efforts
Identification
Reference
Aster
% difference
EFGE
N300
NR
559.9
559.86
0.01
VY
430.8
430.75
0.01
VZ
914.9
914.88
0.
MT
932.5
932.50
0.
MF
587.3
587.35
0.01
Y
MFZ
620.4
620.36
0.01
N700

NR
162.5
1624.83
0.01
VY
1367.
1367.04
0.
VZ
225.4
225.38
0.01
MT
170.6
170.64
0.03
MF
924.7
924.69
0.
Y
MFZ
2150
2150.29
0.01
Spectral answer: one takes account of the correction of the frequencies due to damping (option CORR_FREQ with yes in operator COMB_SISM_MODAL)
Displacement and nodal Reaction
Identification
Reference
Aster
% difference
DEPL
N3
DX
4.847 103
4.8469 103
0
DY
2.192 103
2.1922 103
0.01
N7

DX
3.588 10
3.5881 10
0
DY
2.914 103
2.9135 10
0.01
DRY
1.436 10
1.4361 10
0.01
REAC_NOD
N1
DX
2132.
2131.66
0.02
With
DY
1241.
1240.94
0.02
DZ
564.6
564.56
0
N15
DRX
170.8
170.81
0
DRY
166.8
1668.38
0.02
DRZ
4903.
4902.58
0
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
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4.2 Remarks

Values of the spectrum (interpolation).

Mode
1, 2, 3
4
5
6
7
8, 9
Following Acclération
19.620
8.06148
6.72586
3.38994
3.04168
1.9620
X and y
Acceleration according to Z
9.810
4.03074
3.36293
1.69497
1.52084
0.9810

4.3 Parameters of execution

Version: 3.04.7
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords

Time CPU To use:
14 seconds
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/96/004 - Ind A

---

5 Modeling B

5.1 Characteristics of modeling

The curved elements are modelled by elements "POU_C_T" (2 elements per elbow).
The right elements are modelled by elements "POU_D_T_G".
2.75
=
Z
=
N400
N500
=
N600
N300
=
=
With
N700N800
N900
3.69
B N1000
N200
N1100
N1200
y
=

N1300
=
N1400
=
N1500
=
=
1.96
X
N100

5.2 Functionalities tested

Orders
Keys
AFFE_MODELE
GROUP_MA
“MECHANICAL”
“POU_D_T_G”
[U4.22.01]
“POU_C_T”
CALC_MATR_ELEM
OPTION
“MASS_MECA”
[U4.41.01]
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.01]
CALC_FREQ
DIM_SOUS_ESPACE
NMAX_FREQ

5.3 Characteristics of the grid

A number of nodes:
15
A number of meshs and types:
10 POU_D_T_G
4 POU_C_T

5.4 Remarks

The modes are normalized in the following way: larger component (degree of freedom of translation or rotation) with one.

6 Results of modeling B

6.1 Values tested

Frequencies of the structure (matrix of complete mass).

Eigen frequency	**Reference**	***Aster***	**% difference**
Mode 1	10.39	10.4488	0.566
2	20.02	19.9067	0.566
3	25.45	25.3369	0.444
4	48.32	46.8806	2.979
5	52.60	51.7708	1.576
6	84.81	82.4334	2.802

7
87.16
84.1737
3.426
8
129.31
130.138
0.641
9
131.69
131.691
0

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/96/004 - Ind A

---

7 Modeling C

7.1 Characteristics of modeling

The curved elements are modelled by elements "POU_C_T" (10 elements per elbow).
The right elements are modelled by elements "POU_D_T_G" (10 elements per right beam).

2.75
N3
=
Z
=
N2
=
=
=
With
N4
3.69
B
NS
y
=
=
P1500 = N6
=
=
=
1.96
X
N1 = P100

7.2 Functionalities tested

Orders

Keys

AFFE_MODELE
GROUP_MA
“MECHANICAL”
“POU_D_T_G”
[U4.22.01]
“POU_C_T”
CALC_MATR_ELEM
OPTION
“MASS_MECA”
[U4.41.01]
“MASS_MECA_DIAG”
MODE_ITER_SIMULT
METHOD
“TRI_DIAG”
[U4.52.01]
CALC_FREQ
DIM_SOUS_ESPACE
NMAX_FREQ

7.3 Characteristics of the grid

A number of nodes:
51
A number of meshs and types:
30 POU_D_T_G
20 POU_C_T

7.4 Remarks

The modes are normalized in the following way: larger component (degree of freedom of translation or rotation) with one.

---

8 Results of modeling C

8.1 Values tested

Frequencies of the structure (matrix of complete mass).

Eigen frequency	**Reference**	***Aster***	**% difference**
Mode 1	10.39	10.41	0.170
2	20.02	20.02	0.002
3	25.45	25.52	0.289
4	48.32	48.47	0.314
5	52.60	52.68	0.152
6	84.81	84.89	0.1
7	87.16	87.29	0.153
8	129.31	130.22	0.704

Frequencies of the structure (matrix of diagonal mass).

Reference
Aster
% difference

10.39
10.39
0.058
20.02
20.02
0.089
25.45
25.51
0.265
48.32
48.51
0.392
52.60
52.70
0.192
84.81
84.63
0.215
87.16
87.14
0.021
129.31
129.77
0.357

---

9 Summary of the results and remarks general

Modal calculation:

The results are in conformity with the card of validation.

By refining the grid (modeling C) one obtains correct results.

Spectral answer:

The results are in conformity with the results of reference (the error is lower than the thousandths).

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
Document: V2.05.003

SDLX03 - Assembly of rectangular plates thin braced

Summary:

This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure
composed of an assembly of plates where one simulated an effect of stiffening. This test of Mechanics of
Structures corresponds to a dynamic analysis of an assembled structure having a linear behavior. It includes/understands two modelings.

Via this problem, one tests the element of plate DKT as well as the calculation of the frequencies of vibration by the method of Lanczos with detection of the modes of rigid body.

In the second modeling, one tests in more the connection between hulls (key word LIAISON_COQUE of
order AFFE_CHAR_MECA).

The results obtained are in concord with the results given in guide VPCS (average of results obtained by various computer codes). The six modes of rigid body were indeed detected.
A comparison with experimental results is also satisfactory.

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HI-75/01/010/A

1
Problem of reference

1.1 Geometry

0.005
0.2
0.05
0.05
(lengths
0.375
0.025
0.075
in meters)
1/2 cross section

Thickness of all the plates:
T = 0.005 m

Plates higher and lower:
length has = 0.375 m
dispatcher B = 0.2 m

Vertical plates:
length has = 0.375 m
width B = 0.05 m

1.2
Properties of materials

E = 2.1 1011 Pa

= 0.3

= 7.800. kg/m3

1.3
Boundary conditions and loadings

Free structure in any point.

1.4 Conditions
initial

Without object for the modal analysis.
Handbook of Validation

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SDLX03/89 of guide VPCS.

The reference solution was obtained by experimental study of the frequencies and clean modes free structure on a model produced with welded sheets.
The structure suspended by flexible connections is put in vibration by a discharger electrodynamics. The statement of the Eigen frequencies is obtained starting from an accelerometer.

In addition, of the digital simulations, carried out by various computer codes, allowed to establish "results of reference" for the models finite elements.

2.2
Results of reference

the first 6 nonnull Eigen frequencies.

2.3
Uncertainty on the solution

Lower than 4%.

2.4 References bibliographical

[1]
Tests carried out by Company METRAVIB (64 Way of Dampings - BP 182 - 69132 Ecully Cedex - France). Report/ratio METRAVIB R.D.S. n° 1.604.50 (1987).

---

3 Modeling With

3.1 Characteristics of modeling

Elements of hull DKT
Z
509 508
X
y
502
419
409
501
491
408

201
109
191
108
402401
102 101
origins of the axes = center of the structure

Cutting:

Plates higher and lower
10 in length
==> 160 meshs TRIA3
8 in width

Vertical plates
10 in length
==> 20 meshs TRIA3
1 in width
Names of the nodes:

Lower plate:
N101,…, N109
N111,…, N119
....
N201,…, N209

Higher plate:
N401,…, N409
N411,…, N419
....
N501,…, N509

Vertical plates:
N102, N112,…, N202
N402, N412,…, N502

N108, N118,…, N208
N408, N418,…, N508

3.2
Characteristics of the grid

A number of nodes:
198
A number of meshs and types:
360 TRIA3

3.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

ALL [U4.24.01]
AFFE_MATERIAU ALL

[U4.23.02]
“MECHANICAL” AFFE_MODELE
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU ELAS

[U4.23.01]
MODE_ITER_SIMULT METHOD
“TRI_DIAG”

[U4.52.01]
CALC_FREQ
OPTION
“BAND”

FREQ

NMAX_FREQ

Handbook of Validation

4
Results of modeling A

4.1 Values tested

Order of
Reference
Model reference
Aster
% difference/
experimental clean mode
*elements finis**
model elements
finished
7
606.
584. ± 1%
590.0310
1.03
8
760.
826. ± 1.5%
829.4009
0.41
9

865.
855. ± 1.7%
848.1548
-0.80
10
944.
911. ± 2%
908.8566
-0.23
11
1113.
1113. ± 3.6%
1097.6578
-1.38
12
1144.
1136. ± 4%
1164.0088
2.46

**** average of 5 computer codes***

4.2 Remarks

Calculations carried out by:

MODE_ITER_SIMULT
METHOD: "TRI_DIAG"

OPTION
"BAND"
LIST_FREQ:
(1.,1200.)

DIM_SOUS_ESPACE:
12

4.3
Contents of the file results

The first 6 nonnull Eigen frequencies (clean vectors and modal parameters).

4.4 Parameters of execution

Version: 5.02

Machine: SGI Origin 2000

Obstruction memory:
64 Mo
Time CPU To use: 2.42 seconds

---

5 Modeling B

5.1 Characteristics of modeling

One uses elements of plate DKT

P16
P15
Z
P

y
P
23
8
P22
P14
P
P
7
24
P
P
X
21
13
P
P10
P
P
P
9
11
P12
6
9
P
P
5
X
X
2.5 10-3
P
P
10
20
19
P1
P20
P17
P
P11
2.5 10-3
P18

P
17
P
P
2
12
19
P
P2
P
P
1
4
P
18
0.025
0.15
0.025
3
P4
front view

Cutting is done in the following way:

There is 1
element between P1 and P2

6
elements between P2 and P3

1
element between P3 and P4

1
element between P17 and P20

10 elements according to sides' parallel with y (P4 P5 for example)

2 calculations are passed:

.
in the first calculation, one establishes connections of solid body between the lines:

- P2 P7 and P17 P22

- P3 P6 and P18 P21
- P10 P15 and P20 P23
- P11 P14 and P19 P24

via the key word factor “LIAISON_COQUE” of order AFFE_CHAR_MECA.

.
in the second calculation, one establishes connections of solid body between the nodes in with respect to
above mentioned line couples via the key word factor “LIAISON_SOLIDE” of the order AFFE_CHAR_MECA.

5.2
Characteristics of the grid

A number of nodes:
242
A number of elements TRIA3:
360

5.3 Functionalities
tested

Orders

Keys
AFFE_CHAR_MECA
LIAISON_SOLIDE LIAISON_COQUE [U4.25.01]
AFFE_CARA_ELEM HULL
2
ALL
[U4.24.01]
AFFE_MATERIAU ALL

[U4.23.02]
“MECHANICAL” AFFE_MODELE
“DKT”
ALL
[U4.22.01]
DEFI_MATERIAU ELAS

[U4.23.01]
MODE_ITER_SIMULT METHOD
“TRI_DIAG”

[U4.52.01]
CALC_FREQ
OPTION
“BAND”

FREQ

NMAX_FREQ

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V2.05 booklet: Linear dynamics of the assembled structures
HI-75/01/010/A

6
Results of modeling B

The results of 2 calculations (one with LIAISON_COQUE, the other with LIAISON_SOLIDE) are identical. One will mention only calculation with LIAISON_COQUE.

6.1 Values
tested

Order of

Reference
Model reference
Aster
% difference/
experimental clean mode
elements finis*
model elements
finished
7
606.
584. ± 1%
610.2
4.5
8
760.
826. ± 1.5%
852.4
3.2
9
865.
855. ± 1.7%
864.8
1.1
10
944.
911. ± 2%
923.9
1.4
11
1113.
1113. ± 3.6%
1110.8
-0.2
12
1144.
1136. ± 4%
1179.5
3.8

**** average of 5 computer codes***

6.2 Remarks

Calculations carried out by:

MODE_ITER_SIMULT
METHOD: "TRI_DIAG"

OPTION
"BAND"
LIST_FREQ:
(1.,1200.)

DIM_SOUS_ESPACE:
12

6.3
Contents of the file results

The first 6 nonnull Eigen frequencies (clean vectors and modal parameters).

6.4 Parameters
of execution

Version: 5.02

Machine: SGI Origin 2000

Obstruction memory:
28 Mo
Time CPU To use: 8.7 seconds

7
Summary of the results

For the modeling A, the results provided by Code_Aster are in the interval of dispersion of codes which made it possible to establish the reference solution VPCS.

For modeling B, the two ways of writing the connection between the hulls give the same ones results.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
Document: V2.05.100

SDLX100 - Transitory response of a plate
with a field of pressure resulting from ENSIGHT

Summary:

The applicability of this test relates to the dynamics of the structures, and more particularly the calculation of
linear transitory response direct to a field of pressure evolving/moving in time, defined in files with format ENSIGHT. It includes/understands a modeling.

It is a question of calculating the response of an element of hull supported in its 4 nodes out of 4 stiffnesses and shock absorbers, with
a sinusoidal pressure defined in the four nodes.

This test makes it possible to validate the tools of definition of loading of pressure starting from files to the format
ENSIGHT and of calculation of direct transitory response to this loading.

The results obtained are in very good agreement with the analytical reference solution.

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HT-66/04/005/A

Code_Aster ®
Version

6.4

Titrate:
SDLX100 - Transitory response of a plate to a field of pressure
Date:
17/02/04
Author (S):
E. BOYERE Key
:
V2.05.100-A Page:
2/6

1
Problem of reference

1.1 Geometry

C
N2
K
C
N1
P
K
C
X, U
has
N3
K
C
N4
K

Plate side has = 1. m, thickness E = 1.282 E-04 m
Stiffnesses: K
Viscous depreciation: C

1.2
Material properties

Material of the plate:

E = 2.1x1011 Pa
= 0.3
= 7800 kg/m3

Comes out from linear elastic translation one-way: K = 9.8696 E+4 N/m
One-way viscous damping: C = 3.1416 N (m/s)

These values correspond to a reduced damping of 1% on the first mode of the structure.

1.3
Boundary conditions and loadings

Sinusoidal uniform pressure applied to the plate along axis X, defined by a value in the four nodes:

P= P0 sin T
= 2 F,
F = 100 Hz = first Eigen frequency of the system.

P0
= = 1N/m2 is a total force on the F0 plate = a2P = 1N
constant

1.4 Conditions
initial

Structure initially at rest.

2
Reference solution

2.1
Method of calculation used for the reference solution

The simple oscillator checks the following equation:

mu& + cu& + ku = F sin (T
)
0
with U ()
0 = 0 and u& ()
0 = 0

K
: own pulsation of the oscillator =

m

Critical damping is C
m
critical = 2.

C
The solution for a subcritical damping such as
= is:
ccritic

F
F

F
U (T) = and 0 cos (T) +
0
sin (T) - 0 cos (T)

2 K
D
2k
D

2 K
D

with
2
D = 1 -

2.2
Results of reference

Displacement according to X of the N1 point.

2.3
Uncertainty on the solution

Analytical solution.

---

3 Modeling
With

3.1
Characteristics of modeling

Element of DST hull

Discrete elements:

DISCRETE: with matrices of rigidity in translation K_T_D_N

and matrices of damping
A_T_D_N

Names of the nodes: N1, N2, N3 and N4

Loading of pressure contained in the repertory sdlx100a.ensi:

carre_m.result:

· a number of moments of definition of the pressures: 200
*· urgent of definition of the pressures: n*t (T = 2.5E-04, N =0,199)*
· name of the file containing the affected nodes of a pressure: carre_measured.geom
*· root of the names of the files containing the value of the pressures for each step of time: pressure. ****

carre_measured.geom: coordinated nodes N1, N2, N3 and N4 where the pressure is defined pression.n (pression.000 with pression.199):

*file containing the values of pressure to the 4 nodes with T = n*t.*

Direct transitory calculation:
No time used T = 1.E-4 S
Integration NEWMARK = 0.25, = 0.5

3.2
Characteristics of the grid

A number of nodes = 4
A number of meshs and type = 1 QUAD4

3.3
Functionalities tested

Orders

LIRE_RESU FORMAT "ENSIGHT"

TYPE_RESU
"EVOL_CHAR"

NOM_CHAM
"CLOSE"

AFFE_CHAR_MECA PRES_CALCULEE

AFFE_CARA_ELEM HULL
NET

DISCRETE
GROUP_NO
"K_TR_D_N"

"A_TR_D_N"

DYNA_LINE_TRAN EXCIT
CHARGE

4
Results of modeling A

4.1 Values
tested

Time (S)
Reference (m)
Aster (m) Difference
(%)
0.005 3,917E06
3.906E06
-0.28
0.015 1,139E05
1.136E05
-0.26
0.025 1,841E05
1.836E05
-0.27
0.035 2,500E05
2.493E05

-0.28
0.045 3,119E05
3.111E05
-0.25

5
Summary of the results

The results of analytical reference are found with a very good precision (less than 0.3% of variation).

Intentionally white left page.
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HT-66/04/005/A

Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
Document: V2.05.301

SDLX301 - Building with floor-columns
dissymmetrical subjected to a horizontal excitation

Summary:

Applicability: seismic calculation. Type of analysis: spectral and combinations.
A number of modelings: 1.
Description: three-dimensional study of a building with 3 floors out of 9 columns, embedded at the base of
columns, with unbalance, subjected to a horizontal seismic excitation in displacement. The distribution
offset of the masses of the floors allows to break symmetry, to couple the geometrical directions principal and to generate an effect of torsion. The values of reference are obtained with the code CASTEM 2000 and the SAMCEF software, which have slightly different methods.
The columns are modelled by beams, and the floors by elements of plane hull. Eights first clean modes are preserved for calculations of modal recombination. Objective: to test them displacements, interior efforts, and reactions to the embedding of a column for the recombinations modal CQC, SRSS, DSC. Precision of the results: comparison between codes. Strong tolerances are allowed for certain computed fields whose values are several weaker orders of magnitude.

Code_Aster ®
Version
8.0

Titrate:
SDLX301 - Dissymmetrical building subjected to a seismic excitation
Date:
26/09/05
Author (S):
F.VOLDOIRE, E.LECLERE, P.LACLERGUE, Y.PONS Key
: V2.05.301-B Page:
2/16

1
Problem of reference

This case test is inspired by the report/ratio referred to [bib1].

1.1 Geometry

The studied building is composed of 3 floors and 9 columns embedded in the floors.

Z

y
0.40 m
y
G
H
I
X
0.20 m
E
F
D
section of the columns

Section of columns A with I
: 0.20 m X 0.40m
Surface of columns A with I
: 8.00 102 m2
With

B
C
Inertias of columns A with I
: Ix = 2.667 104 m4
(in the total reference mark)

Iy = 1.066 103 m4
PFI

J =7.45 104 m4
Coefficients of reduced section
AY=AZ=1.2
Thickness of the floors
: 0.2 m
X

PFF

PFA
PFB
PFC

y
Z
B
E
H
G
H
I
PM6
3 m
PM5
Cm
4 m

PM4
D

E
F
X
3 m
PM3
4 m
PM2
With
B
C
3 m
PM1

PM0
y
4 m
4 m

Appear 1.1-a

1.2
Properties of materials

In order to obtain the centre of mass Cm, excentré compared to the geometrical center of 0,3071 m, one
material of density 2 = 1,848 1 is affected with ¼ surface of each floor (PLAN21, PLAN22

and PLAN23).

Columns and left PLAN11, PLAN21 and PLAN31 of the floors:

Young modulus:
E1 = 4,0 1010 Pa Poisson's ratio:
1 = 0,15
Density:
1 = 2500 kg/m3

Parts PLAN12, PLAN22 and PLAN32 of the floors:

Young modulus:
E2 = 4,0 1010 Pa Poisson's ratio:
2 = 0,15
Density:
2 = 4620 kg/m3
y
H
I
G
PLANi2
Cm
X
MAT2
D
E
F
MAT1
PLANi1
With
B
C
Floor n° I (groups of meshs PLANi1 and PLANi2)

Appear 1.2-a

1.3
Boundary conditions and loading

Boundary condition
The columns are embedded on the level of the foundation.

Loading

The seism is applied in direction X.
The spectrum of response of oscillators in displacement is obtained by superposition of four spectra of displacement. Each one of these spectra of displacement corresponds to the response of an oscillator to
a degree of freedom to the sinewave excitations defined in table [Table 1.3-a] Ci below:
SD (
K
F,)
4
=
I

i=
2
1

2
F
2
2
2

F
4
F
1 - I +
2
I

4
2

F
2
F
In particular, the frequencies and depreciation selected are close to the first four modes to the structure.

Frequency F (Hz)
I
Amplitude K (m)
I

Damping
sine 1
1.51
0.15
0.05
sine 2
2.05
0.25
0.05
sine 3
2.34
0.25
0.05
sine 4
4.86
0.30
0.05
Table 1.3-a

The neglected modes are represented by a pseudo-mode.
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V2.05 booklet: Linear dynamics of the assembled structures
HT-66/05/005/A

2
Reference solutions

2.1
Method of calculation used for the reference solutions

The calculations taken for reference are carried out with codes CASTEM 2000 and the SAMCEF software. The solution of reference is not given by the results of [bib1] because it missed in this reference some geometrical characteristics and of material to remake with identical the model of the structure studied. Certain data retained in this case test are thus different from those of the report/ratio [bib1], what does not allow a comparison of the results.

2.2
Results of reference

- *Frequencies calculated with CASTEM 2000 and the SAMCEF software,*
- *Spectrum of response in displacement for a damping from = 5%,*
- *Déplacements by modal recombination CQC, SRSS, DSC for the column B (calculated in taking into account the first 8 modes primarily torsion of the building and inflection of columns, but the floors are bent little),*
- *Dynamic and pseudo fashion for the static correction,*
- *Efforts with the embedding of the column B and the central column E,*
- *Interior efforts along the column B.*

2.3
Uncertainty on the solution

Comparison between codes

2.4 References
bibliographical

[1]
Mr. MONTAY: Dynamic calculation of the structures in seismic zone. Free university of Brussels, 1982.
Handbook of Validation
V2.05 booklet: Linear dynamics of the assembled structures
HT-66/05/005/A

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3 Modeling
With

3.1
Characteristics of modeling

3.2
Characteristics of the grid

The grid of the model calculated with Code_Aster consists of 3357 nodes and 3387 meshs of which 135 elements of right beam of Timoshenko (including 12 SEG2 by column, is 108 for the columns) and 3072 elements plates DKT (1024 per floor). In order to ensure the continuity of ddl DRZ of rotation clean of the beams with rotation around the normal of the plates (uninsured automatically by Code_Aster) of the elements of beams are added locally at the edge of plates DKT, with *level of the 27 connections column-floor, to ensure the transmission of rotations DRZ related to plane movement of the plate in rotation in the plan (X, y).*

The grid of the model calculated with CASTEM 2000 consists of 3765 nodes and 7368 elements including 108 elements right beam of Timoshenko and 6960 elements of hull DKT.
The grid of the model calculated with the SAMCEF software consists of 3360 nodes and 3180 elements of which
108 elements right beam of Mindlin and 3072 elements of hull of Mindlin.

3.3 Functionalities tested

Orders

COMB_SISM_MODAL COMB_MODE
“CQC”

“DSC”

“SRSS”

EXCIT
MONO_APPUI
“YES”

MODE_CORR

Titrate:
SDLX301 - Dissymmetrical building subjected to a seismic excitation
Date:
26/09/05
Author (S):
***F.VOLDOIRE**, E.LECLERE, P.LACLERGUE, Y.PONS Key*
: V2.05.301-B Page:
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4
Results of modeling A

4.1 Remarks

For a given node I, effort generalized for element I - 1 and for element I is compared
respectively in tables "low" element and "high" element.
The efforts are given in the local reference mark of the elements of beam (principal reference mark of inertia).

4.2
Calculation of the modal base

Eigen frequencies (Hz)

Mode
Code_Aster
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
1 1.512
1.512 0.036
1.495
1.11
2 2.052
2.050 0.125
2.014
1.93
3 2.365
2.343 0.916
2.291
3.24
4 4.848

4.859 0.237
4.823
0.522
5 7.488
7.521 0.448
7.415
0.99
6 8.388
8.426 0.456
8.355
0.392
7 8.547
8.543 0.037
8.438
1.30
8 15.185
15.405 1.428
15.186
0.004

Visualization: Mode n° 1;
Mode n° 3;
Mode n° 7.

Effective modal masses (kg)

Mode and Code_Aster direction
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
1 X
2,129E+01
2.300E+01
-7,451
2.070E+01
2,846
Y
1,115E+05
1.113E+05
0,127

1.102E+05
1,186
Z
5,203E02
6.698E02
-22,319
5.816E02
-10,531
2 X
9,559E+04
9.365E+04
2,068
9.294E+04
2,847
Y
1,532E+02
1.817E+02
-15,689
1.683E+02
-8,967
Z
1,002E02
1.440E02
-30,405
1.500E02
-33,186
3 X
1,063E+04
1.238E+04
-14,202
1.201E+04
-11,509
Y
4,954E+02
5.181E+02
-4,399
5.010E+02
-1,119
Z
6,074E03
9.450E03
-35,736
8.390E03

-27,609
4 X
9,222E01
9.3722E01
-1,606
8.338E01
10,599
Y
1,434E+04
1.438E+04
-0,296
1.438E+04
-0,247
Z
1,553E01
2.066E01
-24,850
1.791E01
-13,286
5 X
1,606E+04
1.582E+04
1,514
1.594E+04
0,749
Y
1,537E+01
1.751E+01
-12,252
1.491E+01
3,096
Z
3,026E02
4.386E02 31,012 4.668E02 35,178
6 X
1,829E+02
3.9466E+02
-53,662
1.901E+03
-90,380
Y
3,771E+03
3.622E+03

4,112
1.300E+03
190,089
Z
1,282E01
1.809E01
-29,145
1.336E01
-4,028

---

7 X
2,064E+03
2.1461E+03
-3,842
5.331E+02
287,105
Y
9,264E+01
2.7942E+02
-66,846
2.627E+03
-96,474
Z
1,449E02
1.222E02
18,522
2.709E02
-46,519

8 X
4,932E+03
4.948E+03
-0,346
4.974E+03
-0,851
Y
1,130E+00
1.121E+00
0,752
1.035E+00
9,143
Z
5,731E+01
1.5420E+02
-62,836
5.098E+01
12,411
Office plurality X
1,2948E+05 1,2936E+05
0,092% 1,2832E+05 0,905%
Y
1,3037E+05 1,3030E+05
0,053% 1,2919E+05 0,911%
Z
5,7706E+01 1,5473E+02
-62,706% 5,1448E+01 12,164%

Note:

The standard of error of the modes calculated by the method of Sorensen de Code_Aster is always lower at 10-9.

Note:

The total mass of the building is 132552 kg; the strong orientation according to of the modes is due to the relative one there less inertia according to there of the columns. Effective modal mass cumulated in direction X of the seism obtained by Code_Aster 97.678% of the total mass represent.

Note:

The differences between modelings and software are rather strong in direction Z, because it is little solicited in these modes.

4.3
Spectral answer - method CQC

Displacements - column B (in meter)

Altitude Z (m)
Component Code_Aster CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
PM1: 1.5
X
1.829E03
1.717E03
6.466
1.641E03
11.439
N982 Y
2.303E04
2.276E04
1.190
1.730E03
-86.686
Z
1.882E06
1.763E06
6.728
2.112E05
-91.087
PM2: 3.0
X
5.411E03
5.108E03
5.935
5.255E03
2.968
1st floor
Y
5.709E04
5.679E04
0.526

3.304E03
-82.722
N1245 Z
3.764E06
3.526E06
6.729
4.223E05
-91.087
PM3: 4.5
X
9.762E03
9.243E03
5.608
9.551E03
2.209
N1530 Y
9.277E04
9.246E04
0.331
8.594E03
-89.205
Z
4.750E06
4.452E06
6.671
5.540E05
-91.426
PM4: 6.0
X
1.409E02
1.336E02
5.462
1.381E02
2.047
2nd floor
Y
1.259E03
1.255E03
0.296
1.229E02
-89.756
N1815 Z
5.736E06

5.379E06
6.633
6.857E05
-91.634
PM5: 7.5
X
1.780E02
1.689E02
5.352
1.747E02
1.890
N2106 Y
1.486E03
1.482E03
0.224
1.539E02
-90.347
Z
6.014E06
5.642E06
6.598
7.376E05
-91.846
PM6: 9.0
X
2.085E02
1.980E02
5.319
2.057E02
1.383
3rd floor
Y
1.661E03
1.657E03
0.223
1.789E02
-90.713
N2355 Z
6.293E06
5.905E06
6.567
7.896E05
-92.029

Reaction (NR) and Moment (N.m) with the embedding of the column B (N758 node)

Reaction or Code_Aster moment
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
Fx
3.445E+04
3.325E+04
3.590
3.362E+04
2.460
Fy
1.644E+03
1.629E+03
0.916
2.265E+03
-27.405
Fz
4.015E+03
3.761E+03
6.729
5.000E+03
-19.694
MX
2.986E+03
2.975E+03
0.348
4.145E+03
-27.967
My
8.488E+04
8.135E+04
4.336
8.225E+04
3.208
Mz 1.8460E03
1.772E01
-98.958
2.165E+01
-99.99

Reaction (NR) and Moment (N.m) with the embedding of the central column E (N885 node)

Reaction or Code_Aster moment
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
Fx
5.799E+04
5341E+04
8.552
5.056E+04
14.686
Fy
2.080E+03
2.071E+03
0.428
2.849E+03
-26.994
Fz
2.471E+02
4.067E+02
-39.247
1.978E+03
-87.504
MX

3.419E+03
3.417E+03
0.044
4.728E+03
-27.691
My
1.202E+05
1.116E+05
7.705
1.074E+05
11.913
Mz
1.842E03
1.770E01
-98.959
2.591E+01
-99.99

Generalized efforts of the column B (in local reference mark)

Table “low” element (see remark [§ 4.1])

Altitude Z (m)
Component Code_Aster CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
PM1: 1.5
NR (NR)
4.015E+03
3.7618E+03
6.728
5.000E+03
-19.702
M3158 N982
Vy (NR)
1.640E+03
1.627E+03
0.770
2.260E+03
-27.445
Vz
(NR)
3.441E+04

3.323E+04
3.528
3.320E+04
3.634
MT
(N.m)
1.846E03
1.756E01
-98.949
2.160E+01
-99.99
Mfy
(N.m)
3.325E+04
3.151E+04
5.522
3.320E+04
0.154
Mfz
(N.m)
5.215E+02
5.333E+02
-2.227
7.650E+02
-31.835
PM2: 3.0
NR (NR)
4.015E+03
3.761E+03
6.727
4.999E+03
-19.689
1st floor
Vy (NR)
1.618E+03
1.610E+03
0.482
2.230E+03
-27.450
M3160 N1245
Vz (NR)
3.420E+04
3.308E+04

3.371
3.286E+04
4.073
MT
(N.m)
1.846E03
1.645E01
-98.879
2.160E+01
-99.99
Mfy
(N.m)
1.830E+04
1.824E+04
0.228
1.750E+04
4.603
Mfz
(N.m)
1.925E+03
1.891E+03
1.771
2.620E+03
-26.542
PM3: 4.5
NR (NR)
2.104E+03
1.976E+03
6.448
2.636E+03
-20.176
M3162 N1530
Vy (NR)
1.381E+03
1.368E+03
0.952
1.930E+04
-28.439
Vz
(NR)
3.061E+04
3.000E+04
2.010

2.993E+04
2.265
MT
(N.m)
1.594E03
1.402E01
-98.863
2.570E+01
-99.99
Mfy
(N.m)
1.434E+03
1.390E+03
3.161
1.440E+03
-0.385
Mfz
(N.m)
1.295E+02
1.342E+02
-3.554
1.890E+02
-31.483
PM4: 6.0
NR (NR)
2.104E+03
1.976E+03
6.450
2.636E+03
-20.187
2nd floor
Vy (NR)
1.324E+03
1.315E+03
0.618
1.850E+03
-28.458
M3164 N1815
Vz (NR)
2.993E+04
2.941E+04
1.751
2.931E+04

2.119
MT
(N.m)
1.594E03
1.049E01
-98.481
2.570E+01
-99.99
Mfy
(N.m)
4.583E+04
4.471E+04
2.480
4.430E+04
3.445
Mfz
(N.m)
2.157E+03
2.126E+03
1.456
2.990E+03
-27.858
PM5: 7.5
NR (NR)
5.956E+02
5.629E+02
5.817
7.749E+02
-23.133
M3166 N2106
Vy (NR)
7.279E+02
7.312E+02
-0.453
1.040E+03
-30.006
Vz
(NR)
1.935E+04
1.934E+04
0.039
1.934E+04
0.039

MT
(N.m)
9.470E04
6.137E02
-98.457
2.660E+01
-99.99
Mfy
(N.m)
1.234E+04
1.184E+04
4.184
1.210E+04
2.006
Mfz
(N.m)
2.511E+02
2.578E+02
-2.607
3.800E+02
-33.921

Table "high" element (see remark [§ 4.1])

Altitude Z (m)
Component Code_Aster CASTEM 2000

Variation in %
The SAMCEF software
Variation in %
PM0: 0.0
NR (NR)
4.015E+03
3.762E+03
6.729
- -
M3157 N758
Vy (NR)
1.644E+03
1.629E+03
0.928
- -
Vz
(NR)
3.444E+04
3.325E+04
3.593
- -
MT
(N.m)
1.846E03
1.770E01
-98.957
- -
Mfy
(N.m)
8.488E+04
8.135E+04
4.336
- -
Mfz
(N.m)
2.986E+02
2.975E+02
0.348
- -
PM1: 1.5
NR (NR)
4.015E+03
3.762E+03

6.728
5.000E+03
-19.702
M3159 N982
Vy (NR)
1.640E+03
1.621E+03
1.149
2.250E+03
-27.123
Vz
(NR)
3.440E+04
3.318E+04
3.683
3.300E+04
4.258
MT
(N.m)
1.846E03
1.717E01
-98.925
2.160E+01
-99.99
Mfy
(N.m)
3.325E+04
3.150E+04
5.529
3.260E+04
1.997
Mfz
(N.m)
5.215E+02
5.331E+02
-2.183
7.640E+02
-31.746
PM2: 3.0
NR (NR)
2.104E+03
1.976E+03
6.454

2.640E+03
-20.289
1st floor
Vy (NR)
1.419E+03
1.386E+03
2.319
1.950E+03
-27.233
M3161 N1245
Vz (NR)
3.103E+04
3.020E+04
2.733
3.010E+04
3.094
MT
(N.m)
1.595E03
1.540E01
-98.965
2.570E+01
-99.99
Mfy
(N.m)
4.591E+04
4.485E+04
2.354
4.500E+04
2.022
Mfz
(N.m)
1.976E+03
1.935E+03
2.095
2.730E+03
-27.610
PM3: 4.5
NR (NR)
2.104E+03
1.976E+03
6.453
2.640E+03

-20.297
M3163 N1530
Vy (NR)
1.381E+03
1.344E+03
2.739
1.900E+03
--27.309
Vz
(NR)
3.061E+04
2.974E+04
2.917
2.970E+04
3.062
MT
(N.m)
1.594E03
1.237E01
-98.712
2.570E+01
-99.99
Mfy
(N.m)
1.434E+03
1.391E+03
3.109
1.440E+03
-0.385
Mfz
(N.m)
1.295E+02
1.345E+02
-3.741
1.900E+02
-31.843
PM4: 6.0
NR (NR)
5.960E+02
5.630E+02
5.847
7.750E+02
-23.103

2nd floor
Vy (NR)
7.978E+02
7.660E+02
4.147
1.080E+03
-26.130
M3165 N1815
Vz (NR)
2.023E+04
1.976E+04
2.358
1.970E+04
2.696
MT
(N.m)
9.477E04 8.407E02 98.873
2.670E+01
-99.99
Mfy
(N.m)
1.751E+04
1.762E+04
-0.636
1.790E+04
-2.179
Mfz
(N.m)
8.967E+02
8.675E+02
3.363
1.280E+03
-29.945
PM5: 7.5
NR (NR)
5.956E+02
5.627E+02
5.842
7.750E+02
-23.143
M3167 N2106
Vy (NR)
7.279E+02

6.933E+02
4.987
9.930E+02
-26.693
Vz
(NR)
1.935E+04
1.886E+04
2.561
1.890E+04
2.360
MT
(N.m)
9.470E04 3.736E02 97.466
2.660E+01
-99.99
Mfy
(N.m)
1.234E+04
1.184E+04
4.167
1.210E+04
2.006
Mfz
(N.m)
2.511E+02
2.579E+02
-2.664
3.810E+02
-34.095

4.4
Spectral answer - method SRSS

Displacements column B (in m)

Altitude Z (m)
Component Code_Aster CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
PM1: 1.5
X
1.593E03
1.4749E03
7.998
1.40E03
13.779
N982 Y
2.767E04
2.795E04
-1.050
1.47E03
-81.179
Z
2.253E+06
2.156E06
4.469
1.95E05
-88.447
PM2: 3.0
X
4.714E03
4.386E03
7.475
4.46E03
5.707
1st floor
Y

6.854E04
6.969E04
-1.653
4.12E03
-83.364
N1245 Z
4.506E06
4.312E06
4.469
3.90E05
-88.447
PM3: 4.5
X
8.508E03
7.939E03
7.169
8.13E03
4.655
N1530 Y
1.113E03
1.133E03
-1.797
7.32E03
-84.798
Z
5.684E06
5.443E06
4.412
5.12E05
-88.898
PM4: 6.0
X
1.229E02
1.148E02
7.043
1.18E02
4.153
2nd floor
Y
1.510E03
1.538E03
-1.842
1.05E02

-85.621
N1815 Z
6.862E06
6.574E06
4.374
6.33E05
-89.159
PM5: 7.5
X
1.552E02
1.451E02
6.956
1.49E02
4.187
N2106 Y
1.780E03
1.815E03
-1.902
1.31e02
-86.410
Z
7.195E06
6.896E06
4.338
6.80E06
-89.419
PM6: 9.0
X
1.820E02
1.701E02
6.944
1.75E02
3.981
3rd floor
Y
1.990E03
2.028E03
-1.902
1.52E02
-86.908
N2355 Z
7.528E06
7.217E06

4.303
7.27E06
-89.646

Reaction (NR) and Moment (N.m) with the embedding of the column B (N758 node)

Reaction or Code_Aster moment
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
Fx
2.999E+04
2.854E+04
5.040
2.883E+04
4.006
Fy
1.977E+03
2.006E+03
-1.434
1.914E+03
3.336
Fz
4.806E+03
4.600E+03
4.468
4.254E+03
12.973
MX
3.587E+03
3.657E+03
-1.902
3.510E+03
2.203
My
7.393E+04
6.985E+04
5.830
7.011E+04
5.448
Mz
2.240E03

1.772E01
-98.736
1.989E+01
-99.99

Reaction (NR) and Moment (N.m) with the embedding of the central column E (N885 node)

Reaction or Code_Aster moment
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
Fx
5.591E+04
5.094E+04
9.754
4.797E+04
16.558
Fy
2.499E+03
2.545E+03
-1.818
2.413E+03
3.571
Fz
2.472E+02
4.068E+02
-39.240
1.972E+03
-87.462
MX
4.106E+03
4.196E+03
-2.161
4.008E+03
2.454
My
1.159E+05
1.064E+05
8.897
1.019E+05
13.769
Mz

2.236E03
1.770E01
-98.737
2.288E+01
-99.99

Generalized efforts of the column B

Table "low" element (see remark [§4.1])

Altitude Z (m)
Component Code_Aster CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
PM1: 1.5
NR (NR)
4.806E+03
4.600E+03
4.469
4.250E+03
13.082
M3158 N982
Vy (NR)
1.972E+03
2.003E+03

-1.580
1.910E+03
3.233
Vz
(NR)
2.995E+04
2.853E+04
4.979
2.830E+04
5.832
MT
(N.m)
2.240E03
1.756E01
-98.725
1.990E+01
-99.99
Mfy
(N.m)
2.898E+04
2.706E+04
7.088
2.780E+04
4.261
Mfz
(N.m)
6.254E+02
6.536E+02
-4.319
6.500E+02
-3.781
PM2: 3.0
NR (NR)
4.806E+03
4.600E+03
4.467
4.250E+03
13.078
1st floor
Vy (NR)
1.944E+03
1.980E+03
-1.839

1.890E+03
2.867
M3160 N1245
Vz (NR)
2.977E+04
2.840E+04
4.825
2.800E+04
6.326
MT
(N.m)
2.240E03
1.646E01
-98.639
1.990E+01
-99.99
Mfy
(N.m)
1.590E+04
1.566E+04
1.513
1.510E+04
5.284
Mfz
(N.m)
2.317E+03
2.334E+03
-0.746
2.200E+03
5.327
PM3: 4.5
NR (NR)
2.515E+03
2.414E+03
4.184
2.240E+03
12.268
M3162
Vy (NR)
1.664E+03
1.694E+03
-1.789
1.620E+03

2.703
Vz
(NR)
2.670E+04
2.578E+04
3.551
2.560E+04
4.291
MT
(N.m)
1.935E03
1.402E01
-98.621
2.570E+01
-99.99
Mfy
(N.m)
1.246E+03
1.152E+03
8.141
1.120E+03
11.269
Mfz
(N.m)
1.564E+02
1.656E+02
-5.535
1.600E+02
-2.217
PM4: 6.0
NR (NR)
2.514E+03
2.413E+03
4.183
2.240E+03
12.253
2nd floor
Vy (NR)
1.592E+03
1.626E+03
-2.151
1.560E+03
2.033

M3164 N1815
Vz (NR)
2.611E+04
2.528E+04
3.308
2.500E+04
4.461
MT
(N.m)
1.934E03
1.049E01
-98.156
2.570E+01
-99.99
Mfy
(N.m)
3.993E+04
3.840E+04
3.962
3.780E+04
5.635
Mfz
(N.m)
2.598E+03
2.630E+03
-1.242
2.520E+03
3.085
PM5: 7.5
NR (NR)
7.130E+02
6.904E+02
3.270
6.590E+02
8.197
M3166 N2106
Vy (NR)
8.779E+02
9.099E+02
-3.521
8.730E+02
0.564
Vz

(NR)
1.693E+04
1.663E+04
1.802
1.650E+04
2.635
MT
(N.m)
1.150E03
6.137E02
-98.128
2.500E+01
-99.99
Mfy
(N.m)
1.075E+04
1.017E+04
5.675
1.030E+04
4.382
Mfz
(N.m)
3.034E+02
3.201E+02
-5.243
3.200E+02
-5.199

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Table “high” element (see remark [§ 4.1])

Altitude Z (m)
Component Code_Aster CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
PM0: 0.0
NR (NR)
4.806E+03
4.600E+03
4.468
- -
M3157 N758
Vy (NR)
1.977E+03
2.006E+03
-1.429
- -
Vz
(NR)
2.998E+04
2.854E+04
5.043
- -
MT
(N.m)
2.240E03
1.770E01
-98.735
- -
Mfy
(N.m)
7.393E+04
6.986E+04
5.830
- -
Mfz
(N.m)
3.587E+03
3.657E+03

-1.902

- -

PM1: 1.5

NR (NR)

4.806E+03

4.600E+03

4.469

4.250E+03

13.082

M3159 N982

Vy (NR)

1.972E+03

1.995E+03

-1.176

1.900E+03

3.776

Vz

(NR)

2.995E+04

2.848E+04

5.140

2.810E+04

6.580

MT

(N.m)

2.240E03

1.717E01

-98.696

1.990E+01

-99.99

Mfy

(N.m)

2.898E+04

2.706E+04

7.096

2.780E+04

4.261

Mfz

(N.m)

6.254E+02

6.533E+02

-4.276

6.500E+02

-3.781
PM2: 3.0
NR (NR)
2.515E+03
2.414E+03
4.191
2.240E+03
12.280
1st floor
Vy (NR)
1.709E+03
1.716E+03
-0.403
1.640E+03
4.231
M3161 N1245
Vz (NR)
2.706E+04
2.595E+04
4.269
2.570E+04
5.304
MT
(N.m)
1.935E03
1.540E01
-98.744
2.570E+01
-99.99
Mfy
(N.m)
4.009E+04
3.856E+04
3.969
3.850E+04
4.131
Mfz
(N.m)
2.380E+03
2.397E+03
-0.703
2.300E+03
3.481

PM3: 4.5
NR (NR)
2.515E+03
2.413E+03
4.193
2.240E+03
12.268
M3163 N1530
Vy (NR)
1.664E+03
1.664E+03
-0.025
1.600E+03
3.987
Vz
(NR)
2.670E+04
2.555E+04
4.469
2.530E+04
5.534
MT
(N.m)
1.935E03
1.237E01
-98.437
2.570E+01
-99.99
Mfy
(N.m)
1.246E+03
1.153E+03
8.084
1.120E+03
11.269
Mfz
(N.m)
1.564E+02
1.659E+02
-5.734
1.610E+02
-2.824
PM4: 6.0

NR (NR)
7.134E+02
6.906E+02
3.299
6.590E+02
8.255
2nd floor
Vy (NR)
9.610E+02
9.506E+02
1.087
9.100E+02
5.607
M3165 N1815
Vz (NR)
1.769E+04
1.700E+04
4.099
1.680E+04
5.325
MT
(N.m)
1.150E03
8.407E02
-98.632
2.500E+01
-99.99
Mfy
(N.m)
1.537E+04
1.516E+04
1.330
1.540E+04
-0.197
Mfz
(N.m)
1.092E+03
1.1021E+03
-0.959
1.060E+03
2.974
PM5: 7.5
NR (NR)

7.130E+02
6.902E+02
3.297
6.580E+02
8.362
M3167 N2106
Vy (NR)
8.779E+02
8.644E+02
1.561
8.310E+02
5.647
Vz
(NR)
1.693E+04
1.622E+04
4.345
1.610E+04
5.174
MT
(N.m)
1.149E03
3.736E02
-96.925
2.490E+01
-99.99
Mfy
(N.m)
1.075E+04
1.017E+04
5.654
1.030E+04
4.382
Mfz
(N.m)
3.034E+02
3.202E+02
-5.282
3.210E+02
-5.494

4.5
Spectral answer - method ROSENBLUETH DSC

For this method, we used a time of 30 seconds simulation.

Displacements - column B (in m)

Altitude Z (m)
Component Code_Aster CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
PM1: 1.5
X
1.858E03
1.746E03
6.396
1.643E3
13.110
N982 Y
2.230E04
2.197E04
1.493
1.732E3
-87.124
Z
1.823E06
1.703E06

7.048
2.113E5
-91.372
PM2: 3.0
X
5.499E03
5.194E03
5.864
5.241E3
4.917
1st floor
Y
5.528E04
5.4825E04
0.827
4.845E3
-88.590
N1245 Z
3.646E06
3.406E06
7.048
4.225E5
-91.370
PM3: 4.5
X
9.919E03
9.398E03
5.534
9.560E3
3.751
N1530 Y
8.983E04
8.927E04
0.631
8.603E3
-89.558
Z
4.601E06
4.300E06
6.991
5.453E5
-91.699
PM4: 6.0

X
1.432E02
1.359E02
5.386
1.383E2
3.548
2nd floor
Y
1.219E03
1.212E03
0.596
1.23E2
-90.087
N1815 Z
5.557E06
5.195E06
6.953
6.861E5
-91.901
PM5: 7.5
X
1.808E02
1.717E02
5.273
1.748E2
3.434
N2106 Y
1.439E03
1.431E03
0.525
1.54E2
-90.657
Z
5.827E06
5.450E06
6.918
7.381E5
-92.105
PM6: 9.0
X
2.119E02
2.013E02
5.239

2.059E2
2.892
3rd floor
Y
1.609E03
1.600E03
0.524
1.79E2
-91.015
N2355 Z
6.097E06
5.704E06
6.886
7.901E5
-92.283

Reaction (NR) and Moment (N.m) with the embedding of the column B (N758 node)

Reaction or moment
Code_Aster
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
Fx
3.501E+04
3.381E+04
3.524
3.368E+04
3.938
Fy
1.592E+03
1.572E+03
1.223
2.270E+03
-29.885
Fz
3.889E+03
3.633E+03
7.050
5.007E+03
-22.330
MX

2.891E+03
2.872E+03
0.647
4.154E+03
-30.410
My
8.626E+04
8.273E+04
4.267
8.236E+04
4.738
Mz
1.787E03
1.772E01
-98.992
2.170E+01
-99.99

Reaction (NR) and Moment (N.m) with the embedding of the central column E (N885 node)

Reaction or moment
Code_Aster
CASTEM 2000
Variation in %
The SAMCEF software
Variation in %
Fx
5.827E+04
5.374E+04
8.432
5.061E+04
15.148
Fy
2.014E+03
1.999E+03
0.724
2.855E+03
-29.471
Fz
2.471E+02
4.067E+02
-39.252
1.979E+03

-87.515
MX
3.310E+03
3.298E+03
0.343
4.738E+03
-30.136
My
1.208E+05
1.122E+05
7.586
1.075E+05
12.386
Mz
1.783E03
1.770E01
-98.993
2.601E+01
-99.99

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Generalized efforts of the column B

Table "low" element (see remark paragraph [§4.1])

Altitude Z (m) Component Code_Aster CASTEM 2000 Variation in %
The SAMCEF software
Variation in %
PM1: 1.5
NR (NR)
3.889E+03
3.633E+03
7.048
5.007E+03
-22.327
Vy
(NR)
1.588E+03
1.570E+03
1.070
2.266E+03
-29.938
Vz
(NR)
3.497E+04
3.380E+04
3.461
3.325E+04
5.172
MT
(N.m)

1.786E03
1.756E01
-98.983
2.169E+01
-99.99
Mfy
(N.m)
3.378E+04
3.204E+04
5.445
3.264E+04
3.507
Mfz
(N.m)
5.050E+02
5.149E+02
-1.933
7.659E+02
-34.067
PM2: 3.0
NR (NR)
3.889E+03
3.632E+03
7.047
5.007E+03
-22.330
1st floor
Vy (NR)
1.566E+03
1.554E+03
0.785
2.235E+03
-29.911
M3160
Vz (NR)
3.476E+04
3.364E+04
3.304
3.290E+04
5.646
N1245
MT
(N.m)

1.786E03
1.646E01
-98.915
2.167E+01
-99.99
Mfy
(N.m)
1.861E+04
1.858E+04
0.181
1.752E+04
6.243
Mfz
(N.m)
1.863E+03
1.825E+03
2.075
2.623E+03
-28.960
PM3: 4.5
NR (NR)
2.039E+03
1.910E+03
6.770
2.641E+03
-22.799
M3162 N1530
Vy (NR)
1.338E+03
1.321E+03
1.255
1.934E+03
-30.834
Vz
(NR)
3.109E+04
3.050E+04
1.931
2.997E+04
3.751
MT
(N.m)
1.543E03

1.402E01
-98.900
2.573E+01
-99.99
Mfy
(N.m)
1.441E+03
1.397E+03
3.154
1.447E+03
-0.374
Mfz
(N.m)
1.253E+02
1.295E+02
-3.277
1.900E+02
-34.035
PM4: 6.0
NR (NR)
2.039E+03
1.910E+03
6.767
2.640E+03
-22.780
2nd floor
Vy (NR)
1.282E+03
1.270E+03
0.924
1.859E+03
-31.030
M3164 N1815
Vz (NR)
3.040E+04
2.990E+04
1.675
2.935E+04
3.594
MT
(N.m)
1.542E03
1.049E01

-98.53
2.573E+01
-99.99
Mfy
(N.m)
4.656E+04
4.546E+04
2.413
4.436E+04
4.969
Mfz
(N.m)
2.089E+03
2.053E+03
1.759
2.999E+03
-30.340
PM5: 7.5
NR (NR)
5.775E+02
5.441E+02
6.129
7.773E+02
-25.708
M3166 N2106
Vy (NR)
7.058E+02
7.068E+02
-0.143
1.045E+03
-32.457
Vz
(NR)
1.964E+04
1.965E+04
-0.056
1.937E+04
1.389
MT
(N.m)
9.165E04
6.137E02
-98.51

2.669E+01
-100.00
Mfy
(N.m)
1.254E+04
1.205E+04
4.116
1.210E+04
3.652
Mfz
(N.m)
2.431E+02
2.488E+02
-2.314
3.815E+02
-36.283

Table "high" element (see remark paragraph [§4.1])

Altitude Z (m)
Component Code_Aster CASTEM 2000 Variation in %
The SAMCEF software
Variation in %
PM0: 0.0
NR (NR)
3.889E+03

3.633E+03
7.050
- -
M3157 N758
Vy (NR)
1.592E+03
1.573E+03
1.229
- -
Vz
(NR)
3.501E+04
3.382E+04
3.527
- -
MT
(N.m)
1.787E03
1.770E01
-98.991
- -
Mfy
(N.m)
8.626E+04
8.273E+04
4.267
- -
Mfz
(N.m)
2.891E+03
2.872E+03
0.647
- -
PM1: 1.5
NR (NR)
3.889E+03
3.633E+03
7.048 5.007E+03
-22.327
M3159 N982
Vy (NR)
1.587E+03
1.564E+03

1.451 2.255E+03
-29.596
Vz
(NR)
3.497E+04
3.375E+04
3.620 3.306E+04
5.773
MT
(N.m)
1.786E03
1.718E01
98.96 2.168E+01
-99.99
Mfy
(N.m)
3.378E+04
3.204E+04
5.452 3.263E+04
3.539
Mfz
(N.m)
5.050E+02
5.147E+02
1.891 7.655E+02
-34.033
PM2: 3.0
NR (NR)
2.039E+03
1.910E+03
7.358 2.641E+03 22.791
M3161 N1245
Vy (NR)
1.374E+03
1.339E+03
2.625 1.374E+03 - 29.711
Vz
(NR)
3.153E+04
3.071E+04
2.659 3.017E+04 4.493
MT
(N.m)

1.543E03
1.540E01
98.99 2.572E+01
-99.99
Mfy
(N.m)
4.663E+04
4.559E+04
2.271 4.51E+04 3.363
Mfz
(N.m)
1.914E+03
1.869E+02
2.396 2.742E+03 30.190
PM3: 4.5
NR (NR)
2.039E+03
1.909E+03
6.775 2.641E+03 22.799
M3163 N1530
Vy (NR)
1.338E+03
1.298E+03
3.049 1.902E+03 29.670
Vz
(NR)
3.110E+04
3.023E+04
2.843 2.969E+04 4.734
MT
(N.m)
1.543E03
1.237E01
97.75 2.573E+01 99.99
Mfy
(N.m)
1.442E+03
1.398E+03
3.095 4.440E+04 0.110
Mfz
(N.m)
1.253E+02
1.298E+02

3.464 1.904E+02 34.174
PM4: 6.0
NR (NR)
5.778E+03
5.442E+02
6.158 7.775E+02 25.689
2nd floor
Vy (NR)
7.731E+03
7.402E+02
4.444 1.087E+03 28.875
M3165 N1815
Vz (NR)
2.054E+04
2.008E+04
2.267 1.977E+04 3.887
MT
(N.m)
9.172E04
8.407E02
98.909 2.670E+01 100.00
Mfy
(N.m)
1.776E+04
1.789E+04
0.745 1.797E+04 1.176
Mfz
(N.m)
8.696E+02
8.388E+02
3.663 1.284E+03 32.273
PM5: 7.5
NR (NR)
5.775E+02
5.440E+02
6.153 7.771E+02 25.689
M3167 N2106
Vy (NR)
7.058E+02
6.704E+02
5.279 9.968E+02 29.191
Vz
(NR)

1.964E+04
1.916E+04
2.466 1.891E+04 3.848
MT
(N.m)
9.165E04
3.736E02
97.547 2.669E+01 100.00
Mfy
(N.m)
1.254E+04
1.204E+04
4.099 1.211E+04 3.566
Mfz
(N.m)
2.431E+02
2.490E+02
2.369 3.816E+02 36.299

5
Summary of the results

Comparison with CASTEM 2000:
The variations on the Eigen frequencies calculated with CASTEM 2000 and Aster are lower than 1,4%. The double mode was separate in two close modes (6 and 7) of which one is a dominating mode according to the axis y (mode 6) and the other according to X (mode 7); the variation on the effective

modal masses (in %)
very high according to X for mode 6 and according to there for mode 7, is not relevant being given the weak one
weight of these directions in the modes considered.

The variations obtained on calculation with the spectral method, for displacements remain broadly lower than 8%, the variations on the reactions to the embedding of the columns B and E are broadly lower than 11% (without taking account of the moment of reaction according to Z), and variations on
generalized efforts remain overall lower than 7% (without taking account of the torque).
Strong tolerances are allowed for certain computed fields whose values are of several weaker orders of magnitude.

Comparison with the SAMCEF software:
The method of resolution adopted in the SAMCEF software is based on the method known as of the ground node.
This method consists in binding to a single node all the nodes which are interdependent of the foundation. It
node is affected of a mass in translation which is worth 1000 times the mass of the structure.
displacements deferred in the tables are not corrected effects of residual masses which are results also available.

The variations on the Eigen frequencies calculated with the SAMCEF software and Aster are lower than 3,2%.
type of element of hull used (deformable or not with the sharp effort) influence the result, it goes from there from
even of the smoothness of the grid of the floors. Variations on the Eigen frequencies going until 10% were observed by initially taking a coarser grid for the floors, made up of 345 nodes and 516 elements including 108 elements of right beam of Timoshenko and 408 elements hull DKT. Modes 6 and 7 represent a mode doubles of which percentage of modal mass effective 4% in the direction X and 2% in direction Y. do not exceed.

Variations obtained on calculation with the spectral method, for displacements in the direction excitation remain overall lower than 10,5%. For the reactions to the embedding of column B, these variations are overall lower than 30%. They reach 80% for the column E, however for the reaction according to axis X and the moment according to the axis y, they remain lower than 18%.
reaction of torsion of the columns is not null. Variations in connection with the efforts generalized in direction of the excitation remain overall lower than 26%. On the other hand, a different coupling between the directions of the excitation introduces important variations on the efforts into the directions transverses with the excitation.
Strong tolerances are allowed for certain computed fields whose values are of several weaker orders of magnitude.

Note:

.
the form of the function describing the spectrum in displacement strongly depends on Eigen frequencies fi for which the peaks of displacement are given. In consequence, a shift of the calculated Eigen frequencies disturbs the answer seismic in entry of the data and an effective comparison of calculations does not allow,
.
the results of generalized efforts are expressed in the local reference mark of the beams and corrected static effects.

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V2.05.302 document

SDLX302 - Fixed beam and masses concentrated subjected to a transverse random force

Summary:

A beam fixed with a concentrated mass is subjected to a random effort in the direction transverse.

This test validates, using a comparison between codes, the calculation of the clean modes of inflection and that of
displacement within the framework of a stochastic approach.

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1
Problem of reference

1.1 Geometry

F (T)
L

Length of the beam
L = 20.0 m
Internal diameter
D = 0.388 m
External diameter
D = 0.400 m
Mass concentrated at the top
M = 300. kg
Mass moment of inertia
J = 200. kg m2

1.2
Properties of materials

Density of the tube
= 7850 kg.m-3
Young modulus
E = 210. E+9 N.m-2
Poisson's ratio
= 0.

1.3
Boundary conditions and loading

The tube is embedded at the base. The mass is free. The movement is authorized in a vertical plane (DX, DRZ).

A random effort F (T), applied to the concentrated mass is compared to a random process stationary Gaussian, centered, of white vibration type to band limited of 1.Hz to 101.Hz. It is characterized
by a standard deviation F = 1 kN, and a unilateral spectral concentration in frequency S (F
F
) such as:

F [H
1 Z,
H
101 Z]
2

S (F) = F = 104 NR 2s
F
100

S (F
F)
1
101
F (Hz)

2
Reference solution

2.1
Method of calculation used for the reference solution

Calculations are carried out with 8 computer codes, for 10 modelings. The different ones modelings are presented below.

.
Castem:
20 elements of beam without shearing;
.

Dynam2D:
20 elements of beam without shearing;
•
PERMAS (1): 20 elements of beam without shearing;
•
Nastran:
20 elements of beam without shearing;
•
SYSTUS (1):
20 elements of beam without shearing;
•
ABAQUS:
20 elements of beam with shearing;
•
MECHANICA: 5 elements of beam with shearing, convergence with degree 7;
•
BEAVER:
10 elements of beam with shearing;
•
SYSTUS (2):
40 elements of beam with shearing;
•
PERMAS (2):
20 elements of beam with shearing;

Reduced damping is worth 1% on all the modes.

2.2
Results of reference

Frequencies.

Value RMS, for displacement at the loose lead of the beam.

2.3
Uncertainty on the solution

Comparison between codes.

2.4 References
bibliographical

[1]
IPSI - Day 2 .AS - Flight XVIII, n° 2. Damping in the structural analyses. June 21

---

3 Modeling
With

3.1
Characteristics of modeling

y
X

Along the beam, we have DY = DZ = DRX = DRY = 0.
At the base, all the ddls are blocked.

3.2
Characteristics of the grid

The grid consists of 21 nodes and 20 elements Timoshenko beam.

3.3
Functionalities tested

Orders

DEFI_FONCTION

DEFI_INTER_SPEC PAR_FONCTION

DYNA_ALEA_MODAL EXCIT
INTERSPECTRE

CHAM_NO

ANSWER

REST_SPEC_PHYS

POST_DYNA_ALEA GAUSS

4
Results of modeling A

4.1 Values

tested

Eigen frequencies of inflection

Number

mode 1 2 3 4 5 6 7 8 9 10
Castem 0.70
5.04
14.69
28.78
46.19 66.82 92.74 125.15 163.91 208.81
DYNAM2D/DRAM 0.70 5.04 14.67
28.75 46.18 66.86 92.77 125.05 163.38 208.81
PERMAS (1)
0.70
5.04
14.69
28.78
46.19 66.82 92.74 125.15 163.91 208.81
Nastran 0.70
5.04
14.67
28.75
46.18 66.86 92.78 125.05 163.48 207.70
SYSTUS (1)
0.72
5.13
14.91
29.19
46.83 67.65 93.64 125.95 164.39 208.61
ABAQUS 0.70
5.02
14.57
28.42
45.40 65.17 89.26 118.50 152.33

MECHANICA 0.70
5.03
14.62
28.54
45.63 65.60 90.21 120.43 155.88 196.01
BEAVER 0.70
5.03

14.59
28.46
45.48 65.35 89.88 120.24 154.40 194.06
SYSTUS
(2)
0.70
5.03
14.59
28.42
45.35

PERMAS (2)
0.70
5.03
14.60
28.48 45.50 65.29 89.59 119.41 138.42

Average values
0.70
5.04
14.66
28.66 45.89 66.27 91.51 122.77 157.79 204.69
ASTER 0.70
5.03
14.59
28.43
45.38 65.07 89.17 118.67 153.24 192.40
Variation Aster
0.00 0.26 0.48 0.79 1.12 1.81 2.56 3.34 2.88 6.00
Average values

in %

Displacement (m): with Fx = 1000

PERMAS PERMAS SYSTUS

Value
Variation (%) Value
CASTEM DYNAM2D
(1)
(2)
(1)
Average ABAQUS ASTER moyenne/ASTER
0.039 0.038 0.041 0.038 0.035 0.039 0.038 0.0344
-9.4

4.2 Remarks

Problems of definition between effort intern and forced do not allow to compare them results of ASTER with the other codes (bending moment and sharp effort).

4.3 Parameters of execution

Version: 5.02

Machine: SGI ORIGIN 2000

Obstruction memory:
16 MW
Time CPU To use:
5.98 seconds
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5
Summary of the results

The results of the modal base are good since the maximum change is to the maximum of 6% on last frequency.

For the results in displacement we obtain a variation of 9.4.

Titrate:
Harmonic SHLL100 Response of a bar per under-structuring
Date:
29/05/96
Author (S):
G. ROUSSEAU, C. VARE Key
:
V2.06.100-A Page:
1/6

Organization (S): EDF/EP/AMV

Handbook of Validation
V2.06 booklet: Harmonic response of the linear structures
Document: V2.06.100

SHLL100 - Harmonic response of a bar by dynamic under-structuring

Summary:

The applicability of this test relates to the dynamics of the structures, and more particularly the calculation of harmonic response by dynamic under-structuring.

It is a question of calculating the harmonic response in traction and compression of a embed-free beam modelled by elements of the type "bars". The modelled structure is deadened (damping of Rayleigh by elements).

The results of reference result from a direct harmonic calculation. This test thus makes it possible to validate the tools of calculations of harmonic response per under-structuring established in Code_Aster and more particularly:

- *the catch in depreciation account by element,*
- *the calculation of the second member including the harmonic loading,*
- *restitution of the harmonic response on a grid skeleton, including the fields of displacement, speed and of acceleration.*

1
Problem of reference

1.1 Geometry

ep
With
F
X
D
L

L = 1 m

D = 0,2 m - circular Section

1.2
Material properties

E = 1.1010 Pa

= 0.3

= 1.104 kg/m3

Damping of Rayleigh per element: = 0.1
E
E = 0.1

1.3
Boundary conditions and loadings

Embedding in end a: U (0) = N (0) = W (0) = 0.

For any point M (X): N (0) = W (0) = 0.

Harmonic loading in time, at the loose lead:

.
orientation: according to X,
.
amplitude: 100 NR,
.
frequency: 100 Hz.

1.4 Conditions
initial

Without object for a harmonic calculation of answer.

2
Reference solution

2.1
Method of calculation used for the reference solution

There is an analytical solution detailed in the reference [bib2].

Let us use the following notations:

E
: Young modulus
L
: length of the bar
With
: section of the bar
NR
: normal effort directed according to axis X
,
: damping coefficients of Rayleigh

: frequency
of excitation

and let us pose

1 + 2
/2

R =
1 + 2 2

p
1 -
1 -
K = p+ iq =
R
+ I r+

2nd
1 + 2 2

1 + 2 2

Displacement in a point M (X) unspecified is given by:

(
NR
1
shpxcosqx+ ichpxsinqx
V X) =

EA (p+ iq) (1+ I) chLcosqL+ ishpLsinqL

Displacement (m)
Speed (m/s)
Acceleration (m/s2)
Real part
-7.00 10-11 -3.18
10-6 2.76
10-5
Imaginary part
5.07 10-9 -4.40
10-8 -2.00
10-3

2.2
Results of reference

Fields of displacement, speed and acceleration of the loose lead of the bar.

2.3
Uncertainty on the solution

Numerical solution.

2.4 References
bibliographical

[1] T.
KERBER
"harmonic Under-structuring in Code_Aster", Report/ratio EDF,
HP-61/93-104.
[2]
G. ROBERT, analytical Solutions in dynamics of the structures, Report/ratio Samtech n°121,
March 1996.
[3]
P. RICHARD, Methods of under-structuring in Code_Aster, Internal report
EDF-DER, HP-61/92-149.
Handbook of Validation

3 Modeling With

3.1 Characteristics of modeling

F
L/2
L/2

The bar is cut out in 2 parts of equal size. Each substructure considered is with a grid in segments to which are affected elements "bars".

The structure is studied using the method of the harmonic under-structuring with interfaces of HARMONIC type CRAIG-BAMPTON.

The modal base used is made up of 4 clean modes for the substructure of right-hand side, of 5 clean modes for the substructure of left to which are added the constrained modes harmonics associated with the interfaces (calculated to 300 Hz. This value of the pulsation does not have any influence on the result, it is arbitrary [bib3]).

3.2 Functionalities tested

Orders

Keys
DEFI_INTERF_DYNA INTERFACES
TYPE
“CB_HARMO” [U4.55.03]
DEFI_INTERF_DYNA FREQ
300

[U4.55.03]
MACR_ELEM_DYNA OPTION
“TRADITIONAL”

[U4.55.05]
MACR_ELEM_DYNA MATR_AMOR

[U4.55.05]
ASSE_MATR_GENE OPTION
AMOR_GENE
[U4.55.08]
ASSE_VECT_GENE NUME_DDL_GENE

[U4.55.09]
ASSE_VECT_GENE CHAR_SOUS_STRUC
SOUS_STRUC

[U4.55.09]
ASSE_VECT_GENE CHAR_SOUS_STRUC
VECT_ASSE
[U4.55.09]

3.3
Characteristics of the grid

A number of nodes: 5

A number of meshs and types: 5 SEG 2

4
Results of modeling A

4.1 Values tested

Displacement (m)

Reference	***Aster***	***% difference***	***Tolerance***
Real part			
-7.00 10-11	*-7.00 10-11*	*-0.007*	*2.10-3*
Imaginary part			
5.07 10-9	*5.07 10-9*	*-0.097*	*2.10-3*

Speed (m/s)

Real part
-3.18 10-6 -3.18

10-6
-0.078
2.10-3
Imaginary part
-4.40 10-8 -4.40
10-8
0.033
2.10-3

Acceleration
(m/s2)

Real part
2.76 10-5 2.76
10-5
0.133
2.10-3
Imaginary part
-2.00 10-3 -2.00
10-3
-0.019
2.10-3

4.2 Parameters
of execution

Version: STA3.0.9
Machine: CRAY C90

System:
UNICOS 6.0
Obstruction memory:
8 megawords
Time CPU To use:
8.6 seconds

5
Summary of the results

Precision on the complex co-ordinates of the fields of displacement speed and acceleration is lower than 0,1%.

This test thus validates the operators of harmonic under-structuring.

Handbook of Validation
V2.06 booklet: Harmonic response of the linear structures
Document: V2.06.101
SHLL101 - Right beam. Analyze harmonic

Summary:
This two-dimensional problem consists in calculating the efforts present in a beam subjected to a

traction or
with an inflection during a harmonic analysis. The reference solution is obtained starting from the equations
discretized.
This test comprises two modelings.
For the first modeling, four requests are tested:
· force of traction,
· force of traction and material presenting a damping,
· strength flexural,
· strength flexural and material presenting a damping.
For the second modeling, two requests are tested:
· force of traction,
· force of traction and material presenting a damping.
The second modeling makes it possible to test the complex loadings imposed by the order
AFFE_CHAR_MECA_C.

1
Problem of reference
1.1 Geometry

y
y
y, v

X, U
With
B
X
Z

The geometrical characteristics of the beam constituting the mechanical model are as follows:
Length: L = 10 m
Cross section
Surface
IZ = IY
JX
3.439 103 m2
1.377 105 m4
2.754 105 m4
The co-ordinates (in meters) of the points characteristic of the beam are:
With
B
X
0.
10.
y
0.
0.

1.2
Material properties

The properties of material constituting the beam are:
E = 1.658 1010 Pa
= 0.3
= 1.3404106 104 kg/m3
= Amor_alpha = 0.001
= Amor_beta = 0.

1.3
Boundary conditions and loadings

The boundary condition which characterizes this problem is the embedding of point A and is written:
U = v = 0.
= 0.
For the loading one a:
Fx = 3000. NR
Fy = Fz = 0.
(tractive effort)
Fx = 0.
Fy = 3000. NR
Fz = 0.
(bending stress)

2 *Reference solution*

2.1 *Method of calculation used for the reference solution*

If the beam is modelled by a beam of Euler-Bernoulli and only one finite element, the problem harmonic can be written in the following way:

problem in traction:

(
ES
SL
1+ I)
(
U
)
2
B -
(
U
)
B = F ()
B
L
6
X
from where
(
F B
U
)
( )
B = ES

2
-
SL

+
ES
I
L
6
L
problem in inflection:

13L
-
2
11L

- L

12th I 1

y
2
v ()
B
F ()

B
y

- 2 35
210

+ (1+ I)

2

=

-

2
3
11 L
L

3
L
- L
L ()

B
0

210
105
2
3

Note:
If the material does not present damping, one has then: Amor_alpha = = 0.
The efforts at the point B are calculated in the following way:
problem in traction:
ES
2 SL
NR ()
B =
-
(
U
)
B

L
6
problem in inflection:

13L
-11L2

- L

12
1

VY ()
B
E I

2

y
v ()
B

= - 2 35
210

+

2

MFZ ()
B

-11L2
L3

L3
- L
L ()
B

210
105
2
3

One analytically solves the systems 2 X 2 to obtain the solution.

2.2

Results of reference

The results of reference are displacements, speeds, accelerations and the efforts generalized obtained at the point B during the harmonic analysis.

2.3

Notice for modeling B

For modeling B, one wants to test the problem in traction in the case of key word FORCE_POUTRE who allows to apply efforts distributed. To obtain the same solution as the beam subjected to nodal force in its end, the relation between the effort distributed constant and the nodal force is:

F L
F ()
B =
X
2

With the values given to the 1.3, one a: F = 600 N/m

2.4

Uncertainty on the solution

If the assumptions are checked (beam of Euler-Bernoulli), the solution is analytical.

2.5 References
bibliographical

[1]
Reference material of Code_Aster: Elements of beams "exact" (right and curves) - [R3.08.01].

---

3 Modeling
With

3.1
Characteristics of modeling

y, v
With
B
X, U

The beam consists of only one mesh.
The modeling used for the beam is that of Euler-Bernoulli (POU_D_E).
End A is embedded:
DX = DY = DZ = 0.
DRX = DRY = DRZ = 0.

3.2
Characteristics of the grid

A number of nodes: 2
A number of meshs and types: 1 mesh of the type SEG 2
The points characteristic of the grid are as follows:
Not A = A
Not B = B

3.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
BEAM
"GENERAL"
ALL

[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
NODE
[U4.25.01]
FORCE_NODALE
NODE
FX
FY
DEFI_MATERIAU
ELAS
E, RHO, NAKED
[U4.23.01]
AMOR_ALPHA
AMOR_BETA
CALC_MATR_ELEM
OPTION
“MASS_MECA”
[U4.41.01]
'AMOR_MECA
“RIGI_MECA”
CALC_VECT_ELEM
OPTION
“CHAR_MECA”
[U4.41.02]
DYNA_LINE_HARM
MATR_MASS
[U4.54.02]
MATR_RIGI
MATR_AMOR
EXCIT
VECT_ASSE
CALC_ELEM
OPTION
“EFGE_ELNO_DEPL”
[U4.61.02]
Handbook of Validation
V2.06 booklet: Harmonic response of the linear structures
HI-75/98/040 - Ind A

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4 Results of modeling A

4.1 Values tested (reality-imaginary form)

Problem 1: traction

Not/Size			**Reference**	**Aster**	**% difference**
displacement	B	DX	(5.318 10-5, 0.)	(5.318 10-5, 0.)	0.
speed	B	DX	(0., 3.341 10-3)	(0., 3.341 10-3)	0.
acceleration	B	DX	(-2.099 10-1, 0.)	(-2.099 10-1, 0.)	0.
generalized effort	B	NR	(3000., 0.)		

(3000., 0.)
0.
Problem 2: inflection
Not/Size
Reference
Aster
% difference
displacement
B
DY
(1.828 10-2, 0.)
(1.828 10-2, 0.)
0.
DRZ (1.82 102, 0.)
(1.82 10-2, 0.)
0.
speed
B
DY
(0., 1.1489)
(0., 1.1489)
0.
DRZ (0. , 1.1438)
(0., 1.1438)
0.
acceleration
B
DY
(-7.219 10-1)
(-7.219 10-1, 0.)
0.
DRZ (7.186 101, 0.)
(-7.186 10-1, 0.)
0.
generalized effort
B
VY
(3000., 0.)
(3000., 0.)
0.
MFZ (0. , 0.)
(-1.164 10-10, 0.)
0.

Problem 3: traction + damping
Not/Size
Reference
Aster
% diff
displacement
B D
(5.296 10-5, -3.363 10-3)
(5.296 10-5, -3.363 10-3)
0.
X
speed
B D
(2.113 10-4, 3.327 10-3)
(2.113 10-4, 3.327 10-3)
0.
X
acceleration
B D
(-2.091 10-1, 1.327 10-2)
(-2.091 10-1, 1.327 10-2)
0.
X
generalized effort
B NR
(2.987 103, -1.8975 102)
(2.987 103, -1.8975 102)
0.
Problem 4: inflection + damping
Not/Size
Reference
Aster
%
diff
displacement
B DY
(1.746 10-2, -4.469 10-3)
(1.746 10-2, -4.469 10-3)
0.
DRZ (1.757 102, 3.402 103)
(1.757 10-2, -3.402 10-3)
0.
speed

B DY
(2.808 10-1, 1.097)
(2.808 10-1, 1.097)
0.
DRZ (2.138 101, 1.104)
(2.138 10-1, 1.104)
0.
acceleration
B DY
(-6.895 10-1, 1.764 10-1)
(-6.895 10-1, 1.764 10-1)
0.
DRZ (6.94 101, 1.343 101)
(-6.94 10-1, 1.343 10-1)
0.
generalized effort
B VY
(3.021 103, 1.212 102)
(3.021 103, 1.212 102)
0.
MFZ (1.567 102, 8.583 102)
(-1.567 102, -8.583 102)
0.

4.2 Parameters of execution

Version: NEW 3.06
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
5.9 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

y, v
With
B
X, U
The beam consists of only one mesh.
The modeling used for the beam is that of Euler-Bernoulli (POU_D_E).
End A is embedded:
DX = DY = DZ = 0.
DRX = DRY = DRZ = 0.

5.2
Characteristics of the grid

A number of nodes: 2
A number of meshs and types: 1 mesh of the type SEG 2
The points characteristic of the grid are as follows:
Not A = A
Not B = B

5.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
BEAM
“GENERAL”
ALL
[U4.24.01]
AFFE_CHAR_MECA_C
DDL_IMPO
NODE
[U4.25.01]
FORCE_POUTRE
NODE
FX
DEFI_MATERIAU
ELAS
E, Rho, Naked

[U4.23.01]
Amor_alpha
Amor_Beta
CALC_MATR_ELEM
OPTION
“MASS_MECA”
[U4.41.01]
'AMOR_MECA
“RIGI_MECA”
DYNA_LINE_HARM
MATR_MASS
[U4.54.02]
MATR_RIGI
MATR_AMOR
EXCIT
CHARGE
FONC_MULT_C
CALC_ELEM
OPTION
“EFGE_ELNO_DEPL”
[U4.61.02]
EXCIT
CHARGE
FONC_MULT_C

6
Results of modeling B
6.1

Values tested (reality-imaginary form)
Problem 1: traction (effort distributed real: null imaginary part)

Not/Size	Reference	Aster	% difference
displacement B DX	(5.318 10-5, 0.)	(5.318 10-5, 0.)	0.
speed B DX	(0., 3.341 10-3)	(0., 3.3414 10-3)	0.
acceleration B DX	(-2.099 10-1, 0.)	(-2.0994 10-1, 0.)	0.
generalized effort B NR	(3000., 0.)	(3000., 0.)	0.

Problem 2: traction (effort distributed complex: null rélle part)

Not/Size	Reference	Aster	% difference
displacement B DX	(0., 5.318 10-5)	(0., 5.318 10-5)	0.
speed B			

DX
(-3.341 10-3 , 0.)
(-3.3414 10-3 ,0.)
0.
acceleration
B
DX
(0., -2.099 10-1)
(0., -2.0994 10-1)
0.
generalized effort
B
NR
(0., 3000.)
(0., 3000.)
0.
Problem 3: traction + damping (effort distributed real: null imaginary part)
Not/Size
Reference
Aster
% diff
displacement
B
DX
(5.296 10-5, -3.363 10-3)
(5.2966 10-5, -3.3637 10-3)
0.
speed
B
DX
(2.113 10-4, 3.327 10-3)
(2.1135 10-4, 3.3279 10-3)
0.
acceleration
B
DX
(-2.091 10-1, 1.327 10-2)
(-2.091 10-1, 1.3279 10-2)
0.
generalized effort
B
NR
(2.9879 103, -1.897 102)

(2.987 103, -1.8975 102)
0.
Problem 4: inflection + damping (effort distributed complex: null real part)

Not/Size			Reference	Aster	% diff
displacement	B	DX	(3.363 10-3 , 5.296 10-5)	(5.296 10-5, -3.363 10-3)	0.
speed	B	DX	(-3.327 10-3 , 2.113 10-4)	(-3.3279 10-3 , 2.1135 10-4)	0.
acceleration	B	DX	(-1.327 10-2, -2.091 10-1)	(-1.3279 10-2, -2.091 10-1)	0.
generalized effort	B	NR	(1.897 102 , 2.9879 103)	(1.8975 102 , 2.98794 103)	0.

When the effort distributed is applied as an imaginary part of the loading, the reference solution is obtained from that of real modeling A while exchanging left and imaginary part and in changing the sign of the new real parts.

6.2 Parameters of execution

Version: NEW 4.03
Machine: CRAY C90
Obstruction memory: 16 MW
Time CPU To use: 7.9 seconds

7

Summary of the results
The analytical results well are found.
Handbook of Validation
V2.06 booklet: Harmonic response of the linear structures
HI-75/98/040 - Ind A

Code_Aster ®
Version
8.1

Titrate:
SHLS200 - Nonparametric probabilistic model in harmonic
Date:
04/05/06
Author (S):
***S. CAMBIER**, A. BATOU Key*
:
V2.06.200-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V2.06 booklet: Harmonic response of a linear system
Document: V2.06.200

SHLS200 - Nonparametric probabilistic model:
Harmonic response of a under-structured plate

Summary:

This case-test treats taking into account of random uncertainties for the calculation of a harmonic answer by
under-structuring of the type Craig Bampton. We take again here an example of the literature made up of one
plate supported at its ends.
The functionality of operator GENE_MATR_ALEA consisting in is tested taking for entering concept one
concept macr_elem_dyna of a given substructure and to produce a random macr_elem_dyna (mass,
stiffness and damping). The concepts macr_elem_dyna random products then make it possible to calculate
for example the field of confidence of the harmonic response of the plate.

1
Problem of reference

1.1 Geometry

Springs

charge

1
2

0.5m
Z
y

Specific masses
X

0.6m
0.4m

The model is a thin section thickness 0.4 10-3 m rectangular separate in two substructures including/understanding each one a concentrated mass.

1.2
Material properties

The materials is homogeneous and isotropic.

Mass density: 7800 kg/m3,
11
Young modulus: 2.1 10 N/m2

Concentrated stiffness: 2.388 107 N/m,
Coordinated stiffnesses concentrate: (0.28, 0.22), (0.54, 0.33) and (0.83, 0.44),

Mass concentrated: 3 kg for substructure 1 and 4 kg for substructure 2,
Coordinated masses concentrate: (0.4, 0.2) and (0.75, 0.35).

Damping
The matrix of damping [D] is defined as being a linear combination of the matrices averages of mass [M] and stiffness [K]:
2maxmin

2
[D] =a [M] + B [K] with A =
and
B =
,
max + min
max + min

where =0.04, min=5.2 rad/s and max=212.8 rad/s.

1.3
Boundary conditions and loadings

The flexbeam is in simple support on its four edges.

Substructure 1 is subjected to an effort external with the item (0.24, 0.24) equal to 1N on the tape of analysis [0, 2 .100] rad/s according to direction Z and null on other DDLs and for the others frequencies.

1.4 Conditions
initial

The dynamic system is initially at rest.

2
Reference solution

2.1
Method of calculation used for the reference solution

The method used is the method published in particular in [bib1] (cf [§2.3]). Uncertainties random of the dynamic system are modelled by using the probabilistic model said not parametric of uncertainties due to Soize (cf [bib1]). Statistics on the harmonic answer of linear dynamic system are obtained by the method of Monte Carlo. The procedure is identical with that presented to [§ 3.3], but developed under Matlab.
In the standard commodity, 500 pullings are carried out and the envelopes lower and higher of these 500 pullings are presented.

2.2
Results of reference

The ddls of observation correspond to direction DZ of the node of co-ordinates (0.39, 0.31) for first substructure and of the node of co-ordinates (0.79, 0.24) for the second substructure.
The results of reference are given in the form of the graphs below drawn from [bib1].

Node (0.39, 0.31), DZ
Node (0.79, 0.24), DZ

Inter-quantiles fields (milked thin) of displacements to the ddls of observation
Results of reference
(the fatty features are approximations, not used here for the comparison)

2.3 Reference
bibliographical

[1]
C. SOIZE and H. CHEBLI: "Random Uncertainties Model in Dynamic Substructuring Using has Nonparametric Probabilistic Model, ASCE Newspaper of Engineering Mechanics, 0733-9399(2003)129:4(449).
Handbook of validation
V2.06 booklet: Harmonic response of a linear system
HT-62/06/005/A

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3 Modeling With

3.1 Characteristics of modeling

Modeling: DKT

The average model with the finite elements of the plate consists of a regular rectangular grid whose step is constant and is worth 0.01m in the directions X1 and X2. Consequently, all elements stop are identical and each one is an element plates with 4 nodes.

Modeling: DIS_T

The concentrated masses and the concentrated stiffness are modelled by elements DIST_T.

3.2 Characteristics of the grid

The average model finite elements comprises 14849 active degrees of freedom, including 8840 for substructure, 1, 5860 for substructure 2 and 149 for the interface.

A number of degrees of freedom: 8840+5860+149
A number of finite elements: 6000 QUA4 et3 DIS_T

3.3 Method of calculation

Small-scale model

As for the reference, we take for each substructure 20 modes in order to have good convergence of the calculated response with respect to the number of modes.

Achievements of the random matrices of the nonparametric probabilistic model by under structure

For each under structures, reduced matrices of masses, stiffnesses and dissipation of model means are replaced by achievements of the random matrices of mass, stiffnesses and of dissipation according to the nonparametric probabilistic model. For that, we use the generator random matrices GENE_MATR_ALEA which generates a concept macr_elem_dyna from one macr_elem_dyna average.

One can thus allot to each substructure a level of uncertainty by fixing the parameters of dispersion for each substructure. We fixed them at 0.1 for each matrix of masses, of stiffnesses and generalized damping and for each substructure.

Resolution of the probabilistic linear dynamic system.

Operator DYNA_LINE_HARM is used to build the harmonic response of the plate for each random realization of the matrices of mass, stiffness and dissipation.

The frequential interval of the study is B= [0,100] Hz, with a step of 0.5 Hz.

Construction of the statistical estimates*.*

After each call to DYNA_LINE_HARM, we have a realization of the fields of displacement. With each pulling (iteration of Monte Carlo) we build the statistical estimates with the assistance only of operator CALC_FONCTION and key words WRAPS, POWER and COMB.

5/6

3.4 Functionalities tested

Orders

GENE_MATR_ALEA

The functionality tested of GENE_MATR_ALEA is the possibility of producing a concept of the type macr_elem_dyna starting from an other concept of the macr_elem_dyna type.

3.5 Sizes tested and results

The initial validity of the case test was established by graphic comparison with the bibliographical reference data in [§2.2]. The answers are calculated into 1 point for each substructure; these points have for co-ordinates: (0.39, 0.31) and (0.79, 0.24).

As for the reference, the envelopes lower and higher of 500 pullings are calculated. For each frequency, the inter-quantile field corresponding corresponds, for example with a level of confidence of 0.95, with a probability of 0.994 for the maximum value and 0.006 for the value minimal.

The results obtained with Code_Aster are represented on the curves below:

Node (0.39, 0.31), DZ
Node (0.79, 0.24), DZ

Fatty features: inter-quantiles fields of displacements to the ddls of observation
(thin features: averages)
Code_Aster results

One tests the following values in nonregression (cf comments):

Statistics on the values in displacement with 30Hz with the ddl of observation of the first substructure

Parameters	References	Aster	% Difference
Higher envelope	6.7338296870618D-05	6.7338296870618D-05	0
Lower envelope	5.1116761251425D-05	5.1116761251425D-05	0
Estimate of the average	6.0802671417375D-05	6.0802671417375D-05	0
Estimate of the moment of order 2	3.7457833680156D-09	3.7457833680156D-09	0

Statistics on the values in displacement with 30Hz with the ddl of observation of the second substructure

Parameters	References	Aster	% Difference
Higher envelope	4.3459496115461D-04	4.3459496115461D-04	

0
Lower envelope
2.8511128677169D-04
2.8511128677169D-04
0
Estimate of the average
3.5186242151806D-04
3.5186242151806D-04
0
Estimate of the moment
1.2765909447885D-07 1.2765909447885D-07
0
of order 2

3.6 Comments

The various statistical estimates are not converged here. Only 3 simulations of Monte Carlo were made drastiquement to reduce time CPU of the case test. Convergences having been validated on the study supplements (after convergence, the statistical estimates calculated with to start from Code_Aster correspond to the results given by the cf graphs, standard commodity), case test is satisfied with nonthe regression.

4
Summary of the results

The results obtained are completely in conformity with those of the bibliographical reference [§2.2] obtained entirely in Matlab.

20/09/99
Author (S):
X. DESROCHES
Key:
V2.07.100-C Page:
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Organization (S): EDF/IMA/MMN
Handbook of Validation
V2.07 booklet: Harmonic response of the voluminal structures
V2.07.100 document
SHLV 100 - Harmonic response of a cylinder
hollow in plane deformations
Summary:
This axisymmetric three-dimensional test makes it possible to validate calculations of the matrices of rigidity, mass and of
vectors of pressure on all the elements 3D and 2D plane and axisymmetric deformations (10 modelings).
Displacements are imposed:
· is by ddl,
· is by face of element.
For four modelings 3D, the pressures applied are provided with the minus sign, because the faces elements 3D are badly directed in the files of grid used.

---

1 Problem of reference

1.1 Geometry

y
R
F
E

C
45°
D
P
With
B
Z
face blocked according to Z
X
face blocked according to Z
internal ray has = 0.1 m
external ray B = 0.2 m
Co-ordinates of the points:
With
B
C
D
E
F
X
0.100
0.200
0.1 COS (22.5)
0.2 COS (22.5)

2/2
2
y
0.
0.
0.1 SIN (22.5)
0.2 SIN (22.5)
2/2
2
Z
0.
0.
0.
0.
0.
0.

1.2 Material properties

E = 26 N/m2
= 0.3
= 35 Kg/m3
The very low value of the Young modulus does not have anything physics.

1.3 Boundary conditions and loadings

Pressure interns P = p E jt
with p = 1 Mpa
and
= 0.2 rad/s

1.4 Initial conditions

· without initial conditions,
· direct calculation of the harmonic solution.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

U = A J
+
=
=
R
1 (*K*
R
L
) *B Y1* (*K rL*)
U
U

Z
0

=
1
1
2 µ *K*
With
2
2
- 1
-
+
2
2
-

rr
L
(
) *J0* (*K R*
L
)
J1 (*K R*
L

) *B*
Y0 (*K R*
L
)
Y1 (*K R*
L
)

K R
K R

L

L

=
1
1
2 µ *K*
With

2
2
- 1
+
+
2
2

+

L
(
) *J0* (*K R*
L
)

J1 (*K R*
L
) *B*
Y0 (*K R*
L
)
Y1 (*K R*
L
)

K R
K R

L

L

= 2 µ
2
zz
K L (
2
-) 1 [*A J0* (*kL R*) + *B Y0* (*kL R*)]

= = =

R
rz
Z
0
+ µ
1 -
1

with: 2
2
=
=
K

4 µ
2 (
=
=
=
1 -)
L
2
C
+
4
2 µ
L
J, *J*, *Y*, *Y*
: Functions of Bessel.
1
0
1
0
Constant *A* and *B* are calculated by solving the linear system obtained while writing:
(A) = - *p*
(*b)* =
rr
rr
0
One obtains:
-3
-3
for *R* = 0.1 *U* = 7 3398
.
10
for *R* = 0.2
U =
R
R
4 6816
.
10
= 1
=
rr
rr

0.

= 16685
.

= 0 66738
.

= 0 20055
.
=
zz
zz
0 20031
.
Passage in the system of Cartesian axes:
= cos2 + sin2 - 2 sin cos
xx
rr

R
= sin2 + cos2 + 2 sin cos
yy
rr

R
= sin cos - sin cos - 2
cos2
-
2
xy
rr

R (
sin)
with
= 0° at points A and B =
°
22.5 at the points C and D
= °
45 at the points E and F

2.2 Results of reference

(, , ,

xx
yy
zz
xy)
Displacements (U, v) and forced
at the points A, B, C, D, E, F.

2.3 Uncertainty on the solution

Precision of the calculation of the Functions of Bessel.

2.4 Bibliographical references

[1] Mr. BONNET: Methods of the integral equations regularized into elastodynamic - Bulletin DER - Series C - N°1/2 - (1987).
[2] ERINGEN - SUHUBI - Elastodynamics, Vol.2: linear theory Academic Press (1975).

---

3 Modeling A

3.1 Characteristics of modeling

Elements 3D (PENTA6 and HEXA8) (resulting from the grid 2D below).
F
Normally blocked face
y
D
E
C
45°
X
With
B
Face with imposed pressure
Face blocked out of Dy

along axis Z: 2 layers of elements total thickness: 0.01
Limiting conditions:
DDL_IMPO:
(All: “yes”
Dz: 0.)
face AB
(Group_no: BordAB
Dy: 0.)
face EF
FACE_IMPO:
(Group_ma: FaceEF
Dnor: 0.)
pressure on face AE
PRES_REP:
(Group_ma: FaceAE
Near: -1.)
Names of the nodes:
A=No1
B=No119
C=No36
D=No166
E=No41
F=No171

3.2 Characteristics of the grid

A number of nodes: 513
A number of meshs and types: 400 PENTA6 100 HEXA8 40 QUAD4

3.3 Functionalities tested

Orders

Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”

"3D"
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
"SIGM_ELNO_DEPL"
[U4.61.01]

3.4 Remarks

The pressure has a negative sign (instead of positive) because the faces of the elements 3D are badly directed.

---

4 Results of modeling A

4.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3243 103
0.21
102

With
v
0.
eps
-

0.2
xx
-1.
0.8789
12.1
yy
1.6685
1.6241
2.66
zz
0.20055
0.2235
11.75

0.2
xy
0.
0.0922
-
U
6.78109 103
6.7670 103
0.21
102
C
v
2.80882 103
2.8012 103
0.27
0.3

0.3
xx
0.60921
0.5121
15.94
yy
1.27771

1.3300
4.09
0.3

0.3
zz
0.20055
0.2454
22.39
xy
0.94346
0.8567
9.20
0.3
U
5.19002 103
5.1784 103
0.22
102
E
v
5.19002 103
5.1784 103
0.22
0.6

0.6
xx
0.33425
0.4319
29.23
yy
0.33425
0.5315
59.04
0.6

0.6
zz
0.20055
0.289
44.50
xy
1.33425

1.269
4.87
U
4.6716 103
4.6641 103
0.16
102
B
v
0.
eps
-
xx
0.
0.0132
-
yy
0.66738
0.6724
0.75
2.102
zz
0.20021
0.1977
1.25
-
xy
0.
0.0219
-
-
U
4.32523 103
4.3084 103
0.39
102
D
v
1.79157 103
1.7854 103
0.34
0.3
xx

0.09774
0.0739
24.39
0.3
yy
0.56964
0.5728
0.56
0.3
zz
0.20021
0.1941
3.05
0.3
xy
0.23595
0.2348
0.49
0.3
U
3.31039 103
3.2974 103
0.39
102
F
v
3.31039 103
3.2974 103
0.39
0.2
xx
0.33369
0.2977
10.78
0.2
yy
0.33369
0.3245
2.75
0.2
zz
0.20021
0.1866

6.80
0.2

0.2
xy
0.33369
0.3415
2.34

4.2 Remarks

The grid is insufficient for linear elements.

4.3 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 10.23 seconds

---

5 Modeling B

5.1 Characteristics of modeling

Elements 3D (PENTA15 and HEXA20) (resulting from the grid 2D below).
y
B
D
Face blocked in dx
F
With
Normally blocked face

C
E
45°
Face with imposed pressure
X
along axis Z: 2 layers of elements total thickness: 0.01
Limiting conditions:
DDL_IMPO:
(All: “yes”
Dz: 0.)
face AB
(Group_no: BordAB
Dx: 0.)
face EF
FACE_IMPO:
(Group_ma: FaceEF
Dnor: 0.)
pressure on face AE
PRES_REP:
(Group_ma: FaceAE
Near: -1.)
Names of the nodes:
A=No2
B=No361
C=No121
D=No584
E=No155
F=No503

5.2 Characteristics of the grid

A number of nodes: 2115
A number of meshs and types: 400 PENTA15 100 HEXA20 40 QUAD8

5.3 Functionalities tested

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA

AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
NUME_DDL
RENUM
“RCMK”
“EXTRACTION”
[U4.42.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

5.4 Remarks

The pressure has a negative sign (instead of positive) because the faces of the elements 3D are badly directed.

---

6 Results of modeling B

6.1 Values tested

Localization

Sizes
Reference
Aster
% difference
tolerance
U
0.
eps
-
With
v
7.3398 103
7.3326 103
0.10
102
xx
1.6685
1.6669
0.09
102
yy
-1.
0.9959
0.41
102
zz
0.20055
0.2013
0.37
102
xy
0.
3.3234 103
-
102
U
2.80882 103
2.8063 103
0.09
102
C
v
6.78109 103

6.7745 103
0.10
102
xx
1.27771
1.278
0.02
102
yy
0.60921
0.6078
0.23
102
zz
0.20055
0.20107
0.26
102
xy
0.94346
0.94027
0.34
102
U
5.19002 103
5.1851 103
0.09
102
E
v
5.19002 103
5.1851 103
0.10
102
xx
0.33425
0.3346
0.10
102
yy
0.33425
0.3340
0.07

102
zz
0.20055
0.2006
0.02
102
xy
1.33425
1.331
0.24
102
U
0.
eps
-
B
v
4.6716 103
4.6682 103
0.07
102
xx
0.66738
0.6675
0.02
102
yy
0.
3.2779 104
-
102
zz
0.20021
0.2003
0.04
102
xy
0.
5.0918 104
-
102
U
1.79157 103

1.7864 103
0.29
102
D
v
4.32523 103
4.3129 103
0.29
102
xx
0.56964
0.56957
0.01
102
yy
0.09774
0.09803
0.30
102
zz
0.20021
0.20027
0.03
102
xy
0.23595
0.23623
0.12
102
U
3.31039 103
3.3009 103
0.29
102
F
v
3.31039 103
3.3009 103
0.29
102
xx
0.33369
0.3337

0.003
103
yy
0.33369
0.3337
0.003
103
zz
0.20021
0.2002
0.
103
xy
0.33369
0.3339
0.06
103

6.2 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 94.09 seconds

---

7 Modeling C

7.1 Characteristics of modeling

Elements 3D (TETRA4)

along axis Z: 2 layers of elements total thickness: 0.01
Limiting conditions:
DDL_IMPO:
(All: “yes”
Dz: 0.)
face AB
(Group_no: BordAB
Dy: 0.)
face EF
FACE_IMPO:
(Group_ma: FaceEF
Dnor: 0.)
pressure on face AE
PRES_REP:
(Group_ma: FaceAE
Near: -1.)
Names of the nodes:
A=No3
B=No7
C=No4
D=No8
E=No154
F=No156
plan Z = 0.005
A2=No1
B2=No5
C2=No2
D2=No6
E2=No153
F2=No155
plan Z = 0.01
A3=No283
B3=No285
C3=No284
D3=No286
E3=No359
F3=No360

7.2 Characteristics of the grid

A number of nodes: 423
A number of meshs and types: 1416 TETRA4 72 TRIA3

7.3 Functionalities tested

Orders

Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

7.4 Remarks

The pressure has a negative sign (instead of positive) because the faces of the elements 3D are badly directed.

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8 Results of modeling C

8.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3331 103
0.10
102
With
v
0.
eps
-
xx
-1.
0.9000
+10.00
0.02
yy
1.6685
1.6809
0.74
0.02
zz
0.20055
0.2343
16.83
0.02
xy
0.
0.1016
-
0.02
U
6.78109 103
6.7783 103
0.04

102
C
v
2.80882 103
2.8077 103
0.04

0.04
xx
0.60921
0.5061
16.92
yy
1.27771
1.3184
3.18
0.04

0.04
zz
0.20055
0.2437
21.51
xy
0.94346
0.9123
3.30
0.04
U
5.19002 103
5.1853 103
0.09
102
E
v
5.19002 103
5.1853 103
0.09

0.5
xx
0.33425
0.2888
13.60

yy
0.33425
0.4920
47.19
0.5

0.5
zz
0.20055
0.2343
16.83
xy
1.33425
1.2905
3.28
0.5
U
4.6716 103
4.6634 103
0.18
102
B
v
0.
eps
-
xx
0.
0.0146
-
yy
0.66738
0.6570
1.55
5.102
zz
0.20021
0.1976
1.30
5.102
xy
0.
0.0159

-
5.102
U
4.32523 103
4.2960 103
0.68
102
D
v
1.79157 103
1.7795 103
0.67
xx
0.09774
0.0824
15.69
0.2

0.2
yy
0.56964
0.5809
1.97

0.2
zz
0.20021
0.1921
4.05
xy
0.23595
0.2378
7.84
0.2
U
3.31039 103
3.2976 103
0.39
102
F
v
3.31039 103
3.2975 103

0.39

0.1
xx
0.33369
0.3052
8.54

0.1
yy
0.33369
0.3371
1.02

0.1
zz
0.20021
0.1921
4.05

0.1
xy
0.33369
0.3358
0.63

8.2 Remarks

One notes a variation (< 0.24%) displacements for the points of the z=0.005 plan.
The grid is insufficient for linear elements.

8.3 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 18.55 seconds

---

9 Modeling D

9.1 Characteristics of modeling

Elements 3D (TETRA10)
along axis Z: 2 layers of elements total thickness: 0.01
Limiting conditions:
DDL_IMPO:
(All: “yes”
Dz: 0.)
face AB
(Group_no: BordAB
Dy: 0.)
face EF
FACE_IMPO:
(Group_ma: FaceEF
Dnor: 0.)
pressure on face AE
PRES_REP:
(Group_ma: FaceAE
Near: -1.)
Names of the nodes:
A=No3
B=No7
C=No4
D=No8
E=No1228
F=No230
plan Z = 0.005
A2=No1
B2=No5
C2=No2
D2=No6
E2=No227
F2=No229
plan Z = 0.01
A3=No420
B3=No422

C3=No421
D3=No423
E3=No573
F3=No574

9.2 Characteristics of the grid

A number of nodes: 703
A number of meshs and types: 356 TETRA10 36 TRIA6

9.3 Functionalities tested

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

9.4 Remarks

The pressure has a negative sign (instead of positive) because the faces of the elements 3D are badly directed.

Version
3
Titrate:
Harmonic SHLV100 Response of a hollow roll
Date:
20/09/99
Author (S):
X. DESROCHES
Key:
V2.07.100-C Page:
11/24

10 Results of modeling D

10.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3522 103
0.10
102
With
v
0.
eps
-
102
xx
-1.
0.9925
0.75
5.102
yy
1.6685
1.6725
0.24
5.102
zz
0.20055
0.2040

1.72
5.102
xy
0.
0.0365
-
5.102
U
6.78109 103
6.7836 103
0.04
102
C
v
2.80882 103
2.8099 103
0.04
102
xx
0.60921
0.5977
1.89
5.102
yy
1.27771
1.294
1.28
5.102
zz
0.20055
0.2088
4.11
5.102
xy
0.94346
0.9457
0.24
5.102
U
5.19002 103
5.1988 103
0.17
102

E
v
5.19002 103
5.1988 103
0.17
102

0.15
xx
0.33425
0.3035
9.20
yy
0.33425
0.3766
12.67
0.15

0.15
zz
0.20055
0.2040
1.72
xy
1.33425
1.332
0.17
0.15
U
4.6716 103
4.6711 103
0.01
102
B
v
0.
eps
-
102
xx
0.
8.597 104
-

102
yy
0.66738
0.6679
0.08
102
zz
0.20021
0.2006
0.19
102
xy
0.
1.0181 103
-
102
U
4.32523 103
4.3134 103
0.28
102
D
v
1.79157 103
1.7867 103
0.28
102
xx
0.09774
0.09418
3.64
5.102
yy
0.56964
0.5652
0.78
5.102
zz
0.20021
0.1978
1.20
5.102
xy

0.23595
0.2355
0.19
5.102
U
3.31039 103
3.3029 103
0.23
102
F
v
3.31039 103
3.3029 103
0.23
102
xx
0.33369
0.3357
0.60
102
yy
0.33369
0.3334
0.09
102
zz
0.20021
0.2007
0.24
102
xy
0.33369
0.3336
-
102

10.2 Remarks

One notes a variation (< 0.23%) displacements for the points of the z=0.005 plan.

10.3 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords

Time CPU To use: 21.05 seconds

---

11 Modeling E

11.1 Characteristics of modeling

Elements D_PLAN (TRIA3 + QUAD4)
F
Normally blocked face
y
D
E
C
45°
X
With
B
Face with imposed pressure
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO:
(Group_no: GRNM11
Dy: 0.)
side EF
FACE_IMPO:
(Group_ma: GRMA12
Dnor: 0.)
pressure on AE
PRES_REP:
(Group_ma: GRMA13
Near: 1.)
Names of the nodes:
A=N1
B=N119

C=N36
D=N166
E=N41
F=N171

11.2 Characteristics of the grid

A number of nodes: 171
A number of meshs and types: 200 TRIA3 50 QUAD4

11.3 Functionalities tested

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

---

12 Results of modeling E

12.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3243 103
0.21
102
With
v
0.
eps
-

0.15
xx
-1.
0.8790
12.10
yy
1.6685
1.6241
2.66
0.15

0.15
zz
0.20055
0.2235
11.44

0.15
xy
0.
0.0922
-
U
6.78109 103
6.7670 103
0.21
102
C
v
2.80882 103
2.8012 103
0.27

0.3
xx
0.60921
0.5122
15.92
yy
1.27771
1.3302
4.11
0.3

0.3
zz
0.20055
0.2454
22.36
xy
0.94346
0.8567
9.19
0.3
U
5.19002 103
5.1784 103
0.22
102
E

v
5.19002 103
5.1784 103
0.22

0.6
xx
0.33425
0.4318
29.18
yy
0.33425
0.5315
59.01
0.6

0.6
zz
0.20055
0.2890
44.10
xy
1.33425
1.2686
4.92
0.6
U
4.6716 103
4.6641 103
0.16
102
B
v
0.
eps
-
xx
0.
1.3198 102
-
0.05

0.05
yy

0.66738
0.6723
0.74

0.05
zz
0.20021
0.1977
1.25
xy
0.
0.0219
-
0.05
U
4.32523 103
4.3084 103
0.39
102
D
v
1.79157 103
1.7854 103
0.39
xx
0.09774
0.07393
24.36
0.3

0.3
yy
0.56964
0.5728
0.55

0.3
zz
0.20021
0.1940
3.10
xy
0.23595
0.2347

0.53
0.3
U
3.31039 103
3.2974 103
0.39
102
F
v
3.31039 103
3.2974 103
0.39

0.15
xx
0.33369
0.2976
10.81

0.15
yy
0.33369
0.3245
2.75

0.15
zz
0.20021
0.1866
6.80

0.15
xy
0.33369
0.3415
2.34

12.2 Remarks

The grid is insufficient for linear elements.

12.3 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords

Time CPU To use: 5.87 seconds
Handbook of Validation
V2.07 booklet: Harmonic response of the voluminal structures
HI-75/96/005 - Ind A

---

13 Modeling F

13.1 Characteristics of modeling

Elements D_PLAN (QUAD8 + TRIA6)
y
B
D
Face blocked in dx
F
With
Normally blocked face
C
E
45°
Face with imposed pressure
X
Limiting conditions:
side AB
DDL_IMPO:
(Group_no: GRNM11
Dy: 0.)
side EF
FACE_IMPO:
(Group_ma: GRMA12
Dnor: 0.)
pressure on AE
PRES_REP:

(Group_ma: GRMA13
Near: 1.)
Names of the nodes:
A=N2
B=N361
C=N121
D=N584
E=N155
F=N503

13.2 Characteristics of the grid

A number of nodes: 591
A number of meshs and types: 200 TRIA6 50 QUAD8

13.3 Functionalities tested

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

14 Results of modeling F

14.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
0.
0.
-
102
With
v
7.3398 103
7.3326 103
0.10
102
xx
1.6685
1.6669
0.09
102
yy
-1.
0.9959
0.41
102
zz
0.20055

0.20129
0.37
102
xy
0.
0.00332
-
102
U
2.80882 103
2.8063 103
0.09
102
C
v
6.78109 103
6.7745 103
0.10
102
xx
1.27771
1.27799
0.02
102
yy
0.60921
0.60779
0.23
102
zz
0.20055
0.20106
0.25
102
xy
0.94346
0.94027
0.34
102
U
5.19002 103
5.1851 103
0.09

102
E
v
5.19002 103
5.1851 103
0.09
102
xx
0.33425
0.33462
0.11
102
yy
0.33425
0.33403
0.066
102
zz
0.20055
0.20059
0.02
102
xy
1.33425
1.33117
0.23
102
U
0.
eps
-
102
B
v
4.6716 103
4.6682 103
0.07
102
xx
0.66738
0.66758
0.03
102

yy
0.
0.00033
-
102
zz
0.20021
0.20037
0.08
102
xy
0.
5.1132 104
-
102
U
1.79157 103
1.7865 103
0.28
102
D
v
4.32523 103
4.3129 103
0.28
102
xx
0.56964
0.56962
0.003
102
yy
0.09774
0.09805
0.32
102
zz
0.20021
0.200298
0.044
102
xy
0.23595

0.23623
0.12
102
U
3.31039 103
3.3009 103
0.29
102
F
v
3.31039 103
3.3009 103
0.29
102
xx
0.33369
0.33371
0.006
102
yy
0.33369
0.33366
0.009
102
zz
0.20021
0.20021
0.
102
xy
0.33369
0.33392
0.069
102

14.2 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 6.05 seconds

Handbook of Validation
V2.07 booklet: Harmonic response of the voluminal structures

15 Modeling G

15.1 Characteristics of modeling

D_PLAN (QUAD9)
F
Normally blocked face
y
D
E
C
45°
X
With
B
Face with imposed pressure
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO:
(Group_no: GRNM11
Dy: 0.)
side EF
FACE_IMPO:
(Group_ma: GRMA12
Dnor: 0.)
pressure on AE
PRES_REP:
(Group_ma: GRMA13
Near: 1.)
Names of the nodes:

A=N1
B=N347
C=N21
D=N432
E=N39
F=N229

15.2 Characteristics of the grid

A number of nodes: 441
A number of meshs and types: 100 QUAD9

15.3 Functionalities tested

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

---

16 Results of modeling G

16.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3329 103
0.09
102
With
v
0.
eps
-
102
xx
-1.
0.9968
0.32
102
yy
1.6685
1.6655
0.18
102
zz
0.20055
0.20059
0.02

102
xy
0.
2.97 104
-
102
U
6.78109 103
6.7747 103
0.09
102
C
v
2.80882 103
2.8062 103
0.09
102
xx
0.60921
0.60695
0.37
102
yy
1.27771
1.27563
0.16
102
zz
0.20055
0.20060
0.02
102
xy
0.94346
0.94128
0.23
102
U
5.19002 103
5.1851 103
0.09
102
E

v
5.19002 103
5.1851 103
0.09
102
xx
0.33425
0.33403
0.06
102
yy
0.33425
0.33463
0.11
102
zz
0.20055
0.20059
0.02
102
xy
1.33425
1.33117
0.23
102
U
4.6716 103
4.6682 103
0.07
102
B
v
0.
eps
-
102
xx
0.
2.394 103
-
102
yy
0.66738

0.66759
0.03
102
zz
0.20021
0.200207
0.001
102
xy
0.
2.65 105
-
102
U
4.32523 103
4.3128 103
0.29
102
D
v
1.79157 103
1.7864 103
0.29
102
xx
0.09774
0.09756
0.18
102
yy
0.56964
0.56979
0.02
102
zz
0.20021
0.200206
0.002
102
xy
0.23595
0.23611
0.07

102
U
3.31039 103
3.3009 103
0.29
102
F
v
3.31039 103
3.3009 103
0.29
102
xx
0.33369
0.33366
0.009
102
yy
0.33369
0.33371
0.006
102
zz
0.20021
0.20021
0.
102
xy
0.33369
0.33392
0.07
102

16.2 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 5.38 seconds

17 Modeling H

17.1 Characteristics of modeling

Elements axis (TRIA3 + QUAD4)
Center cylinder
Face blocked out of Dy
y
E
F
C
0.01m
D
X
With
B
Face with imposed pressure
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO:
(Group_no: GRNM11
Dy: 0.)
side EF
FACE_IMPO:
(Group_ma: GRMA12
Dnor: 0.)
pressure on AE
PRES_REP:
(Group_ma: GRMA13
Near: 1.)
Names of the nodes:
A=N111

B=N1
C=N112
D=N3
E=N113
F=N4

17.2 Characteristics of the grid

A number of nodes: 113
A number of meshs and types: 40 QUAD4 80 TRIA3

17.3 Functionalities tested

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“AXIS”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

Titrate:
Harmonic SHLV100 Response of a hollow roll
Date:
20/09/99
Author (S):
X. DESROCHES
Key:
V2.07.100-C Page:
19/24

18 Results of modeling H

18.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3390 103
0.01
102
With
v
0.
eps
-

0.2
xx
-1.
0.9430
5.72
yy
0.20055
0.2248
12.19
0.2

0.2
zz
1.6685
1.6923

1.46

0.2
xy
0.
eps
-
U
7.3398 103
7.3390 103
0.01
102
C
v
0.
eps
-

0.2
xx
-1.
0.9430
5.72
yy
0.20055
0.2248
12.19
0.2

0.2
zz
1.6685
1.6923
1.46
xy
0.
eps
-
0.2
U
7.3398 103
7.3390 103
0.01
102

E
v
0.
0.
-

0.2
xx
-1.
0.9430
5.72
yy
0.20055
0.2248
12.19
0.2

0.2
zz
1.6685
1.6923
1.46
xy
0.
eps
-
0.2
U
4.6716 103
4.6713 103
0.01
102
B
v
0.
eps
-
xx
0.
0.0110
-
0.05

0.05

yy
0.20021
0.1954
2.35

0.05
zz
0.66738
0.6625
0.72
xy
0.
0.0011
-
0.05
U
4.6716 103
4.6713 103
0.01
102
D
v
0.
eps
-
xx
0.
0.0110
-
0.05

0.05
yy
0.20021
0.1954
2.35

0.05
zz
0.66738
0.6625
0.72
xy
0.

eps
-
0.05
U
4.6716 103
4.6713 103
0.01
102
F
v
0.
eps
-

0.05
xx
0.
0.0110
-

0.05
yy
0.20021
0.1954
2.35

0.05
zz
0.66738
0.6625
0.72

0.05
xy
0.
+0.0011
-

18.2 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 5.60 seconds

---

19 Modeling I

19.1 Characteristics of modeling

Elements axis (TRIA6 + QUAD8)
Center cylinder
Face blocked out of Dy
y
E
F
0.01m
C
D
X
With
B
Face with imposed pressure
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO:
(Group_no: GRNM11
Dy: 0.)
side EF
FACE_IMPO:
(Group_ma: GRMA12
Dnor: 0.)
pressure on AE
PRES_REP:

(Group_ma: GRMA13
Near: 1.)
Names of the nodes:
A=N8
B=N174
C=N5
D=N170
E=N3
F=N159
19.2 Characteristics of the grid
A number of nodes: 175
A number of meshs and types: 20 QUAD8 40 TRIA6
19.3 Functionalities tested
Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“AXIS”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

20 Results of modeling I

20.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3397 103
0.00
102
With
v
0.
eps
-
102
xx
-1.
0.9984
0.16
102
yy
0.20055
0.20055
-
102
zz
1.6685

1.669
0.57
102
xy
0.
eps
-
102
U
7.3398 103
7.3397 103
0.00
102
C
v
0.
eps
-
102
xx
-1.
0.9984
0.16
102
yy
0.20055
0.20055
-
102
zz
1.6685
1.669
0.57
102
xy
0.
eps
-
102
U
7.3398 103
7.3397 103
0.00

102
E
v
0.
eps
-
102
xx
-1.
0.9984
0.16
102
yy
0.20055
0.20055
-
102
zz
1.6685
1.669
0.57
102
xy
0.
eps
-
102
U
4.6716 103
4.6716 103
0.00
102
B
v
0.
eps
-
102
xx
0.
3.8 104
-
102

yy
0.20021
0.2002
-
102
zz
0.66738
0.66716 105
0.03
102
xy
0.
-
102
U
4.6716 103
4.6716 103
0.00
102
D
v
0.
eps
-
102
xx
0.
3.8 104
-
102
yy
0.20021
0.2002
-
102
zz
0.66738
0.66716
0.03
102
xy
0.
eps

-
102
U
4.6716 103
4.6716 103
0.00
102
F
v
0.
eps
-
102
xx
0.
3.8 104
-
102
yy
0.20021
0.2002
-
102
zz
0.66738
0.66716
0.03
102
xy
0.
105
-
102

20.2 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 5.06 seconds

21 Modeling J

21.1 Characteristics of modeling

Elements axis (QUAD9)
Center cylinder
Face blocked out of Dy
y
E
F
0.01m
C
D
X
With
B
Face with imposed pressure
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO:
(Group_no: GRNM11
Dy: 0.)
side EF
FACE_IMPO:
(Group_ma: GRMA12
Dnor: 0.)
pressure on AE
PRES_REP:
(Group_ma: GRMA13
Near: 1.)
Names of the nodes:
A=N196

B=N1
C=N200
D=N5
E=N202
F=N7

21.2 Characteristics of the grid

A number of nodes: 205
A number of meshs and types: 40 QUAD9

21.3 Functionalities tested

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“AXIS”
ALL
[U4.22.01]
COMB_MATR_ASSE
[U4.53.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]

---

22 Results of modeling J

22.1 Values tested

Localization
Sizes
Reference
Aster
% difference
tolerance
U
7.3398 103
7.3397 103
0.00
102
With
v
0.
eps
-
102
xx
-1.
0.9984
+0.16
102
yy
0.20055
0.2005
-
102
zz
1.6685
1.667
0.57
102

xy
0.
eps
-
102
U
7.3398 103
7.3397 103
0.00
102
C
v
0.
eps
-
102
xx
-1.
0.9984
+0.16
102
yy
0.20055
0.2005
-
102
zz
1.6685
1.667
0.57
102
xy
0.
eps
-
102
U
7.3398 103
7.3397 103
0.00
102
E
v

0.
eps
-
102
xx
-1.
0.9984
+0.16
102
yy
0.20055
0.2005
-
102
zz
1.6685
1.667
0.57
102
xy
0.
eps
-
102
U
4.6716 103
4.6716 103
0.00
102
B
v
0.
eps
-
102
xx
0.
1.1 104
-
102
yy
0.20021
0.20021

-
102
zz
0.66738
0.66727
0.04
102
xy
0.
eps
-
102
U
4.6716 103
4.6716 103
0.00
102
D
v
0.
eps
-
102
xx
0.
1.1 104
-
102
yy
0.20021
0.20021
-
102
zz
0.66738
0.66727
0.04
102
xy
0.
eps
-
102

U
4.6716 103
4.6716 103
0.00
102
F
v
0.
eps
-
102
xx
0.
1.1 104
-
102
yy
0.20021
0.20021
0.02
102
zz
0.66738
0.66727
0.04
102
xy
0.
eps
-
102

22.2 Parameters of execution

Version: 3.02
Machine: CRAY C90
System: UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use: 4.84 seconds

23 Summary of the results

Summary
3D
D_PLAN
Axis
errors
max in %
MOD A
MOD B
MOD C
MOD D
MOD E
MOD F
MOD G
MOD H
MOD I
MOD J
Displacements
WITH, C, E
0.27
0.10
0.10
0.17
0.27
0.10
0.09
0.01
0.00
0.00
B, D, F
0.39
0.02

0.68
0.28
0.39
0.29
0.29
0.01
0.00
0.00
Constraints
xx
WITH, C, E
29.23
0.10
16.92
9.20
29.18
0.11
0.37
5.72
0.27
0.27
B, D, F
24.39
0.02
15.69
3.64
24.36
0.03
0.18
-
-
-
Constraints
yy
WITH, C, E
59.04
0.41
47.19
12.67
59.01
0.41
0.18
12.19

0.09
0.09
B, D, F
2.75
0.30
1.97
0.78
2.75
0.32
0.03
2.35
0.09
0.02
Constraints
zz
WITH, C, E
44.50
0.37
21.51
4.11
44.10
0.37
0.02
1.46
0.57
0.57
B, D, F
6.80
0.04
4.05
1.20
6.80
0.08
0.001
0.72
0.03
0.04
Constraints
xy
WITH, C, E
9.20
0.34
3.30

0.24
9.19
0.34
0.23
-
-
-
B, D, F
2.34
0.12
7.84
0.19
2.34
0.12
0.07
-
-
-

· The grids for the elements of order 1 are not fine enough.
· The results are more precise with elements of order 2.
· The problem is adapted more to an axisymmetric modeling (H, I, J) - > better results.
· Results of the elements 3D and the plane elements having spaces of interpolation in correspondence are identical.
· The results of axisymmetric elements QUAD8 and QUAD9 are identical.

Organization (S): EDF/IMA/MMN
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures

Document: V3.01.010
SSLL10 - Gantry with side connections
Summary:
Static test in linear elasticity, being used to validate the elements of right beam POU_D_T for a loading specific and a loading distributed (key word FORCE_POUTRE).
The relations and moments bending are tested.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/96/039 - Ind A

1
Problem of reference
1.1 Geometry
Plane problem
C
G
With
B
D
Beam
Length
Moment of inertia
-
AB
L
=
= 64
8
4
AB
4m

lAB
10
m
E
3
y, v
AC
L
= 1
4
m
L
= 1 10-8m

AC
AC
12
AD
L
=
= 1
4
AD
1m
stable-lad
10-8m
12
X, U
AE
L
=
= 4
4
AE
2m
L AE
10-8m
3
G is in the middle of *DA*.
Another characteristic of the beams not being used for calculations: the beams are of square section.
-
With
=

4
AB
16 10
m
-
With
=
4
AD
1 10
m
-
With
=
4
AC
1 10
m
-
With
=
4
AE
4 10
m
1.2
Material properties
Isotropic linear elastic material:
E = 2 1011 Pa
1.3
Boundary conditions and loadings
1) Points
C: articulated (*U* = *v* =
C
C
)0.
C
F
P
D
B
G
With

Specific force in: *G*: *F* = -105 *NR*.
E
Force distributed on beam *AD*: *p* = 103 *NR*/*Mr*.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

One poses:
I.E.(internal excitation)
K
Year
=
Year
lAn
with or
N = *B*, *C*, *D*
E
3
K = *K*
+ *K*
+ *K* + *K*
AB
AD
AE
AC
4
K

R
year
=
Year
K
with or
N = *B*, *C*, *D*
E
Fl
pl2
C
AD
AB
= +
-
1
8
12
· Rotation in *a:*
= *C1*
4K
· Moment in *a:*
pl2
M
AB
= +
+ *R*. *C*
AB
AB
1
12
Fl
M
AD
= -
+ *R*. *C*
AD
AD
1
8
M
= *R*. *C*
AE

AE
1
M
= *R. C*
AC
AC
1

2.2
Results of reference

Value of rotation and the moments in A.

2.3 References
bibliographical

[1]
Guide VPCS - Edition 1990.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/96/039 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SSLL10 Gantry with side connections
Date:
19/01/98
Author (S):
J.M. PROIX
Key:
V3.01.010-A Page:
4/6

3 Modeling
With

3.1
Characteristics of modeling

Elements POU_D_T
1 element for the section AG
1 element for the section GD
1 element for section AE
1 element for the section AC
1 element for section AB
Boundary conditions:
DDL_IMPO
(

ALL: “yes”
D2: 0
DRX: 0 DRY: 0
NODE: (D, B, E) DX: 0
DY: 0
DRZ: 0
NODE C
DX: 0
DY: 0
)
FORCE_NODALE
NODE: G
Fy = -1. 105
FORCE_AUTRE
NET: AB
Fy = -1. 103

3.2

Characteristics of the grid

5 éléménts POU_D_T
6 nodes

3.3 Functionalities
tested

Orders
Keys

AFFE_MODELE
POU_D_T
[U4.22.01]
AFFE_CHAR_MECA
FORCE_POUTRE
[U4.25.01]
FORCE_NODALE
AFFE_CARA_ELEM
BEAM
SECTION:
“RIGHT-ANGLED”
[U4.24.01]
CALC_ELEM
OPTION:
“EFGE_ELNO_DEPL”
[U4.61.02]

4
Results of modeling A
4.1 Values
tested
Not
Size and unit
Reference
Aster
% difference
With
Z, rotation
0.227118
0.227441
0.14
(rad)
With
MAB, moment
11023.72
11020.99
0.03
(Nm)
With
MAC, moment
113.559
113.718
0.14
(Nm)
With
MAD, moment
+12348.588
12347.477

0.009
(Nm)
With
MAE, moment
1211.2994
1212.7712
0.12
(Nm)

4.2 Parameters
of execution

Version: NEW 3.3.31
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
8 seconds

5
Summary of the results

The results show the correct operation of elements POU_D_T in cross-bending under load specific and distributed (FORCE_POUTRE).

Titrate:
SSLL11 - Lattice of pin jointed struts under concentrated loading
Date:
16/02/00
Author (S):
Key ***J.M. PROIX***
:
V3.01.011-E Page:
1/10

Organization (S): EDF/MTI/MMN

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.011

SSLL11 - Lattice of pin jointed struts under load
specific

Summary:

This test makes it possible to check the elements of bar and beam for the structural analysis out of lattice. The lattice
considered is plane. Calculation is static, elastic, linear. The reference solution is analytical.

Three modelings make it possible to test elements POU_D_T with and without rotulées connections, as well as

elements BARS.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

1
Problem of reference

1.1 Geometry

D
F
C
L
L/2
With
B
y, v

L/2
L/2
L
X, U

Length L = 1 m

elements AC and BC surface A = 2. 104 m2

elements CD and data base surface A = 1. 104 m2

Co-ordinates of the points (in m):

WITH B
C D
X 0. 1.
0.5 2.
y 0. 0.
0.5 1.
Z 0. 0. 0. 0.

1.2
Material properties

E = 1.962 1011 Pa

1.3
Boundary conditions and loadings

The nodes A and B are articulated: U = v = 0

Vertical specific force in D: F = 9.81 103 NR

2

Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SSLL11/89 of guide VPCS.

It is obtained by the method of displacements in [bib1].

2.2
Results of reference

Displacements of the points C and D.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
RAO (J.S.): The finite element method in engineering, problem 5.1, p. 275.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLL11 - Lattice of pin jointed struts under concentrated loading
Date:
16/02/00
Author (S):
Key ***J.M. PROIX***
:

3 Modeling With

3.1 Characteristics of modeling

Taking into account the twinges, the taking into account of the articulations modifies the results little. For
this modeling the articulations in A, B, C and D are rigidified (continuity of the 3 components generalized efforts).

4 beams of full circular section: 4 meshs SEG2

elements AC and BC
ray R = 7.978845 103 m
(surface A = 2. 104 m2)
elements CD and data base
ray R = 5.641895 103 m
(surface A = 1. 104 m2)
Poisson's ratio:
= 0.3

Limiting conditions:

in all the nodes:

DDL_IMPO:
(ALL: "YES"
DZ: 0. , DRX: 0. , DRY: 0.)

(NODE: (A, B) DX: 0. , DY: 0.)

Name of the nodes:

Not A = A
Not C = C

Not B = B
Not D = D

3.2
Characteristics of the grid

A number of nodes: 4
A number of meshs and types: 4 SEG2

3.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM BEAM
NET
“CIRCLE”
[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
ALL

[U4.25.01]
GROUP_NO

FORCE_NODALE
NODE

“MECHANICAL” AFFE_MODELE “POU_D_T”

[U4.22.01]
DEFI_MATERIAU ELAS

[U4.23.01]

4
Results of modeling A

4.1 Values
tested

Not Reference Displacement
Aster *%*
difference
(m)

CPU
2.6517 10-4 2.6515
10-4
0.00
C

Vc
0.8839 10-4 0.88386
10-4
0.00

uD
3.47902 10-3 3.4784
10-3
-0.02
D

VD
-5.60084 10-3 -5.5994
10-3
-0.03

4.2 Parameters of execution

Version: 5.2

Machine: SGI/ORIGIN 2000 R10000
Obstruction memory: 64 Mo
Time CPU To use:
2.1 seconds

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

---

5 Modeling B

5.1 Characteristics of modeling

4 elements POU_D_T of full circular section: 4 meshs SEG2

elements AC and BC
ray R = 7.978845 103 m
(surface A = 2. 104 m2)
elements CD and data base
ray R = 5.641895 103 m
(surface A = 1. 104 m2)
Poisson's ratio:
= 0.3

Limiting conditions:

DDL_IMPO: (All: "YES"
DZ: 0. , DRX: 0. , DRY: 0.)

To treat the rotary joints, one creates as many nodes as of ends of bar.

D3
· with the nodes A1, B2 and D4
C3
C1
D4
DDL_IMPO: (DX: 0, D4: 0)
· with the nodes C1, C2, C3 and D3, D4 continuity
C2
translations, by LIAISON_DDL DX and DY,
· no rotation is imposed.

A1
B4
B2

5.2
Characteristics of the grid

A number of nodes: 4

A number of meshs and types: 4 SEG2

5.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM BEAM
NET
"CIRCLE"
[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
NODE

[U4.25.01]
LIAISON_DDL

FORCE_NODALE

"MECHANICAL" AFFE_MODELE "POU_D_T"

[U4.22.01]
DEFI_MATERIAU ELAS

---

6 *Results of modeling B*

6.1 Values tested

Not Reference Displacement
Aster *%*
difference
(m)

CPU
2.6517 10-4 2.6517
10-4
0.00
C

Vc
0.8839 10-4 0.8838
10-4
-0.01

uD
3.47902 10-3 3.4790
10-3
0
D

VD
-5.60084 10-3 -5.6003
10-3
-0.01

6.2 Parameters
of execution

Version: 5.2

Machine: SGI/ORIGIN 2000 R10000
Obstruction memory: 64 Mo
Time CPU To use: 3.7 seconds

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLL11 - Lattice of pin jointed struts under concentrated loading
Date:
16/02/00
Author (S):

7 Modeling C

7.1 Characteristics of modeling

4 elements BARS full circular section: 4 meshs SEG2

elements AC and BC
ray R = 7.978845 103 m
(surface A = 2. 104 m2)
elements CD and data base
ray R = 5.641895 103 m
(surface A = 1. 104 m2)
Poisson's ratio:
= 0.3

Limiting conditions:

DDL_IMPO:
(
ALL: “YES”
DZ:
0.
)

(NODE: (A, B) DX: 0. , DY: 0.)

7.2 Characteristics of the grid

A number of nodes: 4

A number of meshs and types: 4 SEG2

7.3 Functionalities tested

Orders

Keys

AFFE_CARA_ELEM BARS
NET
“CIRCLE”
[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
NODE

[U4.25.01]
FORCE_NODALE

[U4.23.02]
“MECHANICAL” AFFE_MODELE “BAR”

[U4.22.01]
DEFI_MATERIAU ELAS

[U4.23.01]

8
Results of modeling C

8.1 Values
tested

Not Reference Displacement
Aster *%*
difference
(m)

CPU
2.6517 10-4 2.6517
10-4
-0.002
C

Vc
0.8839 10-4 0.8839
10-4
-0.002

uD
3.47902 10-3 3.47902
10-3
0
D

VD
-5.60084 10-3 -5.60035
10-3
-0.009

8.2 Parameters
of execution

Version: 5.2

Machine: SGI/ORIGIN 2000 R10000
Obstruction memory: 64 Mo
Time CPU To use: 2.4 seconds

9
Summary of the results

Results in conformity with the reference solution for three modelings:

.

model of beams,

.

model of linear beams + relations,

.

model of bars.

Handbook of Validation

V3.01 booklet: Linear statics of the linear structures

Document: V3.01.012

SSLL12 - Lattice of bars under three requests

Summary:

Static response in linear mechanics of the structures of a triangulated system of pin jointed struts (plane lattice)
under 3 requests:

· displacement of support,
· specific forces,
· effect of dilation.

This test makes it possible to validate the element BARS under various cases of loading. It validates also the option
LIAISON_OBLIQUE of order AFFE_CHAR_MECA.

---

1 Problem of reference

1.1 Geometry

5 m
5 m
5 m
5 m
5 m
5 m
5 m
4 m
C
With
D
4 m

y, v
B

X, U

1.2 Material properties

Isotropic linear elastic material:
E = 2.1 E+11 Pa
Linear dilation coefficient:
= 1. E05 °C1

1.3 Boundary conditions and loadings

Articulation of A (uA = vA = 0).
Support with roller out of B and C (vB = v' C = 0).

1.4 Conditions
initial

Office plurality of 3 requests:

· displacement of support: vA = 0.02 m, vB = 0.03 m, v' C = 0.015 m
· specific forces: FE = 150 kN, FF = 100 kN
· effect of dilation of all the bars for a variation in temperature of 30°C compared to
temperature of assembly (geometry of reference).

F
F
E
F
E
F
v'
u'
With
C
GOES
V' C
B

VB

2 Reference solution

2.1 Method of calculation used for the reference solution

Determination of the unknown the hyperstatic one by the method of cut to know the tractive effort.

2.2

Results of reference
Not
Size and unit
Value
Data base
Tractive effort (NR)
8.2112 E+03

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Mr. LAREDO, Resistance of materials, Paris, Dunod, 1970, p. 579.

---

3 Modeling
With

3.1
Characteristics of modeling

Type of modeling used: element BARS.
A2
A2
A2
A1
A1
A1
A1
A1

A1
A1
A1
C
With
A2
A2
A2
D
A2
A2
A2
B

3.2
Characteristics of the grid
= 30°.
A1 = 1.41 E03 m2.
A2 = 2.82 E03 m2.
3.3 Functionalities
tested
Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
LIAISON_OBLIQUE
FORCE_NODALE
TEMP_CALCULEE
MECA_STATIQUE
[U4.31.01]
CALC_ELEM
EFGE_ELNO_DEPL
[U4.61.02]
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/96/039 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SSLL12 Lattice of bars under three requests

4 Results of modeling A

4.1 Values tested

Identification	Reference	Aster	% difference
Charge: thermal dilation			
Option: “EFGE_ELNO_DEPL”			
Net M10, Noeud: B, Cmp: NR	12946.	1.29541 E+04	0.063
Net M16, Noeud: C, Cmp: NR	4285.2	4.28926 E+03	0.095
Net M17, Noeud: C, Cmp: NR	-10189.	1.02076 E+04	0.183
Charge: specific forces			
Option: “DEPL”			
Node: E, Cmp: DY	1.0566 E02	1.05800 E02	0.133
Option: “EFGE_ELNO_DEPL”			
Net M10, Noeud: B, Cmp: NR	-87137.	8.71128 E+04	0.028
Net M16, Noeud: C, Cmp: NR	24158.	2.41596 E+04	

0.007
Net M17, Noeud: C, Cmp: NR
-57524.
5.74954 E+04
0.050
Charge: imposed displacements
Option: "EFGE_ELNO_DEPL"
Net M10, Noeud: B, Cmp: NR
65979.1
6.59757 E+04
0.005
Net M16, Noeud: C, Cmp: NR
21839.1
2.18453 E+04
0.029
Net M17, Noeud: C, Cmp: NR
51925.6
5.19877 E+04
0.120
Charge: office plurality of the 3 requests
Option: "EFGE_ELNO_DEPL"
Net M10, Noeud: B, Cmp: NR
8211.2
8.18302 E+03
0.343
Net M16, Noeud: C, Cmp: NR
50282
5.02942 E+04
0.024
Net M17, Noeud: C, Cmp: NR
1.1964 E+05
1.19691 E+05
0.043

4.2 Remarks

No deformation of inflection intervenes in the calculation of the solution.

4.3 Parameters
of execution

Version: 3.02.11
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
60 seconds

---

5 Summary of the results

The variations compared to the references are lower than 0.18% for the requests (dilation thermics, specific face, imposed displacement) separate and lower than 0.34% when these requests are cumulated.

Code_Aster ®
Version
5.0

Titrate:
SSLL14 plane Gantry articulated in foot

Date
:

21/03/02
Author (S):
***J.M. PROIX**, L. VIVAN Key*
:
V3.01.014-A Page:
1/6

Organization (S): EDF/AMA, CS IF

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
V3.01.014 document

SSLL14 - Plane gantry articulated in foot

Summary

This test relates to the study of a gantry made up of hurled beams, articulated in foot, in static analysis
linear.

The gantry is modelled with elements linear (SEG2) and subjected to four loadings (distributed or specific).

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLL14 plane Gantry articulated in foot

1
Problem of reference

1.1 Geometry

F1
L = 20 m
H = 8 m
C
= 4 m have
P
has
F2
D
E
M
H
y
With
B
X
L
Sections AD, EB
I1 = 5. E4 m4
Sections cd., EC
I2 = 2.5 E4 m4

The gantry consists of symmetrical beams of sections, so that IY=IZ.
One takes account only of the energy of inflection, because the beams are very slim. This is why them other characteristics of section of beam do not intervene.

1.2

Material properties

Isotropic linear elastic material:

E = 2.1 E11 Pa

1.3
Boundary conditions and loadings

Feet of articulated posts A and B.

Loadings

Nodal force out of C:
Fy = 2000 NR = F1
Nodal force in D:
Fx = 10.000 NR = F2
Moment in D:
MX = 100.000 N.m = M
Force distributed on section cd.:
Pz = 3000 N/m

2

Reference solution

2.1
Method of calculation used for the reference solution

The method of calculation and the solution are exposed in the document [V3.90.01].

2.2
Results of reference

Horizontal and vertical reactions at point A.
Bending moment out of C.

Displacements horizontal and vertical of the point C.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
F.VOLDOIRE: Calculation of an elastic hyperstatic plane gantry [V3.90.01].

---

3 Modeling With

3.1 Characteristics of modeling

C
D
E
y
With
B
X

- *Modeling POU_D_E*
- *10 elements section by section, is 40 elements SEG2*
- *Displacement in the plan: Dz = 0 on all the grid*
- *Feet of articulated posts A and B: Dx = Dy = 0*

3.2 Characteristics of the grid

Sections AD and EB: I1 inertia = 5 E4 m4

Sections cd. and EC: I2 inertia = 2.5 E4 m4

3.3 Functionalities tested

AFFE_CHAR_MECA
FORCE_NODALE:
Fx, Fy, Mz
FORCE_POUTRE:
Fy
CALC_ELEM
“EFGE_ELNO_DEPL”

CALC_NO
“REAC_NODA”

4
Results of modeling A

4.1 Values
tested

Loading Value
tested

Reference
Aster
% difference
Effort distributed p on CD
Displacement out of C Dx
0.0110476
0.0110472 0.003

Displacement out of C Dy
0.012422374
-0.0124233 0.004

Moment out of C Dz
18672.994
18673.20 3.10-6

Reaction of A Dx
5175.37
5175.36 2.10-4

Reaction of A Dy
24233.24
24233.2 2.10-4

Force concentrated F1 out of C
Displacement out of C Dx
0.00000
0.0000 0

Displacement out of C Dy
0.01497330
-0.0149734 0.005

Moment out of C Dz
41422.161
41422.40 3.10-6

Reaction of A Dx
4881.487
4881.47 2.10-4

Reaction of A Dy
10000.00
10000.0 2.10-4

Force concentrated F2 in D
Displacement out of C Dx
0.03000956
-0.0300098 0.001

Displacement out of C Dy
0.00299466
-0.00299450 0.005

Moment out of C Dz
8284.432
8284.34 3.10-6

Reaction of A Dx
5976.297
5976.31 1.10-4

Reaction of A Dy
4000.00
4000.0 0

Moment out of C
Displacement out of C Dx
0.0273532
0.0273536 0.001

Displacement out of C Dy
0.001215646
-0.00121583 0.015

Moment out of C Dz
4916.724
4916.62 3.10-6

Reaction of A Dx
4576.394
4576.38 2.10-4

Reaction of A Dy
5000.00
5000.0 0
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

5
Summary of the results

The results obtained with modeling POU_D_E are in very good agreement with the solution analytical and thus validate the calculation of lattice of beams subjected to efforts specific or distributed.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures

Document: V3.01.100
SSLL100 - Symmetrical structure of beams
with an elbow
Summary:
This test in statics, linear elasticity makes it possible to validate the elements of rectangular beam and curves in inflection
plane, as well as the discrete elements. Four loadings are defined, of which some in local reference mark.
Two modelings make it possible to test on the one hand the right elements (the elbow is modelled using 20
right elements) and in addition right and curved elements.
The reference solution results from the file of validation of the code LICE. Results obtained with
Code_Aster are very close (lower deviation than 2.104 for modeling to the arc of circle with POU_C_T,
a little higher variation (3%) for that with POU_D_T, which is due to a too coarse discretization).
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/96/039 - Ind A

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1 *Problem of reference*

1.1 Geometry

F
F
Z
D
C
E
B
F
y
With

G
Symmetrical plane structure compared to the line y = 4.
Beams of section
circular
external diameter
of = 0.04 m
internal diameter
di = 0.01 m
Bend
of center
(y = 4 Z = 0)
and of ray = 2 2 m
Connection node-node
Kx = Kz = 105 N/m
in the local repére
Co-ordinates of the points (in m):
With
B
C
D
E
F
G
X
0.
0.
0.
0.
0.
0.
0.
y
-2.
0.
2.
4.
6.
8.
10.
Z
-2.
0.
2.

2 2
2.
0.
-2.

1.2
Material properties

E = 2.1 1011 Pa
= 0.3
= 7800. kg/m3
= 106 m/°C

1.3
Boundary conditions and loadings

Embedded points A and G
(v = W = 0)
(except in the case of load 2)
Loading:
1) loading concentrated out of C and E
F = 1000 NR
2) displacement imposed of A and G
Dx = 2 in local reference mark of meshs AB and GF
3) thermal expansion with T = 100°C
4) actual weights

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in the card of validation STA.MPACO/B of the code LICE of *the D.E.R [bib1].*

2.2

Results of reference

Displacements of the points B, C and D.

2.3

Uncertainty on the solution

· modeling a: < 103 (finite element providing of the exact values to the nodes),

· B: a few % (numerical solution function of the discretization).

2.4 References

bibliographical

[1]

Computer code of structures of beam LICE. Card-index validation of module EFPOU

MPACO/B - Direction of the Studies and Research E.D.F (1988)

Handbook of Validation

V3.01 booklet: Linear statics of the linear structures

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3 Modeling

With

3.1

Characteristics of modeling

6 meshs SEG2:

2 meshs CD, EC

curved beam

POU_C_T

2 meshs BC, EF

right beam

POU_D_T

2 meshs AB, FG

connection element

DIS_T

Limiting conditions:
DDL_IMPO:
(GROUP_NO: Beam
DX: 0. DRY: 0. DRZ: 0.)
(NODE: (A G)
DX: 0. DY: 0. DZ: 0.)
loading case 2
(NODE: With
DX: 0. DY: 1. DZ: 1.)
(only)
(NODE: G
DX: 0. DY: - 1. DZ: 1.)
loading case 1 FORCE_NODALE: (NODE: (C E) FZ = -1000.)
loading case 3 AFFE_CHAM_NO (SIZE: “TEMP_R”
AFFE: (ALL: “yes” NOM_CMP: “TEMP” VALE_R: 100.)
loading case 4 GRAVITY: (9.81 0. 0. -1.)
Name of the nodes: WITH, B, C, D, E, F
Name of the meshs: AB, BC, CD, OF, EF, FG
3.2
Characteristics of the grid
A number of nodes: 7
A number of meshs and types: 6 SEG2
3.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
BEAM
SECTION
“GENERAL”
[U4.24.01]
DISCRETE
K_T_D_L
“LOCAL”
DEFI_ARC
ORIE_ARC
ORIENTATION
CARA
“VECT_Y”
AFFE_CHAM_NO
“TEMP_R”
“TEMP”
[U4.26.01]

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
NODE
TEMP_CALCULEE
GRAVITY
AFFE_MATERIAU
GROUP_MA
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_C_T”
[U4.22.01]
“POU_D_T”
“DIS_T”
DEFI_MATERIAU
ELAS
[U4.23.01]
Handbook of Validation
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HI-75/96/039 - Ind A

4
Results of modeling A
4.1 Values
tested
Case
Not
displacement

Reference
Aster
%diff
tolerance
(m)
B
vB
8.120 103
8.1201 103
0.00
1. 103
1
wB
1.000 102
1.0000 102
0.00
-
Forces
C
vC
7.389 103
7.3895 103
0.00
-
nodal
D
wD
2.553 102
2.5530 102
0.00
-
B
vB
9.858 101
9.8585 101
0.00
1. 103
2
wB
1.000
1.0000
0.00
-

Displacement
C
vC
1.738 101
1.7382 101
0.01
-
imposed
D
wD
1.812
1.8120
0.00
-
B
vB
5.660 106
5.6597 106
0.01
1. 103
3
wB

-
-
Dilation
C
vC
1.305 104
1.3047 104
0.02
-
D
wD
5.248 104
5.2480 104
0.00
-
B
vB
3.111 103
3.1107 103

0.01
1. 103
4
wB
4.552 103
4.5522 103
0.00
-
Gravity
C
vC
1.180 103
1.1802 103
0.02
D
wD
8.850 103
8.8504 103
0.00

4.2 Parameters
of execution

Version: 3.5.2
Machine: CRAY C90
Obstruction memory:
8 megawords
Time CPU To use:
12 seconds

---

5 Modeling
B
5.1
Characteristics of modeling
*The arc of beam was modelled in a polygonal line of 2*20 SEG2*
Limiting conditions:
DDL_IMPO:
(GROUP_NO: Npoutre
DX: 0. DRY: 0. DRZ: 0.)
(NODE: (A G)
DX: 0. DY: 0. DZ: 0.) except for
loading case 2
(NODE: With
DX: 0. DY: 1. DZ: 1.)
(NODE: G
DX: 0. DY: - 1. DZ: 1.)
loading case 1
FORCE_NODALE: (NODE: (C D) Fz = -1000.)
loading case
AFFE_CHAM_NO (SIZE: “TEMP_R”
AFFE: (ALL: 'OUI' Nom_cmp: 'TEMP' VALE_R: 100.)
loading case 4
GRAVITY: (9.81 0. 0. -1.)
Name of the nodes: WITH, B, C, D, E, F
5.2
Characteristics of the grid
A number of nodes: 45
A number of meshs and types: 44 SEG2
5.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
BEAM
SECTION
“GENERAL”
[U4.24.01]
DISCRETE
K_T_D_L
“LOCAL”
ORIENTATION
CARA
“VEC_Y”

AFFE_CHAM_NO
“TEMP_R”
“TEMP”
[U4.26.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
NODE
TEMP_CALCULEE
GRAVITY
AFFE_MATERIAU
GROUP_MA
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“POU_D_T”
GROUP_MA
[U4.22.01]
“DIS_T”
NET
DEFI_MATERIAU
ELAS
[U4.23.01]

6
Results of modeling B

6.1 Values
tested
Case
Not
displacement
Reference
Aster
%diff
tolerance
(m)
B
vB
8.120 103
8.1209 103
0.01
1. 103
1
wB
1.000 102
1.0000 102
0.00
-
Forces
C
vC
7.389 103
7.3863 103
0.04
-
nodal
D
wD
2.553 102
2.5528 102
0.01
-
B
vB
9.858 101
9.8585 101
0.00
1. 103
2

wB
1.000
1.0000
0.00
-
Displacement
C
vC
1.738 101
1.7374 101
0.04
-
imposed
D
wD
1.812
1.8121
0.
-
B
vB
5.660 106
5.6612 106
0.02
1. 103
3
wB

-
-
Dilation
C
vC
1.305 104
1.3051 104
0.01
-
D
wD
5.248 104
5.2484 104
0.01

-
B
vB
3.111 103
3.1145 103
0.11
5. 103
4
wB
4.552 103
4.5521 103
0.00
-
Gravity
C
vC
1.180 103
1.1409 103
3.31
5. 102
D
wD
8.850 103
8.8148 103
0.40
5. 103

6.2 Remarks

The modeling of the elbow by right elements requires a very fine grid, for a precision sufficient (in particular for a loading distributed).

6.3 Parameters of execution

Version: 3.2.11
Machine: CRAY C90
Obstruction memory:
8 megawords
Time CPU To use:
7.6 seconds

7
Summary of the results

The results obtained with Code_Aster coincide well with those of the code LICE (solution of reference) in particular for modeling A (POU_C_T).
For modeling B, they are very close also (< 4 104) except in the case of load to gravity (3% of variation to the maximum) because of the dependence of the solution to the smoothness of discretization.
This test thus validates element POU_C_T.

Organization (S): EDF/MTI/MMN, DeltaCAD

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.101

SSLL101 - Piping: Problem of HOVGAARD

Summary:

It is about a linear elastic test, in statics, of a noncoplanar three-dimensional piping comprising elbows. There is a test in dynamics of same structure (SDLX02) [V2.05.002].

One tests elements POU_D_T, POU_C_T, PIPE (SEG3 and SEG4) and TUYAU_6M (SEG3) by the intermediary
of five modelings, each elbow is represented by:

.

20 elements POU_D_T in modeling A,
.
2 elements POU_C_T in modeling B,
.
28 elements PIPE (SEG3) in modeling C,
.
28 elements TUYAU_6M (SEG3) in modeling D,
.
28 elements PIPE (SEG4) in modeling E.

The loadings are:

.

gravity,

·

thermal dilation,

·

nodal forces.

Handbook of Validation

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1
Problem of reference

1.1 Geometry

Geometry, as well as the points of modeling are represented on the following figure:

0.
With
-1.828
0.922
2.75
Z
0.922
B
=
-0.922
=
0.
4 5
=
3
6
=
7
=
With

8
9
10
B
3.69
11
2
12
y
13
=
14
=
=
15
=
1.96
=
X
1

lengths given in meters

.
diameter external of the pipe:
0.185 m
.
thickness of the pipe:
6.12 mm
.
radius of curvature of the elbows:
0.922 m
.
piping full of water

1.2
Material properties

E = 1.658 E+11 Pa

= 0.3

= 13404.10 kg/m3

= 0.1288 E4 /C °

1.3
Boundary conditions and loadings

.
Items 1 and 15 embedded,
.
Loading:
1) Gravity according to Z,
2) Uniform rise in temperature of 472.22 C°,
3) Forces
nodal.

Nodes
2
3
4 - 10
5 - 9
6 - 7 - 8
11
12 - 13
14
Fz (NR)
-
-
327.654
-
-102.5145 -222.687
-
-176.580
624.897 788.724
214.839
117.720

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solutions adopted to check Code_Aster modelings are as follows:

· for modelings BEAM: comparison with the codes: LICE, ADL and TITUS-T [bib1],
using a modeling of the beam type,
· for modelings PIPES: comparison with code ABAQUS, using one
modeling of the pipe type. The number of mode of Fourier (M) used during calculation of
reference is identical to that used during calculations with Code_Aster.

2.2
Results of reference

Case of
Displacement
Modeling Beam
Modeling
Modeling
Loading
at item 3
(LICE, ADL, TITUS)
Pipe: M=3
Pipe: M=6
(ABAQUS)
(ABAQUS)
Actual weight

DX 0.1658E3
0.16517E3
0.16512E3

DY 0.2040E4 0.13870E4
0.13946E4

DZ 0.8010E5 0.80376E5
0.80369E5

DX 0.1651E3
0.16445E3
0.16441E3
Nodal force
DY 0.2080E4 0.14245E4
0.14320E4

DZ 0.9516E5 0.10047E4
0.10047E4

DX 6.1418E3
6.3277E3
6.3236E3
Dilation
DY 13.090E3
13.092E3 13.093E3

DZ 16.799E3
16.798E3 16.798E3

2.3
Uncertainty on the solution

2%

2.4 References bibliographical

[1]
M.W. KELLOG Co. Design of Piping Systems. New York, 1956 - Problem n°5.9

---

3 Modeling With

3.1 Characteristics of modeling

The curved elements are modelled by right elements.

A curved half element is modelled by 20 right elements.

2.75
=
=
N400
=
N500 N600

=
N300
N700
=
With
N800
N900
N1000
B
3.69
N1100
N200
N1200
y
N1300
=
N1400
=
=
N1500
=
1.96
=
X
N100

Lengths given in meters

3.2 Characteristics of the grid

A number of nodes: 93
A number of meshs and type: 92 POU_D_T

3.3 Functionalities tested

Orders

AFFE_CHAR_MECA GRAVITY

TEMP_CALCULEE

"MECHANICAL" AFFE_MODELE "POU_D_T"
ALL

4
Results of modeling A

4.1 Values
tested

Identification Displacement
Reference
beam
Aster %

Actual weight
N300 DX
0.1658E3
0.1658E3

0.0

DY 0.2040E4
0.2039E4
0.02

DZ 0.8010E5
0.8010E5
0.0

N300 DX
0.1651E3
0.1651E3
0.04
Nodal force
DY 0.2080E4
0.2080E4
-0.01

DZ 0.9516E5
0.9516E5
0.004

N300 DX
6.1418E3
6.1413E3
0.007
Dilation
DY 13.090E3
13.091E3 0.012

DZ 16.799E3
16.799E3 0.003

4.2 Notice

The differences between the Aster results and the reference solution beam are all lower than 0.04%

4.3 Parameters of execution

Version: 5.6

Machine: Origin 2000

Obstruction memory:
16 Mo
Time CPU To use:
3 seconds

5 Modeling B

5.1 Characteristics of modeling

The curved elements are modelled by elements “POU_C_T”.

2.75
=
=
N400
=
N500 N600
=
N300
N700
=
With
N800
N900
N1000
B
3.69
N1100
N200
N1200
y
N1300
=
N1400
=
=
N1500
=
1.96
=
X
N100

Lengths given in meters

5.2 Characteristics of the grid

A number of nodes: 15

A number of meshs and type:
10 POU_D_T
4
POU_C_T

5.3 Functionalities
tested

Orders

AFFE_CHAR_MECA GRAVITY

TEMP_CALCULEE

“MECHANICAL” AFFE_MODELE
“POU_D_T”
ALL
Handbook of Validation
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6
Results of modeling B

6.1 Values tested

Identification Displacement Reference beam Aster %

Actual weight

N300 DX
0.1658E3
0.1658E4
0.017

DY 0.2040E4
0.2053E5
0.65

DZ 0.8010E5
0.8010E6
-0.006

N300 DX
0.1651E3
0.1652E4
0.04

Nodal force

DY 0.2080E4
0.2080E5
0.02

DZ 0.9516E5
0.9516E6
0.002

N300 DX
6.1418E3
6.1404E3
-0.02
Dilation
DY 13.090E3
13.090E2 0.005

DZ 16.799E3
16.799E2
0.003

6.2 Notice

The differences between the Aster results and the results of reference beam are all lower than 0.02% except for DY in actual weight where the variation is 0.65%

6.3 Parameters of execution

Version: 5.6

Machine: Origin 2000

Obstruction memory:
16 Mo
Time CPU To use:
3 seconds

7 Modeling
C

7.1
Characteristics of modeling

5
E
Modeling PIPE (SEG3)
D
4
Z
With
F
B
y
5
10
G
4
Boundary conditions: Points C and H
H
- DDL of Beam: DX = DY = DZ = DRX = DRY = DRZ = 0

- DDL of Hull: UIm = VIm = Wim = 0 (m=2,3)
C
UOm = VOm = WOm = 0 (m=2,3)
X
WI1 = WO1 = WO = 0

7.2
Characteristics of the grid

A number of nodes:
57
A number of meshs and type:
28 SEG3

7.3 Functionalities
tested

Orders

AFFE_MODELE AFFE
MODELISATION=' TUYAU'

AFFE_CARA_ELEM
BEAM: (SECTION: "CIRCLE")

ORIENTATION: (CARA: "GENE_TUYAU"
VALE: (X Y Z)
AFFE_CHAR_MECA GRAVITY

TEMP_CALCULEE

8
Results of modeling C

8.1 Values
tested

Identification Displacement
Reference
pipe Aster %

(M = 3)
Actual weight
Not D DX
0.16517E3
0.1636E3
-0.93

DY
0.13870E4
0.1251E4
-9.80

DZ
0.80376E5
0.8018E5
-0.24

Not D DX
0.16445E3
0.1629E3
-0.94

Nodal force
DY
0.14245E4
0.1288E4
-9.61

DZ
0.10047E4
0.1003E4
-0.20

Not D DX
6.3277E3
6.4534E3
1.99
Dilation
DY
13.092E3
13.103E3
0.08

DZ
16.798E3
16.880 E3
0.49

8.2 Notice

The results obtained with Code_Aster are similar to those of ABAQUS by elements pipes except for the displacement DY (actual weight and nodal force) where the variation is about 10%.

8.3 Parameters of execution

Version: 5.6

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 Mo
Time CPU To use: 4,7 seconds

---

9 Modeling D

9.1 Characteristics of modeling

5
E
Modeling TUYAU_6M (SEG3)
D
4
Z
With
F
B
y
5
10

G
4
Boundary conditions: Points C and H
H
- DDL of Beam: DX = DY = DZ = DRX = DRY = DRZ = 0

- DDL of Hull: UIm = VIm = Wim = 0 (m=2,6)
C
UOm = VOm = WOm = 0 (m=2,6)
X
WI1 = WO1 = WO = 0

Lengths given in meters

9.2
Characteristics of the grid

A number of nodes:
57
A number of meshs and type:
28 SEG3

9.3 Functionalities
tested

Orders

AFFE_MODELE AFFE

MODELISATION=' TUYAU_6M'

AFFE_CARA_ELEM
BEAM: (SECTION: “CIRCLE”)

ORIENTATION: (CARA: “GENE_TUYAU”
VALE: (X Y Z)
AFFE_CHAR_MECA GRAVITY

TEMP_CALCULEE

10 Results of modeling D

10.1 Values tested

Identification Displacement
Reference
pipe Aster %

(M = 6)
Actual weight
Not D DX
0.16512E3
0.1636E3
-0.93

DY
0.13946E4
0.1258E4
-9.78

DZ
0.80369E5
0.8018E5
-0.24

Not D DX
0.16441E3
0.1629E3
-0.94
Nodal force
DY
0.14320E4
0.1295E4
-9.58

DZ
0.10047E4
0.1003E4
-0.21

Not D DX
6.3236E3
6.4495E3
1.99
Dilation
DY
13.093E3
13.104E3
0.08

DZ
16.798E3
16.880E3
0.49

10.2 Notice

The results obtained with Code_Aster are similar to those of ABAQUS for elements pipes except for the displacement DY (actual weight and nodal force) where the variation is about 10%.

10.3 Parameters of execution

Version: 5.6

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 Mo
Time CPU To use: 10,56 seconds

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---

11 Modeling E

11.1 Characteristics of modeling

5
E
Modeling PIPE (SEG4)
D
4
Z
With
F
B
y
5
10
G
4
Boundary conditions: Points C and H
H
- DDL of Beam: DX = DY = DZ = DRX = DRY = DRZ = 0

- DDL of Hull: UIm = VIm = Wim = 0 (m=2,3)
C
UOm = VOm = WOm = 0 (m=2,3)
X

WI1 = WO1 = WO = 0

11.2 Characteristics of the grid

A number of nodes:
85
A number of meshs and type:
28 SEG4

11.3 Functionalities tested

Orders

CREA_MAILLAGE MODI_MAILLE
OPTION: “SEG3_4”
AFFE_MODELE AFFE

MODELISATION=' TUYAU'
AFFE_CARA_ELEM
BEAM: (SECTION: “CIRCLE”)
ORIENTATION: (CARA: “GENE_TUYAU”
VALE: (X Y Z)
AFFE_CHAR_MECA GRAVITY

TEMP_CALCULEE

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Code_Aster ®
Version
5.0

Titrate:
SSLL101 - Piping: problem of HOVGAARD

12 Results of modeling E

12.1 Values tested

Identification Displacement
Reference
pipe Aster %

(M = 3)
Actual weight
Not D DX
0.16517E3
0.1648E3
-0.22

DY
0.13870E4
0.1321E4
-4.73

DZ
0.80376E5
0.8024E5
-0.18

Not D DX
0.16445E3
0.1638E3
-0.37

Nodal force
DY
0.14245E4
0.1400E4
-1.74

DZ
0.10047E4
0.9997E5
-0.50

Not D DX
6.3277E3
6.329E3
0.02
Dilation
DY
13.092E3
13.105E3
0.10

DZ
16.798E3
16.843E3
0.27

12.2 Remarks

The grid in SEG4 is obtained starting from a grid SEG3 with order CREA_MAILLAGE, MODI_MAILLE with option "SEG3_4". It is important that the node medium of the SEG3 is well with
medium, Code_Aster checks this condition with a tolerance.

The results obtained with Code_Aster are similar to those of ABAQUS with elements pipes except for displacement DY (actual weight and nodal force) or the variation is about 5% and 2%.

12.3 Parameters

of execution

Version: 5.6

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 Mo
Time CPU To use: 7,62 seconds
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

---

13 Summary of the results

Modeling beam:

The results are similar to the reference solution (modeling beam: average of results of 3 codes) as well for modeling A, where each elbow is discretized by 20 right elements, POU_D_T, that for modeling B, where one uses the elements curves POU_C_T. One notes *simply, in this case, a variation a little more important in a value of displacement (0.65%).*

Modeling pipe:

The Code_Aster results are similar to those of ABAQUS (for elements pipes), except for displacement DY and for the loadings actual weight and nodal forces where the variation with the solution of *reference is more important with meshs SEG3 (10%) that with meshs SEG4 (5%).*

The loading of dilation gives similar results.

This case-test makes it possible to test a noncoplanar piping.

Organization (S): EDF-R & D /AMA, DeltaCAD

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.102

SSLL102 - Fixed beam subjected to efforts unit

Summary:

This test allows a simple checking of calculations of right beams and hull 1D in mechanics of the structures
linear statics. The model is linear.

· 7 modelings make it possible to test the various types of elements of rectangular beams in Code_Aster.
For each modeling, one calculates simultaneously 3 beams of different sections: rectangle, circle, angle.

Modeling A makes it possible of more than test the change of reference mark: the beam is directed according to
trissectrice with the total reference mark.

Modeling E tests the loading distributed on voluminal edges of elements.

Modeling F corresponds to a loading distributed varying linearly with modeling POU_D_E.

Modeling G corresponds to a loading distributed varying linearly with modeling POU_D_TG.

· Modeling H makes it possible to test the element of hull 1D (COQUE_C_PLAN) subjected to loads unit.
· Modeling I makes it possible to test a loading distributed varying linearly with modeling TUYAU_3M.

The values tested are the generalized displacements, efforts and the constraints.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
6.2

Titrate:
SSLL102 - Fixed beam subjected to unit efforts
Date:
20/12/02

Author (S):
J.M. PROIX, J. PELLET, F. LEBOUVIER

1
Problem of reference

1.1 Geometry

Right beam length L, direction X.

y
L
O
X
O
B
L = 2
Z

One calculates simultaneously 3 types of different cross sections:

B = 0.1
1 rectangular section
= 0.2 have

G

0.008
Z
1 corner section with equal wings
0.12
Gy
0.008
H = 0.12

1 circular section

1.2
Material properties

E = 2. 1011 Pa = 0.3

1.3
Boundary conditions and loadings

Embedding out of O

· 6 unit loadings in b:

Fx = 1
MX = 1
Fy = 1
My = 1
Fz = 1
Mz = 1

· 1 loading combined inflection + traction: Fx = 1 My = 1 Mz = 1
· 1 loading combined sharp efforts + torsion: Fy = 1 Fz = 1 MX = 1
· 1 loading distributed linear: Circular Fy = 1000.x section (modelings F, G, I) (with support simple of A and B in this case)

1.4
Notation of the characteristics of cross sections

The geometrical characteristics of the cross sections are noted: `

A:
surface of the section
I, I
y
Z:
geometrical moments of inertia compared to the principal axes
of inertia of the section
JX:
constant of torsion
ay, az:
coefficients of shearing in the directions Gy and Gz
With
With

A' =
and A'
y
=
:
equivalent reduced surfaces
ay
Z
az
E, E
eccentricity of the center of torsion
y
Z:
JG:
constant of warping

2
Reference solution

2.1
Method of calculation used for the reference solution

· Analytical Solution [bib1] and [bib2]: displacements out of B

L
Simple traction
U = F

X
X E S
F L3
2

y
(4+ y)
L Fy
Pure bending
uy =
=
12th I
Z
2nd I
Z
Z
3
2
L
L F
Pure bending
U =
4 +
= -
Z
F
12th I
Z (
Z)
Z
y
2nd I
y
y
MR. L
Torsion
X
X
=

G Jx
Mr. L2

MR. L
y
y
Pure inflection
uz = -
=
2nd I
y
E I
y
y
M2
M
Pure inflection
Z L
Z L
uy =
= +
2nd I
Z
Z
E Iz
12th I
12th I
with y
=
=
L2 GA'
Z
2
'
y
L Gas

Notice 1:

For the corner section, as the center of shearing is not confused with the center of gravity (ey)
0, it are necessary to add the torque:

M = F .E
X
Z

y with the Fz loading = 1

This modifies displacement:

L3
U =
F
Z
Z (4 + Z
) + .e
12th I
X
y
y

Mr. L
X
X
= G.Jx

In the same way, the loading MX = 1 involves a displacement U = + .e
Z
X
y.

Loading distributed linear:

4
2
2
4
max
00652
.
0
4
U
=
3
-10
+ 7
=
y ()
px

X
(X
L X
L)
pL
U
360LEI
y
I.E.(internal excitation)

in X = 519
.
0
L
Handbook of Validation
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Code_Aster ®
Version
6.2

Titrate:
SSLL102 - Fixed beam subjected to unit efforts
Date:
20/12/02
Author (S):
J.M. PROIX*, J. PELLET, F. LEBOUVIER*
Key: V3.01.102-D Page: 4/18

Notice 2:

1
1
With regard to modeling A, the beam is carried by the vector ***e1*** *=*
1.
3 1
other vectors of the local reference mark are:
-1
-1
1
1
e2 *=*

1 and ***E*** *=*
-1
2
3
6
0
2
The components of the vector displacement in the total reference mark are obtained by:
1
-1 -1

3
2
6
1
1
-1
U =
U
G
room

3
2
6
1
2

0
3
6

· Generalized Efforts and constraints out of O:

NR
NR (O) = Fx
xx = S
M y
T
M
Z

y
Z (O) = T. L
T = F
y
y
y
xx (y) =
=
I
xy
K S
Z
y
- M .z
y
T
M
Z
y (O) = - T. L
T
Z
Z ()
O = Fz xx (y) =
=
I
xz
K S
y
Z
MR. R

M
X
T
X (O) = MX ()
B
xy = xz = Jx
M .z
M
y
y (O) = My ()
B
xx (Z) = Iy

M y
M
y
Z (O) = Mz ()
B
xx (y) = Iz

Loading distributed linear:

1000
1000 L 2 1000 x2
M max. R
M
2
3
Z
Z (X) = -
(L X X) V y (X) = +
-
max
xx
=
6
6
2
Iz

L 3
in X =
3

2.2
Results of reference

· Déplacement of the point B,
· efforts generalized at the point O,
· forced point O.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
J.L. BATOZ, G. DHATT: "Modeling of the structures by finite elements" - Volume 2
ED. HERMES.
[2]
N.D. PIKLEY: "Formulated for Stress, Stain & Structural Matrices" ED. John Wiley & Sounds.

3 Modeling
With

3.1
Characteristics of modeling

2 elements POU_D_E K = K
y
Z = 1 = 0 per type of section

S1: Rectangular section modelled by SECTION: "GENERAL"

With =
Iy =
-4
Iz =
-4
J
-

0 02
01666 10
0 6666 10
4
.
.
.
X = 0 45776
.
10
Ry = 01
.
Rz = 0 0
. 5
RT = 0 0892632
.
(Not of calculation of the constraints)

S2: Corner section

With =
-
1856
.
10 3
Iy =
-
4 167339
.
10 4 Iz =
-
1045547
.
10 4 J
-8
X = 03 9595
.
10
E =
-
41012
.
10 3rd

y
Z = 0.

S3: Rectangular section modelled by SECTION: RECTANGLE

Hy = 0 2
.
Hz = 01
.

S4: Section RINGS R = 01
.

R4

I = I
-4
10
.

y
Z =
=

4
4

3.2
Characteristics of the grid

4 X 2 elements POU_D_E. The beam is directed according to the vector (1, 1, 1).

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM
BEAM: SECTION
“GENERAL”

"RIGHT-ANGLED"

"CIRCLE"

CALC_ELEM "EFGE_ELNO_DEPL"

"SIGM_ELNO_DEPL"

"SIPO_ELNO_DEPL"

4
Results of modeling A

4.1 Values
tested

Loading case
Beam
Identification
Reference
Aster *%*
difference
Fx = 1

S1 = S3 ux (B)
2.887 10-10 2.887
10-10 0

xx (0)
50. 50.
0
S2
ux (B)
3.11 10-9 3.11
10-9 0
S4
ux (B)
1.838 10-10 1.838
10-10 0

xx
31.83 31.831
0
Fy = 1
S1 = S3 uy (B)
+1.414 10-7 1.414
10-7 0

Z (B)
1.225 10-7 1.225
10-7 0

xx (0)
3000 3000
0
S2
uy (B)
9.017 10-8 9.017
10-8 0
S4
xx (0)
2546.479 2546.48
0
Fz = 1

S1 = S3 uz (B)
6.532 10-7 6.532
10-7 0

y (B)
-4.243 10-7 -4.243
10-7 0

xx (0)
6000 6000
0

xz (0)
50 50
0
S2
uz (B)
9.279 10-7 9.279
10-7 0

y (B)
1.553 10-5
1.553 10-5
0

X (B)
1.555 10-5 1.555
10-5 0
S4
uz (B)
1.386 10-7 1.386
10-7 0

y (B)
-9 10-8 -9
10-8 0

xx (0)

2546.479 2546.479
0

xz (0)
31.831 31.831
0
MX = 1
S1 = S3 X (B)
3.279 10-7 3.279
10-7 0

xy = xz (0)
1950 1950
0
S2
X (B)
3.791 10-4 3.791
10-4

uz (B)
2.199 10-5 2.199
10-5 0
S4
X (B)
9.556 10-8 9.556
10-8 0

xy = xz (0)
636.62 636.62
0
My = 1
S1 = S3 uz (B)
-4.899 10-7 -4.899
10-7 0

y (B)
4.243 10-7 4.243
10-7 0

xx (0)
3000 3000
0
S2
uz (B)
-1.959 10-8 -1.959
10-8 0

y (B)
1.697 10-8 1.697
10-8 0
S4
uz (B)
-1.04 10-7 -1.04
10-7 0

y (B)
9 10-8
9 10-8
0

xx (0)
1273.2395 1273.2395
0
Mz = 1
S1= S3
uy (B)
1.061 10-7 1.061
10-7 0

Z (B)
1.225 10-7
1.225 10-7
0

xx (0)
1500 1500
0
S2

uy (B)
6.763 10-8 6.763
10-8 0

Z (B)
7.809 10-8 7.809
10-8 0
S4
uy (B) 9
10-7 9
10-7 0

Z (B)
1.04 10-7
1.04 10-7
0

xx (0)
1273.2395 1273.2395
0

My = 1
S1= S3
xx max (0)
4550 4550
0

M

Z = 1

B has
1550
1550
0
F
,
X = 1
xx 2 2
S4
xx max (0)
1832.4636 1832.46
0
Fy = 1
S1, S3
xy (0)
2000 2000
0
Fz = 1

xz (0)
2000 2000
0
MX = 1

xx max (0)
9000 9000
0

B has

S1, S3

-9000
-9000
0
xx

,

2 2
S4
xx max (0)
3601.27 3601.27
0

xy (0)
668.451
0

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---

5 Modeling
B

5.1
Characteristics of modeling

2 elements POU_D_T.

The coefficients of shearing are:

S1: Rectangular section

1
AY = AZ = 12
. =

ky

S2: Corner section

1
AY = AZ =

0 358
.

S4: Section RINGS

10
AY = AZ =

9

5.2
Characteristics of the grid

4 X 2 elements POU_D_T

5.3 Functionalities
tested

Orders

AFFE_CARA_ELEM
BEAM: SECTION
"GENERAL"

"RIGHT-ANGLED"

"CIRCLE"

CALC_ELEM "EFGE_ELNO_DEPL"

"SIGM_ELNO_DEPL"

6
Results of modeling B

6.1 Values
tested

One gives only the values which differ from modeling A (because of the taking into account of transverse shearing).

Loading Section
Identification Reference
***Aster** %*
difference
Fy = 1
S1 = S3
uy (B)
2.0156 10-7 2.0156
10-7
0

xy (0)
60. 60.
0
S2
uy (B)
1.666552 10-7 1.666552
10-7
0
S4
uy (B)
1.70684 10-7 1.70684
10-7
0

xy (0)

35.367765 35.367765
0
Fz = 1
S1, S3
uz (B)
8.0156 10-7 8.0156
10-7
0

xz (0)
60. 60.
0
S2
uz (B)
1.17559754 10-6 1.17559754
10-6
0
S4
uz (B)
1.70684 10-7 1.70684
10-7
0

xz (0)
35.367765 35.367765
0

---

7 Modeling C

7.1 Characteristics of modeling

2 elements POU_D_TG.

Warping is not constrained.

The coefficients of shearing are identical to those of modeling B.

7.2 Characteristics of the grid

4 X 2 elements POU_D_TG

7.3 Functionalities tested

Orders

AFFE_CARA_ELEM
BEAM: SECTION
"GENERAL"

"RIGHT-ANGLED"

"CIRCLE"

CALC_ELEM "EFGE_ELNO_DEPL"

"SIGM_ELNO_DEPL"

8 Results of modeling C

8.1 Values

tested

Loading Section
Identification
Reference
Aster %
difference
Fy = 1
S1 = S3
uy (B)
2.0156 10-7 2.0156
10-7
0

xy (0)
60. 60.
0
S2
uy (B)
1.666552 10-7 1.666552
10-7
0
S4
uy (B)
1.70684 10-7 1.70684
10-7
0

xy (0)
35.367765 35.367765
0
Fz = 1
S1, S3
uz (B)
8.0156 10-7 8.0156
10-7
0

xz (0)
60. 60.
0

S2
uz (B)
1.17559754 10-6 1.17559754
10-6
0
S4
uz (B)
1.70684 10-7 1.70684
10-7
0

xz (0)
35.367765 35.367765
0

8.2 Notice

Warping is not constrained. The results are thus identical to those of modeling B.

---

9 Modeling
D

9.1
Characteristics of modeling

· Eléments POU_D_TG,

· constrained torsion

- 8
·
5.5556 10
for S1

JG =

- 11
4.439822 10
for S2

· in 0 GRX = 0

9.2
Characteristics of the grid

· 10 elements,
· refinement towards embedding.

10 Results of modeling D

10.1 Values
tested

Same results as for modeling C, except those which relate to the effects of warping.

Loading Section
Identification Reference
Aster %
difference
Fz = 1
S2
X = DRX
2.62034 10-5 2.62021
10-5 5.
10-5

uz = DZ

1.14578 10-6 1.14573
10-6 5.
10-5

GRX
1.34652 10-5 1.34652
10-5 1.
10-5
MX = 1
S1
X = DRX
5.52 10-7 5.52
10-7 5.
10-5

GRX
2.84 10-7 2.84
10-7
0
S2
uz
2.6203 10-5 2.6202
10-5 5.
10-5

X
6.3892 10-4 6.3889
10-4 5.
10-5

GRX
3.28324 10-4 3.28324
10-4
0

10.2 Remarks

For X the solution is (cf [bib1]):

Mr. L
M

X
X

2 L
L
GJ
2
X =
+
1 - E
- 2nd
=

3
2 L
G Jx
E JG (

1 + E
)(
)
E JG

---

11 Modeling
E

11.1 Characteristics of modeling

The beam is with a grid in solid elements quadratic HEXA20.

fz

L2
B = 0.1
surf1
Z
y
= 0.2 have
X
L = 2

The beam is embedded on the level of the section surf1. It is subjected to a unit sharp effort who is modelled by a linear density of load fz applying to 4 constituent meshs SEG3 the higher edge L2.

11.2 Characteristics of the grid

The beam is with a grid with 640 solid elements quadratic HEXA20.

The model comprises 3665 nodes.

11.3 Functionalities tested

One tests functionality FORCE_ARETE of AFFE_CHAR_MECA.

12 Results of modeling E

12.1 Values tested

One tests the value of the arrow according to Z of the node medium of the section where the loading is applied (N62 node).

Identification Reference Aster % difference
dz of the N62 node
-8 10-7 -7.9523
10-7
-0.596

12.2 Remarks

---

13 Modeling F

13.1 Characteristics of modeling

The model is composed of 10 elements right beam of Euler. The section is circular full, of ray 0.1m.

13.2 Characteristics of the grid

It consists of 10 elements POU_D_E. The length of the beam is L = 6 m

13.3 Functionalities tested

Orders

AFFE_CARA_ELEM
BEAM: SECTION
"GENERAL"

AFFE_CHAR_MECA DDL_IMPO

CALC_ELEM EFGE_ELNO_DEPL

SIGM_ELNO_DEPL

14 Results of modeling F

14.1 Values tested

14.1.1 Interior efforts

Results	*analytical Results*	*Aster Variation (%)*
Vy (0)	*6.0000E+03*	*6.0000E+03 0.0000*
Vy (6)	*1.2000E+04*	*1.2000E+04 0.0000*
MFZ (2 3)	*1.3856E+04*	*1.3856E+04 0.0000*

14.1.2 Constraint

Results	*analytical Results*	*Aster Variation (%)*
SIXX (2 3)	*1.7642E+07*	*1.7642E+07 0.0000*

---

15 Modeling G

15.1 Characteristics of modeling

The model is composed of 10 elements right beam of Timoshenko with warping. The section is circular full, of ray 0.1m.

15.2 Characteristics of the grid

It consists of 10 elements POU_D_TG. The length of the beam is L = 6 m

15.3 Functionalities tested

Orders

AFFE_CARA_ELEM
BEAM: SECTION
"GENERAL"

AFFE_CHAR_MECA DDL_IMPO

CALC_ELEM EFGE_ELNO_DEPL

SIGM_ELNO_DEPL

16 Results of modeling G

16.1 Values tested

16.1.1 Interior efforts

Results analytical

Results
Aster Variation
(%)
Vy (0) 6.0000E+03 6.0000E+03
0.0000
Vy (6) 1.2000E+04 1.2000E+04
0.0000
MFZ (2 3)
1.3856E+04 1.3856E+04
0.0000

16.1.2 Constraint

Results
analytical
Results
Aster Variation
(%)
SIXX (2 3)
1.7642E+07 1.7642E+07
0.0000

---

17 Modeling
H

17.1 Characteristics of modeling

y
Modeling COQUE_C_PLAN

4
X
- Rectangular Section
O
B
- Limiting Conditions: Not O U = v = Z = 0
Z
- Unit Loading: Not B Fx, Fy and Mz

17.2 Characteristics of the grid

A number of nodes: 9
A number of meshs and types: 4 SEG3

17.3 Functionalities tested

Orders

AFFE_MODELE AFFE
"COQUE_C_PLAN"
AFFE_CARA_ELEM HULL
THICK
CALC_ELEM OPTION
"EFGE_ELNO_DEPL"
"SIGM_ELNO_DEPL"
AFFE_CHAR_MECA
FORCE_NODALE
FX FY MZ

18 Results of modeling H

18.1 Values
tested

Loading case
Beam Identification
Reference
Aster %
difference
Fx = 1
S1

ux (B)
5. 10-10 5.
10-10 0.

xx (0)
5.
5.
0.
Fy = 1
S1
uy (B)
2. 10-7 2.007
10-7 0.333

Z (B)
1.5 10-7 1.5
10-7 0.

xx (0)
300. 289.27
-3.576
Mz = 1
S1
uy (B)
1.5 10-7 1.5
10-7 0.

Z (B)
1.5 10-7
1.5 10-7
0.

xx (0)
150. 150.
0.

18.2 Remarks

The width for modeling COQUE_C_PLAN is imposed on 1 in Code_Aster. In consequence, we multiplied by 0.1 the Young modulus to take account of the real width of *the beam. This width of 1 modifies the inertia of the beam and consequently the value of the constraint xx which is 10 with times lower than the value of reference. Moreover, for displacements, the results differ from modeling A because of the change of reference mark.*

19 Modeling
I

19.1 Characteristics of modeling

The model is composed of 21 elements TUYAU_3M.

19.2 Characteristics of the grid

It consists of 21 meshs SEG3. The length of the beam is L = 6 m

19.3 Functionalities tested

Orders

AFFE_CARA_ELEM
BEAM: SECTION
“GENERAL”

AFFE_CHAR_MECA DDL_IMPO

AFFE_CHAR_MECA_F FORCE_POUTRE

MECA_STATIQUE

STAT_NON_LINE COMP_INCR
RELATION
ELAS
CALC_ELEM
OPTION
SIEF_ELNO_ELGA
CALC_NO
OPTION
FORC_NODA
CALC_NO
OPTION
REAC_NODA
CALC_NO
OPTION
EFGE_NOEU_DEPL

20 Results of modeling I

20.1 Values tested

20.1.1 Displacements

Results
analytical
Results
Aster Variation
(%)
Maximum Dy
9.38888E-03
9.44033E-03
0.55

20.1.2 Interior efforts

Results
analytical
Results
Aster Variation
(%)
Vy (x=0) 6.0000E+03

6.0076E+03
0.127
Vy (x=L=6) 1.2000E+04 1.1995E+04
0.042
MFZ (2 3)
1.3856E+04 1.388E+04
0.171

21 Summary of the results

This test makes it possible simultaneously to check the correct operation of elements POU_D_E, POU_D_T and
POU_D_TG on 3 types of different sections. The perfect coincidence of the results with the solutions analytical (RDM) is normal, and must always be observed, since the solution is contained in functions of form of the elements.

Moreover, modeling E makes it possible to test the loading distributed on edges of elements voluminal. The variation with the analytical solution (RDM) is lower than 0.6%.

Modelings F, G and I make it possible to test the loading distributed (linear variation) for elements of beam POU_D_E, POU_D_TG and pipe sections. The variation with the analytical solution
(RDM) is lower than 0.6%.

For modeling COQUE_C_PLAN the results are satisfactory (displacements and constraints)

for the unit loadings of extension type and inflection (imposed moment). For the loading of inflection (load imposed at an end) the error on displacement is weak 0.5%. It is more important on the constraint: 3.6%.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

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Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.103

SSLL103 - Elastic buckling of an angle

Summary:
A right beam (corner with equal wings) biarticulée is subjected to a normal effort (excentré or not) or to one
bending moment.
One seeks the critical loads of elastic buckling.
· mechanical linear rubber band,
· buckling of a beam,
· eccentricity of the center of torsion,
· interest of the test: calculation of the geometrical matrix of rigidity of elements POU_D_TG and POU_D_T,
· 2 modelings.
An uncertainty persists on the number of modes of buckling of the reference solution [§5].

1
Problem of reference

1.1 Geometry

Z
M

y
M
P
With
With
P
1
2
X
L = 1200 mm

Characteristics of the section:

To = 1856 mm2
Z
I = 4167339 mm4
y
Section A and A
I
1
2
Z = 1045547 mm4
With
J = 39595 mm4
I = 44398819 mm6
G
I
= 84948392 mm5
C
yr2
y
yc = 41.012 mm
has
Z = 0
C
= 120 mm have
E
E = 8 mm
CG = 41.012 mm

1.2

Material properties

E = 2.1 105 MPa
= 0.3

1.3

Boundary conditions and loadings
C.L. :
A1: DX = DY = DZ = DRX = 0
A2: DY = DZ = DRX = 0
Loading
· case 1: axial load P in G
· case 2: axial load P out of C
· case 3: axial load P in A
· case 4: bending moment M

1.4 Remarks

For cases 2 and 3, one applies in A2 an effort in G, then one superimposes in A1 and A2 one moment of inflection (according to OZ for cases 2 following OY for case 3) to offset the effort out of C (or in A).

2
Reference solution

2.1
Method of calculation used for the reference solution

With taking into account of warping, the calculations made by V. Of City De Goyet [bib1] give:
that is to say:
I =
2
;
=
2
2
2
2
2

;
2 =
+
;
2 =
+
y
Z dA Iz
With
y dA Iyr
With
(yy Z) dA
Izr
With
Z (y Z) dA
With
Pcry = 2
E I/L2; Pcrz = 2
E I/L2; Pcrx =
+ 2
2

Z
y
(GJ I.E.(INTERNAL EXCITATION)/L

) Macaw
Arc = (I + I/+ 2 + 2 +
/
- 2
+
2 /
-
y
Z) With y
Z
y
C
C
C (I
I
y
yrz

Z
c)
zc (I
I
2z
Zr
y
c)
Macaw = (I + I/+ 2 + 2 +
/
- 2
+
(
-
Zr
/Iy
Z
2
2 c)
y
Z) With y
Z
y
C
C
(I has
I
y
yrz
Z
c)
Z
I
has
with:
(y, Z
has
has): co-ordinates of the point of load application
(y, Z
C
c): co-ordinates of the center of torsion
Case 1, 2, 3:
One obtains 3 critical loads by solving the equation of the 3° degree out of P:

2
2
Macaw (Pcry - P) (Pcrz - P) (Pcrx - P) - P2 (Pcrz - P) (Z - Z) - P2 (Pcry - P) (y - y
=
C
has
C
has)
0

Case 4:

The moment criticizes Mcr (around the axis y) is worth:
1/2
Mcr = ± (GJ + the 2nd I/L2

) Pcry)

By neglecting warping: the analytical solution of reference is given in [bib2] [bib3].

2.2
Results of reference

Values of the critical loads corresponding to the first modes of buckling for the various cases of load.

2.3
Uncertainty on the solution

Analytical solution. The values of reference are obtained using NAG (routine C0SAGF, EPS = 10-8).

2.4 References
bibliographical

[1]
V. OF TOWN OF GOYET "Analyzes static nonlinear by the finite element method of formed space structures of beams with nonsymmetrical section " - Thesis of doctorate University of Liege, MSM, academic year (1988-1989).
[2]
P. PENSERINI "elastic Instability of the beams with open mean profile: theoretical aspects and numerical " EDF/DER/HM77/112 Notes.
[3]
J. CHERRY TREE "Propagation of two cases tests of modeling of the calculation of the beams in elastic buckling in Code_Aster " HM77/184

---

3 Modeling
With

3.1
Characteristics of modeling

8 elements POU_D_TG
With
With
1
2

3.2
Characteristics of the grid

A number of nodes: 9
A number of meshs and types: 8 SEG2

3.3 Functionalities
tested

Orders		***Keys***	
CALC_MATR_ELEM		*"RIGI_GEOM"*	*[U4.41.01]*
MODE_ITER_SIMULT		*"PLUS_PETITE"*	*[U4.52.02]*

***Code_Aster* ®**
Version
4.0
Titrate:
Elastic SSLL103 Buckling of an angle
Date:
19/01/98

4 Results of modeling A

4.1 Values tested

Identification	***Reference***	***Aster***	***% difference***
Case 1			
mode 1	*6.92531E+05*	*6.92533E+05*	*0.000*
mode 2	*1.50487E+06*	*1.50492E+06*	*0.003*
mode 3	*1.00589E+07*	*1.00593E+07*	*0.003*
Case 2			
mode 1	*1.50487E+06*	*1.50492E+06*	*0.003*
mode 2	*5.99812E+06*	*5.99831E+06*	*0.003*
mode 3	*1.47904E+06*	*1.47904E+06*	*0.000*
Case 3			
mode 1	*5.72260E+05*	*5.72265E+05*	

0.001
mode 2
2.45950E+06
2.45957E+06
0.003
mode 3
1.85673E+07
1.85679E+07
0.003
Case 4
mode 1
7.00631E+07
7.00642E+07
0.002

4.2 Remarks

The precision is excellent with 8 elements in the length.

4.3 Parameters
of execution

Version: 3.02
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
11 seconds

---

5 Modeling

B
5.1
Characteristics of modeling
8 elements POU_D_T
With
With
1
2
5.2
Characteristics of the grid
A number of nodes: 9
A number of meshs and types: 8 SEG2
5.3 Functionalities
tested
Orders
Keys
CALC_MATR_ELEM
"RIGI_GEOM"
[U4.41.01]
MODE_ITER_SIMULT
"PLUS_PETITE"
[U4.52.02]

6
Results of modeling B
6.1 Values
tested
Identification

Reference
Aster
% difference
Case 1
mode 1
6.796E+05
6.8E+05
0.06
mode 2
1.505E+06
1.50492E+06
0.005
mode 3
1.0055E+07
9.968E+07
0.816
Case 2
mode 1
1.505E+06
1.50492E+06
0.005
mode 2
5.998E+06
5.99831E+06
+0.005
Case 3
mode 1
5.638E+05
5.649E+05
0.2
mode 2
2.453E+06
2.443E+06
0.4
mode 3
1.8525E+07
1.7883E+07
3.5
Case 4
mode 1
6.9376E+07
6.982E+07
0.064

6.2 Remarks

The precision is rather good with 8 elements in the length. The solution differs a little that obtained with warping (modeling A).

6.3 Parameters
of execution

Version: 3.6
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
50 megawords
Time CPU To use:
15 seconds

7
Summary of the results

The analytical solution gives us 3 modes of buckling of which the critical loads are roots of an equation of the 3° degree.
Y-a it of other critical loads intercallées between the 3 found values?
Aster finds the good critical loads, but in the middle of much of others… for example for case 3, the 3 sought critical loads corresponds to the nume_mode: 1, 10 and 19!
This is true for two modelings.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.104

SSLL104 - Initial deformations in a beam right-hand side

Summary:

This test validates the taking into account of the initial deformations in the elastic design of a right beam.
characteristics of calculation are:

·

analyze static,

·

linear behavior,

·

linear model,

·

1 only modeling testing elements POU_D_E, POU_D_T and POU_D_TG,

·

the solution is analytical.

Handbook of Validation

V3.01 booklet: Linear statics of the linear structures

HT-66/02/001/A

1
Problem of reference

1.1 Geometry

Z
X
Y
B
With
X

A beam AB length L = 100 mm is located on the trissectrice of trihedron (X, Y, Z): coordinated bridge B are:

100

3
100
B =

3
100

3

One defines also a point C medium of A, B.

The local reference mark (A, X, y, Z) results from the total reference mark (A, X, Y, Z) by the nautical angles

= °
45

2

= -35. °
26 cos =

3

1.2
Material properties

The material is elastic linear.

Young modulus E = 1.0 MPa (without influence on the result).
Poisson's ratio: = 0

1.3
Boundary conditions and loadings

Embedding in a: DX = DY = DZ = DRX = DRY = DRZ = 0.

Loading: initial deformation in the local reference mark (A, X, y, Z)

·
elongation according to X: EPX = 0.001
·
curve according to Ay: KY = 0.002
·
curve according to Az: KZ = 0.003

1.4
Characteristics of the section of beam

All the characteristics (surface, inertias,…) are taken equal to 1.

They are without influence on the result.

2
Reference solution

2.1
Method of calculation used for the reference solution

The solution is analytical. It is calculated in the local reference mark.

U

= (U, v, W, X, y, Z)
the displacement of the beam
That is to say: E =

(X, y, Z, xy, xz) generalized deformation of the beam

x2
x2
U
=. X; v =
; W = -
That is to say the solution:
2

2

= 0
; =. X
; =. X
X
y
Z

= U, X
X
=

=, X
y
y
=

then:
=, X
Z
Z
=
= v, X
xy
- Z = 0

= W, X
xz
+ y = 0

If one chooses = EPX (= 0.001); = KY (= 0.002); = KZ (= 0.003) then E - Einit = 0 efforts are null. Balance is checked. In addition, the solution checks the C.L. (embedding in A). Thus it is the solution of the problem arising.

2.2
Results of reference

The results expressed in the local reference mark are:

In b: Dx = 0.1; Dy = 15. ; Dz = 10. ; DRx = 0. ; DRy = 0.2; DRz = 0.3

Out of C: Dx = 0.05; Dy = 3.75. ; Dz = 2.5; DRx = 0. ; DRy = 0.1; DRz = 0.15

In the total reference mark, one finds at the points B and C:

3
3
3
3
DX (B) =
+ 5
(- 3 6 + 2 2)
DX (C) =
+ 5
(- 3 6 + 2 2)
30
6
60
24
3
3
3
3
DY (B) =
+ 5
(3 6 + 2 2)
DY (C) =
+ 5
(3 6 + 2 2)
30
6
60
24
3
3
3
3
DZ (B) =
+ 5
(- 4 2)
DZ (C) =
+ 5
(- 4 2)
30

6
60
24
1
1
DRX (B) =
(- 6 - 2 2)
DRX (C) =
(- 6 - 2 2)
20
40
1
1
DRY (B) =
(- 6 + 2 2)
DRY (C) =
(- 6 + 2 2)
20
40
1
1
DRZ (B) =
(2 6)
DRZ (C) =
(2 6)
20

40

2.3
Uncertainty on the solution

The solution is exact for the theory of the beams of Euler (or Timoshenko because it there not of shearing). Torsion not intervening, the solution is also valid for elements POU_D_TG.

SSLL104 - Initial deformations in a right beam

Date:
14/09/00
Author (S):
J. Mr. PROIX, J. PELLET, L. VIVAN Key
:
V3.01.104-B Page:
4/6

3 Modeling With

3.1 Characteristics of modeling

Z
X
Y
B
With
X

- *AB is cut out in 10 of the same elements length (10.). (Only one element would be sufficient).*
- *3 identical calculations are successively made on this grid with 3 modelings different:*
  - *with 10 elements POU_D_E*
  - *with 10 elements POU_D_T*
  - *with 10 elements POU_D_TG*

3.2 Characteristics of the grid

A number of nodes: 11

A number of meshs and types: 10 SEG2

3.3 Functionalities
tested

Orders
Key word factor
Key word argument
AFFE_CHAR_MECA
EPSI_INIT
EPX, KY, KZ
AFFE_MODELE MODELING
POU_D_E
AFFE_MODELE MODELING
POU_D_T
AFFE_MODELE MODELING
POU_D_TG

4
Results of modeling A

4.1 Values
tested

Modeling Identification Reference
Aster %
difference
POU_D_E
B DX
6.4664E+00
6.4664E+00
< 10-9
DY
1.4747E+01
1.4747E+01
< 10-9
DZ
8.1072E+00
8.1072E+00
< 10-9
DRX
2.6390E01
2.6390E01
< 10-9
DRY
1.8947E02
1.8947E02
< 10-9
DRZ
2.4495E01
2.4495E01
< 10-9

C DX
1.6022E+00
1.6022E+00
< 10-9
DY
3.7011E+00
3.7011E+00
< 10-9
DZ
2.0124E+00
2.0124E+00
< 10-9
DRX

1.3195E01
1.3195E01
< 10-9
DRY
9.4734E03
9.4734E03
< 10-9
DRZ
1.2247E01
1.2247E01
< 10-9

POU_D_T
B DX
6.4664E+00
6.4664E+00
< 10-9
DY
1.4747E+01
1.4747E+01
< 10-9
DZ
8.1072E+00
8.1072E+00
< 10-9
DRX
2.6390E01
2.6390E01
< 10-9
DRY
1.8947E02
1.8947E02
< 10-9
DRZ
2.4495E01
2.4495E01
< 10-9

C DX
1.6022E+00
1.6022E+00

< 10-9
DY 3.7011E+00
3.7011E+00
< 10-9
DZ 2.0124E+00
2.0124E+00
< 10-9
DRX
1.3195E01
1.3195E01
< 10-9
DRY 9.4734E03
9.4734E03
< 10-9
DRZ 1.2247E01
1.2247E01
< 10-9

POU_D_TG
B DX
6.4664E+00
6.4664E+00
< 10-9
DY
1.4747E+01
1.4747E+01
< 10-9
DZ
8.1072E+00
8.1072E+00
< 10-9
DRX
2.6390E01
2.6390E01
< 10-9
DRY
1.8947E02
1.8947E02
< 10-9
DRZ
2.4495E01

2.4495E01
< 10-9

C DX
1.6022E+00
1.6022E+00
< 10-9
DY
3.7011E+00
3.7011E+00
< 10-9
DZ
2.0124E+00
2.0124E+00
< 10-9
DRX
1.3195E01
1.3195E01
< 10-9
DRY
9.4734E03
9.4734E03
< 10-9
DRZ
1.2247E01
1.2247E01
< 10-9

4.2 Parameters of execution

Version: 5.3

Machine: SGI Origin2000 - R12000
System:
IRIX 64
Obstruction memory:
64 Mo
Time CPU To use: 3 seconds

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures

5
Summary of the results

As one could expect it, the results are very precise. They validate the good taking into account initial strains and stresses in the elements of beam.

The test does not test the curved beams (POU_C_T) because one does not have reference solution.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.105

SSLL105 - Elastic buckling of a structure
in L

Summary:

An L-shaped structure made up of two slim beams of mean rectangular section is subjected with a force at an end, and is embedded at the other end. One seeks the critical loads elastic buckling associated the positive and negative values of the force. The field of the test is:

- ***linear elastic mechanics,***
- ***buckling of beams,***
- ***The first 3 modelings relate to (POU_D_E, POU_D_T, POU_D_TG).***
- ***The fourth modeling tests the criterion of buckling in the nonlinear operator of statics.***

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/03/008/A

1
Problem of reference

1.1 Geometry

Y
L
With
Z
B
Section:
X
B
L
T
C
P
Geometrical characteristics:

L = 240 mm

B = 30 mm

T = 0.6 mm

1.2
Material properties

E = 71240 MPa

= 0.3

1.3
Boundary conditions and loadings

.
C.L. : embedding in A

.
Loading: F = X
P

-
case 1: P = 1 NR

-
case 2: P = +1 NR

2

Reference solution

2.1
Method of calculation used for the reference solution

Average of codes (8 results in [bib1]).

2.2
Results of reference

Values of the critical load for the two loading cases.

2.3
Uncertainty on the solution

2% (maximum variation compared to the average of results used).

2.4 References
bibliographical

[1]
G. DEVESA: Treatment of great displacements in the element of angle with 7 ddl established in Code_Aster validation by a traditional case test (HM-77/94/079).
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/03/008/A

Code_Aster ®
Version
7.2

Titrate:
SSLL105 - Elastic buckling of a structure in L

Date:
28/10/03
Author (S):
J.M. PROIX, G. DEVESA Key
:

3 Modeling With

3.1 Characteristics of modeling

20 elements POU_D_E

3.2 Characteristics of the grid

A number of nodes: 21

A number of meshs and types: 20 SEG2

3.3 Functionalities tested

Orders

CALC_MATR_ELEM “RIGI_GEOM”

4 Results of modeling A

4.1 Values tested

Loading case	Reference	Aster	% difference
1	1.088	1.090	0.19
2	-0.680	-0.6813	0.19

5 Modeling B

5.1 Characteristics of modeling

20 elements POU_D_T

5.2

Characteristics of the grid

A number of nodes: 21

A number of meshs and types: 20 SEG2

5.3 Functionalities tested

Orders

CALC_MATR_ELEM “RIGI_GEOM”

6 Results of modeling B

6.1 Values tested

Loading case	*Reference*	*Aster*	*% difference*
1	*1.088*	*1.090*	*0.19*
2	*-0.680*	*-0.6813*	*0.19*

HT-66/03/008/A

---

7 Modeling C

7.1 Characteristics of modeling

20 elements POU_D_TG

7.2 Characteristics of the grid

A number of nodes: 21

A number of meshs and types: 20 SEG2

7.3 Functionalities tested

Orders

CALC_MATR_ELEM "RIGI_GEOM"

8
Results of modeling C

8.1 Values tested

Loading case	***Reference***	***Aster***	*%* ***difference***
1	*1.088*	*1.0918*	*0.35*
2	*-0.680*	*-0.688*	*1.2*

8.2 Remarks

The results of this modeling differ slightly from the others and are identical to those obtained by calculation Aster of the reference [bib1].

---

9 Modeling D

9.1 Characteristics of modeling

20 elements POU_D_E

9.2 Characteristics of the grid

A number of nodes: 21

A number of meshs and types: 20 SEG2

9.3 Functionalities tested

Orders

STAT_NON_LINE CRIT_FLAMB

10 Results of modeling D

10.1 Values tested

Loading case	Reference	Aster	% difference
1	1.088	1.0866	0.12

2 -0.680
-0.67983
0.025

---

11 Summary of the results

The results of 4 modelings are very close to the reference solution which is an average results of 8 codes. One notes a small effect due to warping since the results of modeling C (POU_D_TG) are slightly different from the others, while remaining with less than 2% of reference.

Author (S):
J. Mr. PROIX
Key: V3.01.106-B Page: 1/22

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.106

SSLL106 - Right pipe

Summary:

This test allows a simple checking of the right pipe sections in static mechanics of the structures linear.

The model is linear.

For each modeling, 6 types of loading are applied at the end: a traction, 2 efforts edges, 2 moments bending and a torsion. One applies moreover one internal pressure, a linear force distributed and a thermal expansion.

The values tested are displacements, the efforts with the nodes, and the constraints and deformations at the points of Gauss. The reference solution is analytical (RDM).

Two modelings (A and B) make it possible to test the element PIPE with 3 modes of Fourier (modeling
TUYAU_3M)
: modeling A uses MECA_STATIQUE, modeling B uses STAT_NON_LINE
(elastic behavior).

Two modelings (C and D) make it possible to test the element PIPE with 6 modes of Fourier (modeling TUYAU_6M).

Two modelings (E and F) make it possible to test the element PIPE with 3 modes of Fourier and 4 nodes (modeling TUYAU_3M).
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/03/008/A

1
Problem of reference

1.1 Geometry

Right beam length L, directing vector (4, 3, 0).

y
B
X
Y
3

0.032
L
Z
0.04
O
X
O
4
L =5
Z

Section of the pipe

Tubular section of external ray has = 0.04m, of ray interns B = 0.032m, thickness E = 0.008 m

1.2
Material properties

E = 2. 1011 Pa = 0.3
density =7800 kg/m3, thermal dilation coefficient
5
10-
=

1.3
Boundary conditions and loadings

· Encastrement out of O
· 6 elementary Loadings at the end B

-
in reference mark (X, y, Z) related to the beam:

Fx = 5.102 NR MX = 5.102 Nm
Fy = 5.102 NR My = 5.102 Nm
Fz = 5.102 NR Mz = 5.102 Nm

-
maybe, in the total reference mark (X, Y, Z):
-
1 loading of traction: FX = 4.102 NR and FY = 3.102 NR
-

2 sharp efforts: in the plan (oxy) FX = 3.102 NR and FY = 4.102 NR and in the plan (oyz) FZ = 5.102 NR

-

1 torque: MX = 4.102 Nm and MY = 3.102 Nm

-

2 sharp efforts: in the plan (oxy) MX = 3.102 Nm and MY = 4.102 Nm and in the plan (oyz) MZ = 5.102 Nm

· Internal Pression: P=107 Pa
· Pesanteur, with g=10m/s ², in the direction - Z
· Linear Chargement, Fz=-141.146 N/m (what corresponds to the load due to gravity: Fz=mg)
· Thermal Dilatation: Temp = 100°C

1.4
Notation of the characteristics of cross sections

The geometrical characteristics of the cross sections are noted:

S:
surface of the section
I, I
y
Z:
geometrical moments of inertia compared to the principal axes of inertia of section
Jx:
constant of torsion

Key: V3.01.106-B Page: 3/22

2
Reference solution

2.1
Method of calculation used for the reference solution

· Analytical Solution [bib1]: displacements out of B in the reference mark (Oxyz) related to the beam.

L
Traction simple U = F
X
X E S
(F L3
2
y
)
L Fy
Pure bending
uy =
=
3rd I
Z
2nd I
Z
Z
F 3
L2 F
Pure bending
Z L
Z
U =
= -
Z
y
3rd I
2nd I
y
y
MR. L
Torsion
X

X = G Jx
Mr. L2
MR. L
y
y
Pure inflection
uz = -
=
2nd I
y
E I
y
y
M
2
M
Pure inflection
Z L
Z L
U y =
= +
2nd I
Z
Z
E I Z
P
has 2

b2
+ B has
Pressure
U =
R (
1 -) + (1 +)
=
R

calculated in R
E b2 - a2
R 2
2
in fact U v
arie enters

-
7 1
, 2 10 6 in R = B
R
and
-
7 7
, 8 10 6 in R = has

Here, the values are obtained with:

S =
-3 m2 Iy = Iz =
-6 m4 J =
-
1809557 10
118707 10
2 37414
.
10 6 m4
.
.
X

L = 5 m

For the generalized deformations of beam, one obtains, by the law of behavior:

Fx
simple

Traction
Ex = ES
Fy
Fy (L - X)
simple

Inflection
xy =
Z =
GS
I.E.(internal excitation) Z
Z

F
Fz (L - X)
simple

Inflection

=
xz = GS
y
I.E.(internal excitation) y

M X
Torsion
X = GJx
M y
pure

Inflection
y = EIy
M Z
pure

Inflection
Z = + EIz

Loading of gravity and linear loading:
2

pL
If p indicates the distributed load, the moment in the beginning is worth: M (O) =
and of following displacement
2
pL4
Z at the end B is worth: U (B) =

Z
8EI

The thermal loading of dilation led to an axial displacement (in the local direction X):

U (B) = L

X
(T)

The deformations of free dilation of the surface of the pipe are simply, in local reference mark:

= =
xx
(T
yy
)

Finally to validate the calculation of the matrix of mass, a modal analysis of the first 12 modes clean (with embedding out of O) must give, for the modes of inflection:

2

I.E.(internal excitation)
F
I
=

I
L
S

Lambdai mode
Frequency
1 1,87510407
2,9030234

2 4,69409113 18,192937
3 7,85475744 50,9407506
4 10,9955407
99,8235399
5 14,1371684
165,015464
6 17,2787596
246,504532
7 20,4203522
344,291453
8 23,5619449
458,376195
9 26,7035376
588,758758
10 29,8451302
735,43914
11 32,9867229
898,417343
12 36,1283155
1077,69337

2.2
Results of reference

- ***Déplacement at the point B, efforts, constraints and deformations in the vicinity of the point O.***
- ***Déformation generalized.***
- ***Eigen frequencies***

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Handbook of validation, test SSLL102 fixed Beam subjected to unit efforts
[V3.01.102]

3 Modeling With

3.1 Characteristics of modeling

10 elements PIPE.

3.2 Characteristics of the grid

10 meshs SEG3. The beam is directed according to the vector (4, 3, 0).

3.3 Functionalities tested

Orders

AFFE_MODELE MODELING
PIPE
AFFE_CARA_ELEM BEAM
SECTION RINGS

MACRO_ELAS_MULT
OPTION
SIEF_ELGA_DEPL

OPTION
EPSI_ELGA_DEPL

OPTION
EFGE_ELNO_DEPL

Notice on the contents of the fields:

Fields at the points of Gauss for the element PIPE
, EPSI_ELGA_DEPL and
SIEF_ELGA_DEPL, which provide the strains and the stresses to the points of integration
in the local reference mark of the element, are organized in the following way:

The values are stored:

· for each point of Gauss in the length, (n=1, 3)
· for each point of integration in the thickness, (n=1, 2NCOU+1=7)
· for each point of integration on the circumference, (n=1, 2NSECT+1=33)
· 6 components of strain or stresses:
EPXX EPYY EPZZ EPXY EPXZ EPYZ or SIXX SIYY SIZZ SIXY
SIXZ SIYZ
where X indicates the direction given by the two nodes tops of
the element, Y represents the angle describing the circumference and Z
represent the ray. EPZZ and EPYZ corresponding to,
in
rr
R
case of the deformations and SIZZ and SIYZ corresponding to,
in
rr R
the case of the constraints is taken equal to zero.

(for MECA_STATIQUE or MACRO_ELAS_MULT, the number of layers is fixed, and equal to 3,
and
the number of sectors is equal to 16).

EFGE_ELNO_DEPL represents the efforts generalized with the 3 nodes in the traditional way: NR,
VY, VZ, MT, MFY, MFZ.

4
Results of modeling A

4.1 Values
tested

Loading case
Size
Reference
Aster %
difference
FX = 4.102
DX
5.53E06
5.52E06
-0.04
FY = 3.102 DY
4.14E06
4.14E06
-0.04
FX = 3.102 DRZ
2.63E02
2.63E02
-0.04
FY = 4.102 DX
5.27E02
5.26E02
-0.056
DY
7.02E02
7.02E02
-0.056

FZ = 5.102 DRX
1.58E02
1.58E02
-0.04
DRY
2.11E02
2.11E02
-0.039
DZ
8.78E02
8.77E02
-0.056
MX = 4.102 DRX
1.10E02
1.10E02
0
MY = 3.102 DRY
8.21E03
8.21E03
0
MX = 3.102 DRX
6.32E03
6.32E03
-0.04
MY = 4.102 DRY
8.42E03
8.42E03
-0.04
DZ
2.63E02
2.63E02
-0.04
MZ = 5.102 DRZ
1.05E02
1.05E02
-0.039
DX
1.58E02
1.58E02
-0.04
DY
2.11E02
2.11E02

-0.039
7: pressure
WO
7.38E06
7.16E06
-2.946
8: gravity
DZ
4.646 E-02 4.642
E-02
0.09
9: charge distributed
DZ
4.646 E-02 4.642
E-02
0.09

Loading case
Field
Net Point Component Reference
Aster %
difference
1
EFGE_ELNO_DEPL
M18 1 NR
5.00E+02
5.01E+02 0.136
1
EPSI_ELGA_DEPL
M18 1 EPXX 1.38E06
1.38E06
-0.031
1
SIEF_ELGA_DEPL
M18 1 SIXX 2.76E+05
2.73E+05
-1.159
4
EFGE_ELNO_DEPL
M18 1 MT
5.00E+02
5.00E+02 0

4
EPSI_ELGA_DEPL
M18 1 EPXY 8.77E05 8.76E05
-0.102
4
EPSI_ELGA_DEPL
M18 693 EPXY 1.09E04 1.10E04 0.049
4
SIEF_ELGA_DEPL
M18 1 SIXY 6.75E+06 6.74E+06
-0.159
4
SIEF_ELGA_DEPL
M18 693 SIXY
8.42E+06 8.42E+06 0.049
5
EFGE_ELNO_DEPL
M18 1 MFY 5.00E+02
5.01E+02 0.123
5
EPSI_ELGA_DEPL
M18 479 EPXX
6.74E05
6.74E05 0.046
5
SIEF_ELGA_DEPL
M18 479 SIXX
1.35E+07
1.33E+07 1.288
6
EFGE_ELNO_DEPL
M18 1 MFZ 5.00E+02
5.01E+02 0.123
6
EPSI_ELGA_DEPL
M18 471 EPXX
6.74E05
6.74E05 0.046
6
SIEF_ELGA_DEPL
M18 471 SIXX
1.35E+07
1.33E+07 1.288

7
EPSI_ELGA_DEPL
M18 1 EPYY 2.28E04
2.24E04
-1.716
7
EPSI_ELGA_DEPL
M18 693 EPYY
1.78E04
1.79E04 0.741
7
SIEF_ELGA_DEPL
M18 1 SIYY 4.56E+07
4.53E+07
-0.641
7
SIEF_ELGA_DEPL
M18 693 SIYY
3.56E+07
3.54E+07 0.371
8
EFGE_ELNO_DEPL
M1 1 MFY
1764.3
1728
2
9
EFGE_ELNO_DEPL
M1 1 MFY
1764.3
1728
2

Titrate:
SSLL106 - Right pipe

Generalized deformations DEGE_ELNO_DEPL:

Loading case
Loadings
Size
Reference
Aster %
difference
1 FX = 4.102
EPXX
1.38155E-06
1.38155E-06
-0.04

FY = 3.102

2 FX = 3.102 GAXY 3.5920E-06 4.7415E06 32

FY = 4.102 KZ
1.0530E02 1.04E02 1.2
3 FZ = 5.102 GAXZ 3.5920E-06 4.7415E06
32

KY
1.0530E02
1.04E02
-1.2
4 MX = 4.102 GAT 2.73783E-03 2.73783E-03 0

MY = 3.102

5 MX = 3.102 KY
2.1060E-03 2.1052E-03 0.04

MY = 4.102

6 MZ = 5.102 KZ
2.1060E-03 2.1052E-03
-0.04

Fréquenc
Reference
Aster %
difference
E clean
1 2.90229
2.90378
0.05
2 2.90229
2.
90378
0.05
3 18.18967
18.2047
0.08
4 18.18967
18.2047
0.08
5 50.99367
51.006 0.02
6 50.99367
51.006 0.02
7 99.81783
100.0478
0.2
8 99.81783
100.0478
0.2
9 157.0190
157.0185 0.001
10 164.9922

165.606 0.3
11 164.9922
165.606 0.3
12 253.185 247.82 2

4.2 Remarks

The values of shearings corresponding to the shearing action are not precise for this modeling. This is due to the functions of interpolation of order 2 of this element, for displacements of beam and rotations of beams. As transverse shearings of beam are obtained by:

duy
= -
, and that for the pure bending, rotations vary like polynomials of order 2,
xy
Z
dx
but displacements, like polynomials of order 3, which is badly approached by the functions of interpolation. The derivative of displacements is thus not precise.

5 Modeling B

5.1 Characteristics of modeling

10 elements PIPE, calculation with STAT_NON_LINE.

5.2 Characteristics of the grid

10 meshs SEG3. The beam is directed according to the vector (4, 3, 0).

5.3 Functionalities tested

Orders

AFFE_MODELE
MODELING
PIPE
AFFE_CARA_ELEM BEAM
SECTION
RING

STAT_NON_LINE COMP_INCR
RELATION ELAS

COMP_INCR
TUYAU_NCOU

3

COMP_INCR
TUYAU_NSEC
16

OPTION
SIEF_ELNO_ELGA

Notice on the contents of the fields:

Stress fields at the points of Gauss for the element PIPE, ***SIEF_ELGA,*** *in the local reference mark of the element, are organized in the following way:*

The values are stored:

· for each point of Gauss in the length, (n=1, 3)
· for each point of integration in the thickness, (n=1, 2NCOU+1)
· for each point of integration on the circumference, (n=1, 2NSECT+1)
· 6 components of strain or stresses:
EPXX EPYY EPZZ EPXY EPXZ EPYZ *or* ***SIXX SIYY SIZZ SIXY***
SIXZ SIYZ
where X indicates the direction given by the two nodes tops of the element, Y represents the angle describing the circumference and Z represent the ray. ***EPZZ*** *and* ***EPYZ*** *corresponding to,*
in
rr
R
case of the deformations and ***SIZZ*** *and* ***SIYZ*** *corresponding to,*
in
rr R
the case of the constraints is taken equal to zero.

(in ***STAT_NON_LINE****, the number of layers is variable, as well as the number of sectors.*
One uses here 3 layers and 16 sectors by analogy with modeling A).

Titrate:
SSLL106 - Right pipe

Date:
05/01/04
Author (S):
J. Mr. PROIX
Key: V3.01.106-B Page: 9/22

6
Results of modeling B

6.1 Values tested

Loading case	Size	Reference	Aster %	difference
1	DX	5.53E06	5.52E06	-0.04
1	DY	4.14E06	4.14E06	-0.04
2	DRZ	2.63E02	2.63E02	-0.04
2	DX	5.27E02	5.26E02	-0.056
2	DY	7.02E02	7.02E02	-0.056
3	DRX	1.58E02		

1.58E02
-0.04
3 DRY
2.11E02
2.11E02
-0.039
3 DZ
8.78E02
8.77E02
-0.056
4 DRX
1.10E02
1.10E02
0
4 DRY
8.21E03
8.21E03
0
5 DRX
6.32E03
6.32E03
-0.04
5 DRY
8.42E03
8.42E03
-0.04
5 DZ
2.63E02
2.63E02
-0.04
6 DRZ
1.05E02
1.05E02
-0.039
6 DX
1.58E02
1.58E02
-0.04
6 DY
2.11E02
2.11E02
-0.039
7 WO

7.38E06
7.16E06
-2.946

Loading case
Field
Net
Not Component Reference
***Aster** %*
difference
1
SIEF_ELGA
M18 Z SIXX 2.76E+05
2.73E+05
-1.159
1
SIEF_ELNO_ELGA
M18 1 NR 5.00E+02
5.01E+02 0.136
4
SIEF_ELGA
M18 1 SIXY 6.75E+06
6.74E+06
-0.159
4
SIEF_ELGA
M18 693
SIXY 8.42E+06
8.42E+06 0.049
4
SIEF_ELNO_ELGA
M18 1 MT 5.00E+02
5.00E+02 0
5
SIEF_ELGA
M18 479
SIXX 1.35E+07
1.33E+07 1.288
5
SIEF_ELNO_ELGA
M18 1 MFY 5.00E+02
5.01E+02 0.123

6
SIEF_ELGA
M18 471
SIXX 1.35E+07
1.33E+07 1.288
6
SIEF_ELNO_ELGA
M18 1 MFZ 5.00E+02
5.01E+02 0.123
7
SIEF_ELGA
M18 1 SIYY 4.56E+07
4.53E+07
-0.641
7
SIEF_ELGA
M18 693
SIYY 3.56E+07
3.54E+07 0.371

Generalized deformations DEGE_ELNO_DEPL:

Loading case
Loadings
Size
Reference
***Aster** %*
difference
1 FX = 4.102
EPXX
1.38155E-06 1.38155E-06
-0.04

FY = 3.102

2 FX = 3.102 GAXY 3.5920E-06
4.7415E06
32

FY = 4.102 KZ 1.0530E02

1.04E02
-1.2
3 FZ = 5.102 GAXZ
3.5920E-06
4.7415E06
32

KY
1.0530E02
1.04E02
-1.2
4 MX = 4.102 GAT 2.73783E-03
2.73783E-03
0

MY = 3.102

5 MX = 3.102 KY
2.1060E-03
2.1052E-03
-0.04

MY = 4.102

6 MZ = 5.102 KZ 2.1060E-03
2.1052E-03
-0.04
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/03/008/A

Code_Aster ®
Version
7.2

Titrate:
SSLL106 - Right pipe

Date:

6.2 Remarks

The values of shearings corresponding to the shearing action are not precise for this modeling. This is due to the functions of interpolation of order 2 of this element, for displacements of beam and rotations of beams. As transverse shearings of beam are obtained by:

duy
= -
, and that for the pure bending, rotations vary like polynomials of order 2,
xy
Z
dx
but displacements, like polynomials of order 3, which is badly approached by the functions of interpolation. The derivative of displacements is thus not precise.

---

7 Modeling
C

7.1

Characteristics of modeling

10 elements TUYAU_6M.

7.2
Characteristics of the grid

10 meshs SEG3. The beam is directed according to the vector (4, 3, 0).

7.3 Functionalities
tested

Orders

AFFE_MODELE MODELING
TUYAU_6M

AFFE_CARA_ELEM BEAM
SECTION RINGS

MACRO_ELAS_MULT
OPTION
SIEF_ELGA_DEPL

OPTION
EPSI_ELGA_DEPL

OPTION
EFGE_ELNO_DEPL

Notice on the contents of the fields:

Fields at the points of Gauss for the element PIPE
, EPSI_ELGA_DEPL and
SIEF_ELGA_DEPL, which provide the strains and the stresses to the points of integration
in the local reference mark of the element, are organized in the following way:

The values are stored:

· for each point of Gauss in the length, (n=1, 3)
· for each point of integration in the thickness, (n=1, 2NCOU+1=7)
· for each point of integration on the circumference, (n=1, 2NSECT+1=33)

· 6 components of strain or stresses:
EPXX EPYY EPZZ EPXY EPXZ EPYZ or SIXX SIYY SIZZ SIXY
SIXZ SIYZ
where X indicates the direction given by the two nodes tops of
the element, Y represents the angle describing the circumference and Z
represent the ray. EPZZ and EPYZ corresponding to,
in
rr
R
case of the deformations and SIZZ and SIYZ corresponding to,
in
rr R
the case of the constraints is taken equal to zero.

(for MECA_STATIQUE or MACRO_ELAS_MULT, the number of layers is fixed, and equal to 3, and
the number of sectors is equal to 16).

EFGE_ELNO_DEPL represents the efforts generalize with the 3 nodes in the traditional way: NR, VY, VZ, MT, MFY, MFZ.

8
Results of modeling C

8.1 Values
tested

Loading case
Size
Reference
Aster %
difference
1 FX = 4.102
DX
5.53E06
5.52E06
-0.04
1 FY = 3.102 DY
4.14E06
4.14E06
-0.04
2 FX = 3.102 DRZ
2.63E02
2.63E02
-0.04
2 FY = 4.102 DX
5.27E02
5.26E02
-0.056
2
DY
7.02E02
7.02E02
-0.056
3 FZ = 5.102 DRX
1.58E02
1.58E02
-0.04
3
DRY
2.11E02
2.11E02
-0.039
3
DZ
8.78E02
8.77E02
-0.056
4 MX = 4.102 DRX

1.10E02
1.10E02
0
4 MY = 3.102 DRY
8.21E03
8.21E03
0
5 MX = 3.102 DRX
6.32E03
6.32E03
-0.04
5 MY = 4.102 DRY
8.42E03
8.42E03
-0.04
5
DZ
2.63E02
2.63E02
-0.04
6 MZ = 5.102 DRZ
1.05E02
1.05E02
-0.039
6
DX
1.58E02
1.58E02
-0.04
6
DY
2.11E02
2.11E02
-0.039
7: pressure
WO
7.38E06
7.16E06
-2.946
8: gravity
DZ
4.646 E-02 4.642
E-02

0.09
9: charge distributed
DZ
4.646 E-02 4.642
E-02
0.09

Loading case
Field
Net Point Component Reference
Aster %
difference
1
EFGE_ELNO_DEPL
M18 1 NR
5.00E+02
5.01E+02 0.136
1
EPSI_ELGA_DEPL
M18 1 EPXX 1.38E06
1.38E06
-0.031
1
SIEF_ELGA_DEPL
M18 1 SIXX 2.76E+05
2.73E+05
-1.159
4
EFGE_ELNO_DEPL
M18 1 MT
5.00E+02
5.00E+02 0
4
EPSI_ELGA_DEPL
M18 1 EPXY 8.77E05 8.76E05
-0.102
4
EPSI_ELGA_DEPL
M18 693
EPXY 1.09E04 1.10E04 0.049
4
SIEF_ELGA_DEPL

M18 1 SIXY 6.75E+06 6.74E+06
-0.159
4
SIEF_ELGA_DEPL
M18 693
SIXY 8.42E+06 8.42E+06 0.049
5
EFGE_ELNO_DEPL
M18 1 MFY 5.00E+02
5.01E+02 0.123
5
EPSI_ELGA_DEPL
M18 479
EPXX
6.74E05
6.74E05 0.046
5
SIEF_ELGA_DEPL
M18 479
SIXX
1.35E+07
1.33E+07 1.288
6
EFGE_ELNO_DEPL
M18 1 MFZ 5.00E+02
5.01E+02 0.123
6
EPSI_ELGA_DEPL
M18 471
EPXX
6.74E05
6.74E05 0.046
6
SIEF_ELGA_DEPL
M18 471
SIXX
1.35E+07
1.33E+07 1.288
7
EPSI_ELGA_DEPL
M18 1 EPYY 2.28E04
2.24E04
-1.716

7
EPSI_ELGA_DEPL
M18 693
EPYY
1.78E04
1.79E04 0.741
7
SIEF_ELGA_DEPL
M18 1 SIYY 4.56E+07
4.53E+07
-0.641
7
SIEF_ELGA_DEPL
M18 693
SIYY
3.56E+07
3.54E+07 0.371
8
EFGE_ELNO_DEPL
M1 1 MFY
1764.3
1728
2
9
EFGE_ELNO_DEPL
M1 1 MFY
1764.3
1728
2

Generalized deformations DEGE_ELNO_DEPL:

Loading case
Loadings
Size
Reference
Aster %
difference
1 FX = 4.102
EPXX
1.38155E-06 1.38155E-06
-0.04

FY = 3.102

2 FX = 3.102 GAXY 3.5920E-06
4.7415E06
32

FY = 4.102 KZ 1.0530E02
1.04E02
-1.2
3 FZ = 5.102 GAXZ
3.5920E-06
4.7415E06
32

KY
1.0530E02
1.04E02
-1.2
4 MX = 4.102 GAT 2.73783E-03
2.73783E-03
0

MY = 3.102

5 MX = 3.102 KY
2.1060E-03
2.1052E-03
-0.04

MY = 4.102

6 MZ = 5.102 KZ 2.1060E-03
2.1052E-03
-0.04

Fréquenc
Reference
Aster %
difference
E clean
1 2.90229 2.90378
0.05
2 2.90229 2.
90378
0.05
3 18.18967 18.2047 0.08
4 18.18967 18.2047 0.08
5 50.99367 51.006 0.02
6 50.99367 51.006 0.02
7 99.81783 100.0478 0.2
8 99.81783 100.0478 0.2
9 157.0190 157.0185 0.001
10 164.9922
165.606
0.3
11 164.9922
165.606
0.3
12 253.185
247.82
2

8.2 Remarks

The values of shearings corresponding to the shearing action are not precise for this modeling. This is due to the functions of interpolation of order 2 of this element, for displacements of beam and rotations of beams. As transverse shearings of beam are obtained by:

duy
= -
, and that for the pure bending, rotations vary like polynomials of order 2,
xy
Z
dx
but displacements, like polynomials of order 3, which is badly approached by the functions of interpolation. The derivative of displacements is thus not precise.

---

9 Modeling D

9.1 Characteristics of modeling

10 elements TUYAU_6M, calculation with STAT_NON_LINE.

9.2 Characteristics of the grid

10 meshs SEG3. The beam is directed according to the vector (4, 3, 0).

9.3 Functionalities tested

Orders

AFFE_MODELE
MODELING
TUYAU_6M

AFFE_CARA_ELEM BEAM
SECTION
RING

STAT_NON_LINE COMP_INCR
RELATION ELAS

COMP_INCR
TUYAU_NCOU
3

COMP_INCR
TUYAU_NSEC
16

OPTION
SIEF_ELNO_ELGA

Notice on the contents of the fields:

Stress fields at the points of Gauss for the element PIPE, SIEF_ELGA, in the local reference mark of the element, are organized in the following way:

The values are stored:

· for each point of Gauss in the length, (n=1, 3)
· for each point of integration in the thickness, (n=1, 2NCOU+1)
· for each point of integration on the circumference, (n=1, 2NSECT+1)
· 6 components of strain or stresses:

EPXX EPYY EPZZ EPXY EPXZ EPYZ or SIXX SIYY SIZZ SIXY
SIXZ SIYZ
where X indicates the direction given by the two nodes tops of
the element, Y represents the angle describing the circumference and Z
represent the ray. EPZZ and EPYZ corresponding to,
in
rr
R
case of the deformations and SIZZ and SIYZ corresponding to,
in
rr R
the case of the constraints is taken equal to zero.

(in STAT_NON_LINE, the number of layers is variable, as well as the number of sectors.
One uses here 3 layers and 16 sectors by analogy with modeling A).

---

10 Results of modeling D

10.1 Values
tested

Loading case
Size
Reference
Aster %
difference
1 DX

5.53E06
5.52E06
-0.04
1 DY
4.14E06
4.14E06
-0.04
2 DRZ
2.63E02
2.63E02
-0.04
2 DX
5.27E02
5.26E02
-0.056
2 DY
7.02E02
7.02E02
-0.056
3 DRX
1.58E02
1.58E02
-0.04
3 DRY
2.11E02
2.11E02
-0.039
3 DZ
8.78E02
8.77E02
-0.056
4 DRX
1.10E02
1.10E02
0
4 DRY
8.21E03
8.21E03
0
5 DRX
6.32E03
6.32E03
-0.04

5 DRY
8.42E03
8.42E03
-0.04
5 DZ
2.63E02
2.63E02
-0.04
6 DRZ
1.05E02
1.05E02
-0.039
6 DX
1.58E02
1.58E02
-0.04
6 DY
2.11E02
2.11E02
-0.039
7 WO
7.38E06
7.16E06
-2.946

Loading case
Field
Net
Not Component Reference
Aster %
difference
1
SIEF_ELGA
M18 Z SIXX 2.76E+05
2.73E+05
-1.159
1
SIEF_ELNO_ELGA
M18 1 NR 5.00E+02
5.01E+02 0.136
4
SIEF_ELGA

M18 1 SIXY 6.75E+06
6.74E+06
-0.159
4
SIEF_ELGA
M18 693
SIXY 8.42E+06
8.42E+06 0.049
4
SIEF_ELNO_ELGA
M18 1 MT 5.00E+02
5.00E+02 0
5
SIEF_ELGA
M18 479
SIXX 1.35E+07
1.33E+07 1.288
5
SIEF_ELNO_ELGA
M18 1 MFY 5.00E+02
5.01E+02 0.123
6
SIEF_ELGA
M18 471
SIXX 1.35E+07
1.33E+07 1.288
6
SIEF_ELNO_ELGA
M18 1 MFZ 5.00E+02
5.01E+02 0.123
7
SIEF_ELGA
M18 1 SIYY 4.56E+07
4.53E+07
-0.641
7
SIEF_ELGA
M18 693
SIYY 3.56E+07
3.54E+07 0.371

Generalized deformations DEGE_ELNO_DEPL:

Loading case
Loadings
Size
Reference
Aster %
difference
1 FX = 4.102
EPXX
1.38155E-06 1.38155E-06
-0.04

FY = 3.102

2 FX = 3.102 GAXY 3.5920E-06
4.7415E06
32

FY = 4.102 KZ 1.0530E02
1.04E02
-1.2
3 FZ = 5.102 GAXZ
3.5920E-06
4.7415E06
32

KY
-1.0530E02
-1.04E02
-1.2
4 MX = 4.102 GAT 2.73783E-03
2.73783E-03
0

MY = 3.102

5 MX = 3.102 KY
2.1060E-03
2.1052E-03

-0.04

MY = 4.102

6 MZ = 5.102 KZ 2.1060E-03
2.1052E-03
-0.04

10.2 Remarks

The values of shearings corresponding to the shearing action are not precise for this modeling. This is due to the functions of interpolation of order 2 of this element, for displacements of beam and rotations of beams. As transverse shearings of beam are obtained by:

duy
= -
, and that for the pure bending, rotations vary like polynomials of order 2,
xy
Z
dx
but displacements, like polynomials of order 3, which is badly approached by the functions of interpolation. The derivative of displacements is thus not precise.

---

11 Modeling
E

11.1 Characteristics of modeling

8 elements PIPE with 3 modes of Fourier and 4 nodes

11.2 Characteristics of the grid

8 meshs SEG4. The beam is directed according to the vector (4, 3, 0).

11.3 Functionalities
tested

Orders

AFFE_MODELE MODELING
PIPE
AFFE_CARA_ELEM BEAM
SECTION
RING

MACRO_ELAS_MULT
OPTION
SIEF_ELGA_DEPL

OPTION
EPSI_ELGA_DEPL

OPTION
EFGE_ELNO_DEPL

CREA_MAILLAGE OPTION
SEG3_4

Notice on the contents of the fields:

Fields at the points of Gauss for the element PIPE
, EPSI_ELGA_DEPL and
SIEF_ELGA_DEPL, which provide the strains and the stresses to the points of integration
in the local reference mark of the element, are organized in the following way:

The values are stored:

· for each point of Gauss in the length, (n=1, 3)
· for each point of integration in the thickness, (n=1, 2NCOU+1=7)
· for each point of integration on the circumference, (n=1, 2NSECT+1=33)
· 6 components of strain or stresses:
EPXX EPYY EPZZ EPXY EPXZ EPYZ or SIXX SIYY SIZZ SIXY
SIXZ SIYZ
where X indicates the direction given by the two nodes tops of
the element, Y represents the angle describing the circumference and Z
represent the ray. EPZZ and EPYZ corresponding to,
in
rr
R
case of the deformations and SIZZ and SIYZ corresponding to,

rr R
in the case of the constraints are taken equal to zero.

(for MECA_STATIQUE or MACRO_ELAS_MULT, the number of layers is fixed, and equal to 3,
and
the number of sectors is equal to 16).

EFGE_ELNO_DEPL represents the efforts generalize with the 3 nodes in the traditional way: NR,

VY, VZ, MT, MFY, MFZ.

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Code_Aster ®
Version
7.2

Titrate:
SSLL106 - Right pipe

Date:
05/01/04
Author (S):
J. Mr. PROIX
Key: V3.01.106-B Page: 18/22

12 Results of modeling E

12.1 Values tested

Loading case
Size
Reference
Aster %
difference
FX = 4.102
DX
5.53E06
5.52E06
-0.04
FY = 3.102 DY 4.14E06
4.14E06
-0.04
FX = 3.102 DRZ 2.63E02 2.63E02
-0.04
FY = 4.102 DX
5.27E02
5.264E02
-0.02
DY
7.02E02
7.019E02
-0.02
FZ = 5.102 DRX

1.58E02
1.58E02
-0.04
DRY
2.11E02
2.11E02
-0.04
DZ
8.78E02
8.77E02
-0.02
MX = 4.102 DRX
1.10E02
1.10E02
0
MY = 3.102 DRY
8.21E03
8.21E03
0
MX = 3.102 DRX
6.32E03
6.32E03
-0.04
MY = 4.102 DRY
8.42E03
8.42E03
-0.04
DZ
2.63E02
2.63E02
-0.04
MZ = 5.102 DRZ
1.05E02
1.05E02
-0.039
DX
1.58E02
1.58E02
-0.04
DY
2.11E02
2.11E02
-0.039

7: pressure
WO
7.38E06
7.16E06
-2.946
8: gravity
DZ
4.646 E-02 4.644
E-02 0.04
9: charge distributed
DZ
4.646 E-02 4.644
E-02 0.04

Loading case
Field
Net
Not Component Reference
Aster %
difference
1
EFGE_ELNO_DEPL
M18 1 NR
5.00E+02
5.01E+02
0.136
1
EPSI_ELGA_DEPL
M18 1 EPXX 1.38E06
1.38E06
-0.031
1
SIEF_ELGA_DEPL
M18 1 SIXX 2.76E+05
2.73E+05
-1.159
4
EFGE_ELNO_DEPL
M18 1 MT 5.00E+02
5.00E+02
0

4
EPSI_ELGA_DEPL
M18 1 EPXY
8.77E05 8.76E05
-0.102
4
EPSI_ELGA_DEPL
M18 693
EPXY 1.09E04 1.10E04 0.049
4
SIEF_ELGA_DEPL
M18 1 SIXY 6.75E+06 6.74E+06
-0.159
4
SIEF_ELGA_DEPL
M18 693
SIXY 8.42E+06 8.42E+06 0.049
5
EFGE_ELNO_DEPL
M18 1 MFY 5.00E+02
5.01E+02
0.123
5
EPSI_ELGA_DEPL
M18 479
EPXX 6.74E05
6.74E05 0.046
5
SIEF_ELGA_DEPL
M18 479
SIXX
1.35E+07
1.33E+07 1.288
6
EFGE_ELNO_DEPL
M18 1 MFZ 5.00E+02
5.01E+02
0.123
6
EPSI_ELGA_DEPL
M18 471
EPXX 6.74E05
6.74E05 0.046

6
SIEF_ELGA_DEPL
M18 471
SIXX
1.35E+07
1.33E+07 1.288
7
EPSI_ELGA_DEPL
M18 1 EPYY 2.28E04
2.24E04
-1.716
7
EPSI_ELGA_DEPL
M18 693
EPYY 1.78E04
1.79E04 0.741
7
SIEF_ELGA_DEPL
M18 1 SIYY 4.56E+07
4.53E+07
-0.641
7
SIEF_ELGA_DEPL
M18 693
SIYY
3.56E+07
3.54E+07 0.371
8
EFGE_ELNO_DEPL
M1 1 MFY
1764.3
1760
0.2
9
EFGE_ELNO_DEPL
M1 1 MFY
1764.3
1760
0.2

Generalized deformations DEGE_ELNO_DEPL:

Loading case
Loadings
Size
Reference
Aster %
difference
1 FX = 4.102
EPXX
1.38155E-06
1.38155E-06
-0.04

FY = 3.102

2 FX = 3.102 GAXY 3.5920E-06 4.7415E06 1.1

FY = 4.102 KZ
1.0530E02
1.04E02 0.05
3 FZ = 5.102 GAXZ 3.5920E-06
4.7415E06 1.1

KY
1.0530E02

1.04E02
-0.05
4 MX = 4.102 GAT 2.73783E-03
2.73783E-03
0

MY = 3.102

5 MX = 3.102 KY
2.1060E-03 2.1052E-03 0.04

MY = 4.102

6 MZ = 5.102 KZ
2.1060E-03 2.1052E-03
-0.04

Fréquenc
Reference
Aster %
difference
E clean
1 2.90229
2.90303
0.02
2 2.90229
2.90303
0.02
3 18.18967
18.171 0.1
4 18.18967
18.171 0.1
5 50.99367
50.781 0.4
6 50.99367
50.781 0.4
7 99.81783

99.923 0.6
8 99.81783
99.923 0.6
9 157.0190
157.0185 0.001

12.2 Remarks

The values of shearings corresponding to the shearing action are precise for this modeling. This is due to the functions of interpolation of order 3 of this element, for displacements of beam and rotations of beams.

---

13 Modeling F

13.1 Characteristics of modeling

1 elements TUYAU_3M with 4 nodes, calculation with STAT_NON_LINE.

13.2 Characteristics of the grid

1 meshs SEG4. The beam is directed according to the vector (4, 3, 0).

13.3 Functionalities tested

Orders

AFFE_MODELE
MODELING
PIPE
AFFE_CARA_ELEM BEAM
SECTION
RING

STAT_NON_LINE COMP_INCR
RELATION ELAS

COMP_INCR
TUYAU_NCOU
3

COMP_INCR
TUYAU_NSEC
16

OPTION
SIEF_ELNO_ELGA

CREA_MAILLAGE OPTION
SEG3_4

Notice on the contents of the fields:

Stress fields at the points of Gauss for the element PIPE, SIEF_ELGA, in the local reference mark of the element, are organized in the following way:

The values are stored:

· for each point of Gauss in the length, (n=1, 3)
· for each point of integration in the thickness, (n=1, 2NCOU+1)
· for each point of integration on the circumference, (n=1, 2NSECT+1)
· 6 components of strain or stresses:
EPXX EPYY EPZZ EPXY EPXZ EPYZ or SIXX SIYY SIZZ SIXY SIXZ SIYZ
where X indicates the direction given by the two nodes tops of the element, Y represents the angle describing the circumference and Z

represent the ray. EPZZ and EPYZ corresponding to,
in
rr
R
case of the deformations and SIZZ and SIYZ corresponding to,
in
rr R
the case of the constraints is taken equal to zero.

(in STAT_NON_LINE, the number of layers is variable, as well as the number of sectors.
One uses here 3 layers and 16 sectors by analogy with modeling A).

---

14 Results of modeling F

14.1 Values
tested

Loading case
Size
Reference
Aster %
difference
1 DX
5.53E06
5.52E06 0.04
1 DY
4.14E06

4.14E06 0.04
2 DRZ
2.63E02
2.63E02 0.04
2 DX
5.27E02
5.26E02 0.02
2 DY
7.02E02
7.02E02 0.02
3 DRX
1.58E02
1.58E02 0.04
3 DRY
2.11E02
2.11E02 0.02
3 DZ
8.78E02
8.77E02 0.04
4 DRX
1.10E02
1.10E02 0
4 DRY
8.21E03
8.21E03 0
5 DRX
6.32E03
6.32E03 0.04
5 DRY
8.42E03
8.42E03 0.04
5 DZ
2.63E02
2.63E02 0.04
6 DRZ
1.05E02
1.05E02 0.04
6 DX
1.58E02
1.58E02 0.04
6 DY
2.11E02
2.11E02 0.04

7 WO
7.38E06
7.167E06 3.3

Loading case
Field
Net
Not Component Reference
Aster %
difference
1
SIEF_ELGA
M18 Z SIXX 2.76E+05
2.73E+05
-1.159
1
SIEF_ELNO_ELGA
M18 1 NR 5.00E+02
5.01E+02 0.136
4
SIEF_ELGA
M18 1 SIXY 6.75E+06
6.74E+06
-0.159
4
SIEF_ELGA
M18 693
SIXY 8.42E+06
8.42E+06 0.049
4
SIEF_ELNO_ELGA
M18 1 MT 5.00E+02
5.00E+02 0
5
SIEF_ELGA
M18 479
SIXX 1.35E+07
1.33E+07 1.288
5
SIEF_ELNO_ELGA
M18 1 MFY 5.00E+02
5.01E+02 0.123

6
SIEF_ELGA
M18 471
SIXX 1.35E+07
1.33E+07 1.288
6
SIEF_ELNO_ELGA
M18 1 MFZ 5.00E+02
5.01E+02 0.123
7
SIEF_ELGA
M18 1 SIYY 4.56E+07
4.53E+07
-0.641
7
SIEF_ELGA
M18 693
SIYY 3.56E+07
3.54E+07 0.371

Generalized deformations DEGE_ELNO_DEPL:

Loading case
Loadings
Size
Reference
Aster %
difference
1 FX = 4.102
EPXX
1.38155E-06 1.38155E-06
-0.04

FY = 3.102

2 FX = 3.102 GAXY 3.5920E-06
4.7415E06
21

FY = 4.102 KZ 1.0530E02

1.04E02
-0.04
3 FZ = 5.102 GAXZ
3.5920E-06
4.7415E06
21

KY
1.0530E02
1.04E02
-0.04
4 MX = 4.102 GAT 2.73783E-03
2.73783E-03
0

MY = 3.102

5 MX = 3.102 KY
2.1060E-03
2.1052E-03
-0.04

MY = 4.102

6 MZ = 5.102 KZ 2.1060E-03
2.1052E-03
-0.04
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Titrate:
SSLL106 - Right pipe

Date:

14.2 Remarks

The values of shearings corresponding to the shearing action are not precise for this modeling. This is due to the weak discretization for this modeling (only one element).

15 Summary of the results

This test makes it possible to check the correct operation of the element PIPE (3 modes and 6 modes of Fourier)
in linear elasticity, with operators MECA_STATIQUE and STAT_NON_LINE, for the whole of loadings applicable to this element.

The variations compared to the analytical reference solution (solution in assumption of beam) are very
weak for displacements (0,04% to 0,06%), except for the loading of pressure where the variation of 3%
is due to the fact that Wo represents an average radial displacement. Actually this radial displacement varies
in the thickness. The variation on the strains and the stresses (~
-1%) is more important than that
on displacements but remains acceptable taking into account the fact that these values are calculated in
points of integration located in the thickness of the pipe.

02/06/03
Author (S):
J.M. PROIX
Key: V3.01.107-A Page: 1/24

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.107

SSLL107 - Validation of MACRO_CARA_POUTRE

Summary:

The whole of modelings of this test make it possible to validate the macro_commande calculation of characteristics of section of beam, MACRO_CARA_POUTRE, for all the options suggested. Sections studied are different according to modelings.

· Modeling A validates the calculation of the characteristics of section of a corner type.
· Modeling B validates the calculation of the characteristics of a circular section.
· Modeling C validates the calculation of the characteristics of a rectangular section.
· Modeling D validates the calculation of the characteristics of an alveolate rectangular section.
· Modeling E validates the calculation of the characteristics of an octagonal section.
· Modeling F validates the calculation of the characteristics of a circular section with a sequence on a calculation of beam.
· Modeling G validates the calculation of a network of 2 rectangular beams of section.

· Modeling H validates the calculation of the characteristics of a mean section out of U.
· Modeling I validates the calculation of the constant of torsion for a perforated section.

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Version
6.4

Titrate:
SSLL107 - Validation of MACRO_CARA_POUTRE

Date:
02/06/03
Author (S):
J.M. PROIX
Key: V3.01.107-A Page: 2/24

1
Problem of reference

1.1 Geometry

The geometry of the various sections is provided via a plane grid. It are different for each modeling, and will thus be described in the corresponding paragraphs.

Modeling G also implements the chained calculation of the characteristics of a section circular, and the use of these characteristics in a calculation of a right beam, L=1m length, in pure traction.

1.2
Material properties

Without object, except for modeling G, where the treated beam has a Young modulus of 2.E11Pa and one
Poisson's ratio of 0.3.

1.3
Boundary conditions and loadings

Without object, except for modeling G: the right beam is embedded at an end, and is subjected to

the other end with a tractive effort F=1000N.

2
Reference solution

2.1
Method of calculation used for the reference solution

Since the solutions are specific to each modeling, they are described in corresponding paragraphs. They are drawn mainly from [bib1] and [bib2];

2.2
Results of reference

One describes here the characteristics calculated by MACRO_CARA_POUTRE [R3.08.03]:

· Caractéristiques geometrical of the sections

1) In reference mark OXY of description of the grid 2D for the grid provided by the user
· surface: AIRE_M
· position of the centre of gravity: CDG_X_M, CDG_Y_M
· moments and product of inertia of surface, in the centre of gravity G in reference mark GXY: IX_G_M,
IY_G_M, IXY_G_M
2) In the same total reference mark, for the grid obtained by symmetrization if SYME_X or SYME_Y:
· surface: SURFACE
· position of the centre of gravity: CDG_X, CDG_Y
· moments and product of inertia of surface, in the centre of gravity G in reference mark GXY: IX_G, IY_G,
IXY_G
3) In the principal reference mark of inertia GYZ. cross-section, whose denomination corresponds to that used with the description of the elements of neutral fibre beam GX [U4.24.01].
· principal moments of inertia of surface in reference mark GYZ, usable for the calculation of rigidity of inflection of the beam: IY_PRIN_G and IZ_PRIN_G
· angle of flow of reference mark GXY to the principal reference mark of inertia GYZ: ALPHA
· characteristic distances, compared to the centre of gravity G of the section for calculations of maximum constraints: Y_MAX, Y_MIN, Z_MAX, Z_MIN and R_MAX.
4) In the total reference mark, in a point P provided by the user:
· X_P Y_P: not calculation of the moments of inertia
· IX_P IY_P IXY_P: moments of inertia in reference mark PXY
· IY_PRIN_P IZ_PRIN_P: moments of inertia in reference mark PYZ.

· Characteristic mechanics:
Handbook of Validation

Identification
Significance
CT
Constant of torsion
EY
Position of the center of torsion/shearing
EZ
Position of the center of torsion/shearing
PCTX
PCTY
AX
Coefficient of shearing
AY
Coefficient of shearing
JG
Constant of warping

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
PILKEY W.D.: "Formulated for stress, Strain and Structural Matrices". Wiley & Idiots,
New York, 1994.
[2]
D. BLEVINS: Formulated for natural frequency and shape mode.
Handbook of Validation
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---

3 Modeling
With

3.1
Characteristics of modeling

Corner section:

The co-ordinates of the points are:

P1
0.0
0.0
P2
1.3E02
0.0
P3
4.75E02
0.0
P4
5.0E02

0.0E+00
P5
5.0E02
5.5E03
P6
4.750E02
8.0E03
P7
1.30E02
8.0E03
P8
9.4645E03
9.4645E03
P9
4.750E02
5.500E03
P10
8.0E03
1.300E02
P11
8.0E03
4.75E02
P12
5.5E03
5.0E02
P13
0.
5.0E02
P14
5.5E03
4.75E02

3.2 Characteristics of the grid

182 meshs TRIA6.

3.3 Functionalities tested

Orders

MACRO_CARA_POUTRE GROUP_MA_BORD

3.4 Reference solution

No the exact analytical solution. The values are values of nonregression.

4
Results of modeling A

4.1 Values tested

Identification Reference Aster % difference
SURFACE 7.39E04
7.39E04
-0.043
ALPHA 1.35E+02
1.35E+02
0
CDG_X 1.53E02
1.53E02
0.131
CDG_Y 1.53E02
1.53E02
0.131
CT 1.43E08
1.60E08
11.0
EY 0.00E+00
7.13E08
0
EZ 1.60E02
1.51E02

0.001
IX_G 1.64E07
1.64E07
0.138
IXR2_P 1.41E08
1.39E08
-1.295
IXY_G 9.50E08
9.49E08
-0.066
IY_G 1.64E07
1.64E07
0.138
IY_PRIN_G 6.95E08 6.93E08
-0.303
IYR2_P 1.41E08
1.39E08
-1.295
IZ_PRIN_G 2.60E07 2.59E07
-0.321
PCTX 4.00E03
4.67E03
6.66E04
PCTY 4.00E03
4.67E03
6.66E04
R_MAX 3.79E02
3.79E02
-0.018
Y_MAX 3.54E02
3.54E02
-0.013
Y_MIN 3.54E02
3.54E02
-0.013
2.17E02
2.17E02
0.026
Z_MAX

Z_MIN 1.83E02
1.83E02

0.005

---

5 Modeling B

5.1 Characteristics of modeling

Section external circle of radius R=0.025m and thickness 0.005m. One represents only one quarter of section. This modeling makes it possible to test key word CARA_GEOM of POST_ELEM, employee also by MACRO_CARA_POUTRE to calculate the geometrical characteristics of a surface plane.

y
R
G
Z
ep

5.2 Characteristics of the grid

30 meshs QUAD8.

5.3 Functionalities tested

Orders

POST_ELEM CARA_GEOM
SYME_X
SYME_Y

5.4 Reference solution

For the complete section:

With = [2
R - (
R
- ep) 2]
-4
2
= 76714
.
1
10 m

I

=
I

=

-
-
=
-

y
Z
[4
R (
R ep) 4]
7
4
81132
.
1
10 m
4

I

=

-
-
p
[4
R (
R ep) 4]
2

6
Results of modeling B

6.1 Values

tested

Identification Reference
***Aster** %*
difference
AIRE_M 1.76714E04
1.76714E04
7.76E05
CDG_X_M 1.438288E02 1.43829E02
1.25E04
CDG_Y_M 1.438288E02 1.43829E02
1.25E04
IX_G_M 8.7265757E09
8.7266E09
2.78E04
IY_G_M 8.7265757E09
8.7266E09
2.78E04
IXY_G_M 7.72837E09 7.7284E09
3.83E04
SURFACE 7.0685745E04
7.06858E04
7.76E05
CDG_X 0.00000E+00
0.00000E+00
0
CDG_Y 0.00000E+00
0.00000E+00
0
IX_G 1.81132E07
1.81132E07
4.19E06
IY_G 1.81132E07
1.81132E07
4.19E06
IXY_G 0.00000E+00
0.00000E+00

IY_PRIN_G 1.81132E07 1.81132E07
4.19E06
IZ_PRIN_G 1.81132E07 1.81132E07
4.19E06
Y_MIN 2.50000E02

2.50000E02
0.00E+00
Y_MAX 2.50000E02
2.50000E02
0.00E+00
Z_MIN 2.50000E02
2.50000E02
0.00E+00
Z_MAX 2.50000E02
2.50000E02
0.00E+00

---

7 Modeling C

7.1 Characteristics of modeling

Rectangular section digs which one represents a quarter. This modeling makes it possible to test the word key CARA_GEOM of POST_ELEM, employee also by MACRO_CARA_POUTRE to calculate them geometrical characteristics of a level surface.

y
epy
X

G
hy
epx
hx

Hx=0.02m, Hy=0.05m, epx=0.002m, epy=0.005m.

7.2
Characteristics of the grid

The co-ordinates of the nodes are:

N1 8.00E-03 0.00E+00
N2 8.00E-03 2.00E-02
N3 0.00E+00 2.00E-02
N4 0.00E+00 2.50E-02
N5 1.00E-02 2.50E-02
N6 1.00E-02 0.00E+00
N7 8.00E-03 6.6667E-03
N8 8.00E-03 1.3333E-02
N9 4.00E-03 2.00E-02
N10 5.00E-03 2.50E-02
N11 1.00E-02 1.66667E-02
N12 1.00E-02 8.3333E-03

7.3 Functionalities tested

Orders

POST_ELEM CARA_GEOM
SYME_X
SYME_Y

7.4 Reference solution

With = H H
-
-
-
-
=
y Z
(H2 ep H2 ep
6
.
3 10 m
y
y) (Z
Z)
4
2
1

I

=

-
-

-
-
=
X
[3
H H

H2 ep H2 ep
10
23
.
1
m
y
Z
(y
y) (Z
) 3
Z
]
7
4
12

1
I

=

y
[3
H H

- H - ep

2

H - ep

2

10
968

.
1
-
=
Z
y
(Z
Z) (y
) 3
y
]
8
12

8 *Results of modeling C*

8.1 Values tested

Identification
Reference
Aster
% difference
SURFACE 3.60000E04
3.60000E04

2.26E13
ALPHA 9.00000E+01
9.00000E+01
0.00E+00
CDG_X 0.00000E+00
0.00000E+00
0
CDG_Y 0.00000E+00
0.00000E+00
0.00E+00
IX_G 1.23000E07
1.23000E07
6.46E14
IXY_G_M 1.11111E09 1.11111E09 1.00E04
IY_G 1.96800E08
1.96800E08
2.52E13
IY_PRIN_G 1.96800E08 1.96800E08
2.52E13
IZ_PRIN_G 1.23000E07 1.23000E07
6.46E14
R_MAX 2.69258E02
2.69260E02
6.54E04
Y_MAX 2.50000E02
2.50000E02
0.00E+00
Y_MIN 2.50000E02
2.50000E02
0.00E+00
Z_MAX 1.00000E02
1.00000E02
0.00E+00
Z_MIN 1.00000E02
1.00000E02
0.00E+00

9 Modeling D

9.1 Characteristics of modeling

Hollow rectangular section. This modeling makes it possible to test MACRO_CARA_POUTRE to calculate
geometrical and mechanical characteristics of a level surface.
Two calculations are carried out:

· first is carried out with the key word SYME_Y = "YES", i.e. that the section considered is obtained by symmetry around the axis Y (alveolate section). Moreover inertias are calculated compared to the point of co-ordinates (0, 0.025) (key word ORIG_INER),
· second is carried out without symmetry, on the section with a grid, with a calculation of inertias with center grid, C of co-ordinates (0.005, 0), and 2 different groups of meshs, which correspond each one to the vertical half of the grid (on both sides of the axis Cy).

9.2 Characteristics of the grid

40 meshs QUAD4.
Co-ordinates of the nodes tops of
rectangle are:
N1 0.00E+00 2.50E02
N2 0.00E+00 2.50E02
N3 1.00E02 2.50E02
N4 1.00E02 2.50E02
N5 2.00E03 2.00E02
N6 2.00E03 2.00E02
N7 8.01E03 2.00E02
N8 8.01E03 2.00E02

N9 0.00E+00 0.00E+00

9.3 Functionalities tested

Orders

MACRO_CARA_POUTRE SYME_Y YES

MACRO_CARA_POUTRE ORIG_INER

10 Results of modeling D

10.1 Values tested

For the section symmetrized according to OY, the geometrical characteristics are:

Identification
Reference

Aster
% difference
AIRE_M 2.600E04
2.6000E04
1.25E13
SURFACE 5.200E04
5.2000E04
1.25E13
ALPHA 9.000E+01
9.0000E+01
0.00E+00
CDG_X_M 5.000E03
5.0000E03
5.20E14
CDG_X 0.000E+00
0.0000E+00
0.00E+00
CDG_Y_M 0.000E+00
1.4008E18
1.40E18
CDG_Y 0.000E+00
1.4002E18
1.40E18
IX_G_M 7.21667E08
7.21667E08
4.62E05
IX_G 1.44333E07
1.44333E07
2.31E04
IX_P 4.69333E07
4.69333E07
7.10E05
IXY_G_M 0.000E+00
4.332E26
4.33E26
IXY_G 0.000E+00
4.332E26
4.33E26
IY_G_M 3.44667E09
3.446667E09
9.67E05
IY_G 1.98933E08
1.989333E08

1.68E04
IY_PRIN_G 1.98933E08 1.989333E08
1.68E04
IY_P 1.98933E08
1.989333E08
1.68E04
IZ_PRIN_G 1.44333E07
1.443333E07
2.31E04
R_MAX 2.69260E02
2.692582E02
6.54E04
Y_MAX 2.500E02
2.5000E02
0.00E+00
Y_MIN 2.500E02
2.5000E02
0.00E+00
Z_MAX 1.000E02
1.0000E02
1.73E14
Z_MIN 1.000E02
1.0000E02
1.73E14

For the not symmetrized section, the geometrical characteristics are:

Place
Identification
Reference
Aster
% difference
ALL
IX_P
3.60833E08
3.60833E08
9.24E05
GR1
IX_P
3.60833E08
3.60833E08
9.24E05

GR2
IX_P
7.21667E08
7.21667E08
4.62E05
ALL
IY_P
1.72333E09
1.72333E09
1.93E04
GR1
IY_P
1.72333E09
1.72333E09
1.93E04
GR2
IY_P
3.44667E09
3.44667E09
9.67E05

---

11 Modeling E

11.1 Characteristics of modeling

Hollow octagonal section, which one nets a quarter.

11.2 Characteristics of the grid
N1 2.30969E-02 0.00000E+00
N2 2.30969E-02 9.56708E-03
N3 9.56708E-03 2.30969E-02
N4 0.00000E+00 2.30969E-02
N5 2.11835E-02 0.00000E+00
N6 2.11835E-02 8.77452E-03
N7 8.77452E-03 2.11835E-02
N8 0.00000E+00 2.11835E-02

11.3 Functionalities
tested

Orders

MACRO_CARA_POUTRE SYME_Y
YES

12 Results of modeling E

12.1 Values tested

For the section symmetrized according to OY, the geometrical characteristics are:

Identification
Reference
Aster
% difference
ALPHA 9.00000E+01
9.000000E+01
0.00E+00

IXY_G 0.00000E+00
0.000000E+00
0.00E+00

IY_G 7.28824E08
7.288478E08
0.003

IY_PRIN_G 7.28824E08
7.288478E08
0.003

IZ_PRIN_G 7.28824E08
7.288478E08
0.003

R_MAX 2.50000E02
2.500000E02
4.58E13

Y_MAX 2.30967E02
2.309698E02
0.001

Y_MIN 2.30967E02
2.309698E02
0.001

Z_MAX 2.30967E02
2.309698E02
0.001

Z_MIN 2.30967E02
2.309698E02
0.001

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---

13 Modeling F

13.1 Characteristics of modeling

Full circular section, of ray 0.025m. The characteristics calculated are then used directly in a calculation of right beam (L=1m length), in pure traction (F=1000N). Young modulus is worth 2.E11 Pa.

The characteristics of the section are introduced into AFFE_CARA_ELEM via variables python.

13.2 Characteristics of the grid

A number of meshs: 52 TRIA6, 299 QUAD8

13.3 Functionalities tested

Orders

MACRO_CARA_POUTRE
GROUP_MA_BORD

13.4 Reference solution

With = [2
R]
3

-
2
= 9635
.
1
10 m

I

=
I

=

-
=

y
Z
[4
R]
7
4
06796
.
3
10 m
4
10
With

=
With

=

y
Z
9
4
R
-7
C
=

I

=

X

= 13592
.
6
10
2

Pure traction of a beam of full circular section, L=1m length, subjected to a force F=1000N:

With = [R2

]
F
U (X) =
X
EA
F
U (L) =
L
-6
= 54648
.
2
10 m
EA

---

14 Results of modeling F

14.1 Values tested

For the section symmetrized according to OY, the geometrical characteristics are:

Identification	*Reference*	*Aster*	*% difference*
SURFACE	*1.963495E03*	*1.963495E03*	*1.46E06*
AY	*1.166666E+00*	*1.166664E+00*	*1.45E04*
AZ	*1.166666E+00*	*1.166664E+00*	*1.45E04*
CDG_X	*0.000000E+00*	*1.033285E19*	*1.03E19*
CDG_Y	*0.000000E+00*	*3.715818E19*	*3.72E19*
CT	*6.135900E07*	*6.135909E07*	*1.54E04*
EY			

0.000000E+00
1.263839E18
1.26E18
EZ
0.000000E+00
9.610445E20
9.61E20
IX_G
3.067961E07
3.067960E07
1.99E05
IXY_G
0.000000E+00
2.774478E22
2.77E22
IY_G
3.067961E07
3.067960E07
1.99E05
IY_PRIN_G 3.067961E07

3.067960E07
1.99E05
IZ_PRIN_G
3.067961E07
3.067960E07
1.99E05
JG
0.000000E+00
9.814751E41
9.81E41
Y_MAX
2.500000E02
2.500000E02
0.00E+00
Y_MIN
2.500000E02
2.500000E02
0.00E+00
Z_MAX
2.500000E02
2.500000E02
0.00E+00

Z_MIN
2.500000E02
2.500000E02
0.00E+00

For the calculation of traction of beam, the result is:

Identification	***Reference***	***Aster***	***% difference***
DEPL	*2.546479E06*	*2.546479E06*	*1.66E14*
FORC_NOD	*1.000000E+03*	*1.000000E+03*	*0.00E+00*

With

15 Modeling G

15.1 Characteristics of modeling

Full rectangular section, of width 0.02m and height 0.05m. It is divided into two rectangles respective heights 0.025m, in order to test the calculation of the characteristics on groups of meshs for a network here made up of two parallel beams, ranging between two floors distant of L=0.0002 (what makes it possible to obtain characteristics (coefficient of shearing) very close to that of the complete section).

y
B
B
B = 0.01
GR2
H
H = 0.025
0
X
GR1
H

15.2 Characteristics of the grid

A number of meshs: 32 QUAD8

15.3 Functionalities tested

Orders

MACRO_CARA_POUTRE GROUP_MA

MACRO_CARA_POUTRE LENGTH
0.0002

MACRO_CARA_POUTRE CONNECTION
EMBEDDING

MACRO_CARA_POUTRE MATERIAL

15.4 Reference solution

Geometrical characteristics for the complete section and each half-section:

PLACE
SURFACE
CDG_X
CDG_Y
IX_G
IY_G
IXY_G
All
1.00E-03

0
0
2.08E-07
3.33E-08
0
GR1
5.00E-04

0
-1.25E-02
2.60E-08
1.67E-08
0
GR2
5.00E-04

0
1.25E-02
2.60E-08
1.67E-08
0

PLACE
X_P

Y_P
IX_P
IY_P
IXY_P

IY_PRIN_P
IZ_PRIN_P
All
0.00E+00
0.00E+00
2.08E-07 3.33E-08 0

3.33E-08
2.08E-07

GR1
0.00E+00
0.00E+00
1.04E-07 1.67E-08 0

1.67E-08
1.04E-07

GR2
0.00E+00
0.00E+00
1.04E-07 1.67E-08 0

1.67E-08
1.04E-07

Coefficients of shearing: for each rectangular section, it is worth

Ay = Az = 2
.
1 .

---

16 Results of modeling G

16.1 Values tested

For the complete section, the geometrical and mechanical characteristics are:

Identification	*Reference*	*Aster*	*% difference*
SURFACE	*1.0000000E03*	*1.000000E03*	*0.00E+00*
ALPHA	*9.0000000E+01*	*9.000000E+01*	*0.00E+00*
AY	*1.2000000E+00*	*1.199951E+00*	-0.004
AZ	*1.2000000E+00*	*1.199218E+00*	-0.065
CDG_X	*0.0000000E+00*	*1.032683E19*	*1.03E19*
CDG_Y	*0.0000000E+00*	*2.669725E19*	*2.67E19*

CT
9.9805000E08
9.968135E08
-0.124
EY
0.0000000E+00
1.550963E18
1.55E18
EZ
0.0000000E+00
4.792477E18
4.79E18
IX_G
2.0833333E07
2.083333E07
1.60E06
IXY_G
0.0000000E+00
1.395261E24
1.40E24
IY_G
3.3333330E08
3.333333E08
1.00E05
PCTX
0.0000000E+00
4.895746E18
4.90E18
PCTY
0.0000000E+00
1.817936E18
1.82E18
Y_MAX
2.5000000E02
2.500000E02
0.00E+00
Y_MIN
2.5000000E02
2.500000E02
0.00E+00
Z_MAX
1.0000000E02
1.000000E02

1.73E14
Z_MIN
1.0000000E02
1.000000E02
1.73E14

For the two disjoined groups, one obtains:

Identification place
Reference
Aster
% difference
GR2
SURFACE
5.00000E04
5.00000E04
2.17E14
GR1
SURFACE
5.00000E04
5.00000E04
4.34E14
ALL
AY
1.20000E+00
1.19924E+00
-0.064
GR1
AY
1.20000E+00
1.19922E+00
-0.065
GR2
AY
1.20000E+00
1.19922E+00
-0.065
GR1
AZ
1.20000E+00
1.19922E+00
-0.065
GR2

AZ
1.20000E+00
1.19922E+00
-0.065
GR1
CDG_X
0.00000E+00
1.59374E19
1.59E19
GR2
CDG_X
0.00000E+00
2.11345E19
2.11E19
GR1
CDG_Y
1.25000E02
1s.25000E02
1.39E14
GR2
CDG_Y
1.25000E02
1.25000E02
4.16E14
GR1
IX_G
2.60417E08
2.60417E08
1.28E04
GR2
IX_G
2.60417E08
2.60417E08
1.28E04
GR1
IXY_G
0.00000E+00
1.57868E24
1.58E24
GR2
IXY_G
0.00000E+00
1.98030E24

1.98E24
GR1
IY_G
1.66667E08
1.66667E08
2.00E04
GR2
IY_G
1.66667E08
1.66667E08
2.00E04

17 Modeling H

17.1 Characteristics of modeling

Section out of U, of dimension l=20mm, and thickness e=0.5mm

17.2 Characteristics of the grid

A number of meshs: 236 QUAD8

17.3 Functionalities tested

Orders

MACRO_CARA_POUTRE GROUP_MA_BORD

17.4 Reference solution

The approximate analytical values result from [bib1].

Identificatio
Reference
Numerical value
N
SURFACE
With = it
2 + (L - 2nd) E = E (L
3 - 2nd)
29.5
AY

4.25300E+00
AZ

1.61800E+00
CDG_X
X = 20 + 25
.
0
- 2
/
6.8602
G
(it
(L E) E) A
CDG_Y
L/2
10
CT
12
.
1

2.4984 [bib2]
3
3
C =
L E = 12
.
1
the =2.8 [bib1]
3
I I
i=,
1 3
1
3 3
3 3
C = L E
I
I
= L E
I
I
= 2.4984 [bib2]
3
2
2
2
2
i=,
1 3
Li + E L L
I
I
+ E L
I
EY
0
0
EZ
E
=-15.43
15.09 [bib4]
Z = - xg - (3/7) L +
25

.
0
JG
J
5
= 5/84
=9.52 E+4
8.69 E+04 [bib4]
G
(
) L E

18 Results of modeling H

18.1 Values tested

For the complete section, the geometrical and mechanical characteristics are:

Identification
Reference
Aster %
difference
SURFACE 29.5
2.9500000E+01

0.00E+00
AY 4.25300E+00
4.4862058E+00

5.483
AZ 1.61800E+00
1.916878E+00

18.472
CDG_X 6.8602 6.860169E+00

-0.015
CDG_Y 10
1.00000E+01

2.31E13
CT 2.4984
2.449398E+00

-1.9
EY 0 4.E-11

4.18E11
EZ 15.43 1.507743E+01

-0.089
JG
8.69 E+04 [bib4]
8.711924E+04
0.253

---

19 Modeling I

19.1 Characteristics of modeling

Hollow circular section, of external ray 10mm, and thickness 1mm.

19.2 Characteristics of the grid

A number of meshs: 300 QUAD8

19.3 Functionalities tested

Orders

MACRO_CARA_POUTRE GROUP_MA_BORD

MACRO_CARA_POUTRE GROUP_MA_INTE

19.4 Reference solution

4
R
(R - E) 4
4
C
=
I

=

-
=
97
.
5401
m
X

2
2

---

20 Results of modeling I

20.1 Values
tested

The constant of torsion is worth:

Identification	***Reference***	***Aster***	***% difference***
CT	***5401.97***	*5391.48*	*-0.194*

---

21 Summary of the results

This test makes it possible simultaneously to check the correct operation of the order MACRO_CARA_POUTRE for various types of sections.

Code_Aster ®
Version
6.0

Titrate:
SSLL108 - Discrete elements 2D

Date:
19/08/02
Author (S):
J.M. PROIX, G. BERTRAND Clé
:
V3.01.108-A Page:
1/4

Organization (S): EDF/AMA, CS IF

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.108

SSLL108 - Discrete elements 2D

Summary:

The problem is quasi-static linear in mechanics of the structures.

One analyzes the response of a bar, modelled by 10 discrete elements, with a loading of traction, for to validate the two-dimensional discrete elements.

Only one modeling uses at the same time operators MECA_STATIQUE, and STAT_NON_LINE, to validate the use of these elements (of which the behavior remains linear) with other finite elements with behavior unspecified.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

---

1 Problem of reference

1.1 Geometry

A bar L=10m length, along axis X, modelled by 10 discrete elements with 2 nodes.

1.2 Material properties

Each discrete element has a stiffness: K = 1.000 NR /m

1.3 Boundary conditions and loadings

In x=0
dx = Dy = 0
In x=L
Fx=10N

2 Reference solution

2.1 Method of calculation used for the reference solution

Analytical solution: displacement for an element is given by:
Ux=F/Kx

Thus for N springs: Ux = N F/Kx

2.2
Results of reference

Values of displacement for x=L/2 and X=L, as well as effort in the elements (constant):

U (L/2) = 0.05 m, U (L) = 0.1 m, N=10N

2.3
Uncertainty on the solution

Exact analytical solution.

---

3 Modeling
With

3.1

Characteristics of modeling

Modeling 2D_DISCRET

3.2
Characteristics of the grid

10 meshs SEG2.

3.3 Functionalities
tested

Order
Key word factor
Simple key word
Argument
AFFE_CARA_ELEM
DISCRETE
K_T_D_L
MECA_STATIQUE
STAT_NON_LINE
COMP_INCR
RELATION
ELAS
CALC_ELEM

OPTION
SIEF_ELGA_DEPL

OPTION
SIEF_ELGA_DEPL

4
Results of modeling A

4.1 Values
tested

Identification Reference
***Aster** %*
difference

MECA_STATIQUE

DX (L/2)
0.05 0.05 0s
DX (L)
0.1 0.1 0
NR (SIEF_ELGA_DEPL)
10 10 0
STAT_NON_LINE

DX (L/2)
0.05 0.05 0s
DX (L)
0.1 0.1 0
NR (SIEF_ELGA)
10 10 0

5
Summary of the results

This very simple test voluntarily makes it possible to check the correct operation of the discrete elements 2D
with STAT_NON_LINE, which makes it possible to use them with other modelings.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLL110 - System of 3 bars out of U under actual weight

Date:
23/09/02
Author (S):
J.M. PROIX
Key: V3.01.110-A Page: 1/4

Organization (S): EDF/AMA

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.110

SSLL110 - System of 3 bars out of U under weight
clean

Summary:

This test allows a simple checking of calculations of gravity for the elements of bar in mechanics of structures linear statics. The model is linear.

Only one modeling is used: it makes it possible to test the application of gravity on elements of bar, located in a reference mark different from the direction of gravity.

The values tested are the generalized displacements, efforts and the constraints.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLL110 - System of 3 bars out of U under actual weight

Date:
23/09/02
Author (S):
J.M. PROIX
Key: V3.01.110-A Page: 2/4

1 *Problem of reference*

1.1 Geometry

A system of 3 bars out of U:

B

With

y

D
X

C

The surface of the cross sections is worth A=1m ². The length of each of the 3 bars is worth L=10m.

1.2
Material properties

E = 2. 1011 Pa for the 3 bars.
Rho=8000 kg/m3 only for the bar CD. For the 2 other bars, Rho=0.

1.3
Boundary conditions and loadings

Embedding in A and B.
In order to avoid the movements of rigid body, DZ=0 for all the nodes, and DX=0 out of C and D.

1 only loading is applied: gravity, with g=2m/s ², in the direction (0.866, - 0.5, 0), which

to G = 10m/s ² is equivalent, in direction Y.

2
Reference solution

2.1
Method of calculation used for the reference solution

· Analytical Solution:

*Normal effort in each bar AC and data base: N=Rho*L*A*g/2*

Uy displacement out of C and D: Uy=NL/ES

2.2
Results of reference

· Normal Effort in bars AC and data base: N= 4.105 NR
· displacements out of C and D: Uy=2 10-5m

2.3

Uncertainty on the solution

Analytical solution.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

Each bar is modelled by only one element.

3.2
Characteristics of the grid

Three meshs SEG2.

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM
BAR

AFFE_CHAR_MECA
GRAVITY

CALC_ELEM
"EFGE_ELNO_DEPL"

4
Results of modeling A

4.1 Values
tested

Identification Reference Aster %
difference
ux (C)
2 10-5 2
10-5 0
ux (C)
2 10-5 2
10-5 0
NR (AC) 4.105 4.105 0
NR (DATA BASE) 4.105 4.105 0

5
Summary of the results

This test, very simple, makes it possible simultaneously to check the correct operation of gravity in elements of bar, which is checked by the perfect coincidence of the results with the solution analytical. It was introduced following the discovery D `an anomaly on gravity into the bars, and allows to validate the correction.

V3.01 booklet: Linear statics of the linear structures
Document: V3.01.111

SSLL111 - Static response of a beam concrete armed (section in T) with linear behavior

Summary:

The problem consists in analyzing the response of a concrete beam reinforced via a modeling multifibre beam. This test corresponds to a static analysis of a beam having a linear behavior. Three successive loading cases are tested: a specific force, the actual weight and a rise in temperature. For the first loading case, two grids of the section, one coarse and the other finer are tested.

---

1 Characteristics general

1.1 Geometry

Beam in inflection three points, defined by:
y
X
With
B
5 m

With a section in double T:
30 cm
10 C m
10 C m
5 cm
y
12, 5 cm
O
20 C m
Z
10 cm
12,5 cm
8 cm
8 cm
5 cm
20 cm

On this diagram, O is located at middle height of the section.

The total section of higher steels is 3.104 m2 and that of lower steels is 4.104 m2.

1.2
Material properties

· concrete: E = 2. 1010 Pa; = 0.2; = 2400 kg.m3; = 10-5 K1
· steel: E = 2,1. 1011 Pa; = 0.33; = 7800 kg.m3; = 10-5 K1

1.3
Boundary conditions

Simple support in b: Dy = 0
Support "doubles" in a: dx = Dy = dz = 0 just as X-ray = ry = 0.

1.4 Loadings

Three loading cases are tested successively:

Loading 1: effort concentrated in the mediums of the beam, F = 10000 NR
Loading 2: actual weight of the beam, G = 9,8 m.s2
Loading 3: homogeneous heating of the beam T = 100 K
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

2
Reference solution

Calculations of reference are carried out starting from a simple elastic design in RdM.

2.1 Center
rubber band

In pure bending, for an elastic behavior, the neutral axis passes by the elastic center
(barycentre of the sections balanced by the modules of materials):
C such as E CM dS = 0
S
One determines initially the position of the centres of gravity of the concrete only G and steel only G
by
B
has
report/ratio at the point O.

y = 0,125 × 0,3 ×0,05 -0,125 × 0,2 ×0,05 =1,38888.10-2 m
G B
0,2 × 0,05 + 0,1×0,2 + 0,3× 0,05

y = 0,125 × 3 -0,125 × 4 = -1,78571.10-2 m

G has
3+ 4
Z = Z = 0 m
Ga
GB

One can then determine the position compared to O of the elastic center C.

EaSa OGa + EbSb
B
OG
OC =

EaSa + EbSb

The concrete S section is 0,045 m2 and the section of steel S is 7.104 m2. The Young modulus of
B
has
concrete is 2.1010 MPa and that of steel 21.1010 MPa. One thus has

y = 2 × 0,045 ×1,38888 -21× 7.10-4 ×1,78571 = 0,94317.10-2 m
C
2 ×0,045 + 21× 7.10-4

Z = 0 m
C

2.2 Moments
quadratic

The quadratic moments of the rectangular concrete sections are calculated by the formula following:
3
bh
2
+ B × H × D
12

Where, B represents the width, H the height and D the distance from the centre of gravity of the section by report/ratio
with the axis for which one calculates the moment.
One then obtains the quadratic moment of the concrete section compared to axis Z passing by center elastic:

3
3
,
0 × 05
,
0
×
I
-
-
concrete =
+ (3
,
0 × 05
,
0
) (125
,
0
-
10
.
94317
,
0
)
3
2
2
1
,
0
,
0 2
+
+ (1,
0 × ,
0 2)(
.
94317
,
0

10) 2
2
12
12
3
,
0 2 × 05
,
0
+
+ (,
0 2 × 05
,
0
) (125
,
0
+ 94317
,
0
10
. -) 2
2
3
-
4
= ,
0
.
4547 10
m
12

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Inertias of steels are calculated by the following formula:

4 + S ×d2 S×d2
64

Where, represents the diameter of steel, S the steel section and D the distance from the centre of gravity from
section compared to the axis for which one calculates the moment. The diameter of steels being small, one
neglect the first term.
One then obtains the quadratic moment of the steel sections compared to axis Z passing by the center rubber band:

$3.10^{-4} \times (0,125 - 0,94317.10^{-2})^2 + 4.10^{-4} \times (0,125 + 0,94317.10^{-2})^2 = 0,1124.10^{-4}\ m^4$

For the complete section of the beam, the quadratic moment balanced by the Young moduli of materials is:

I.E.(internal excitation) $= 2.10^{10} \times 0,4547.10^{-3} + 21.10^{10} \times 0,1124.10^{-4} = 11,4544.10^{6}\ Pa.m^4$

2.3 Loading case 1

In the case of load 1 (loading concentrated in the middle of the beam), the arrow is calculated by formulate following RDM:

F L 3
×

F =

48EI

What gives the arrow:
F =
10000 × 53
= 2,2735.10-3 m
48 ×11,4544.106

One can also calculate the following generalized efforts:
F
· the shearing action at the beginning of the beam (left left) is worth
= 5000 NR,
2
F × L
· the bending moment in the middle of the beam is worth:
=1,25.104 N.m.
4

2.4
Loading case 2

In the case of load 2 (actual weight of the beam), the arrow is calculated by the formula of RDM following:
F = 5 × p × l4
384 I.E.(internal excitation)

where p is the linear load due to the weight of materials:

p = G (S + S) = 9,8 × (2800 × 7.10-4 + 2400 × 0,045) =1111,9 NR .m-1
has has
B B

What gives the arrow:
F = 5 ×1111,9 × 54 = 7,9.10-4 m
384 ×11,4544.106

2.5
Loading case 3

In the case of load 3 (homogeneous rise in temperature), the beam being isostatic and them dilation coefficients of the concrete and steel being identical, the solution is simple:
The generalized constraints and efforts are null.
The lengthening of the beam is: L = × L ×T

What gives with the values of our case:

L =10-5 ×5 ×100 = 5.10-3 m

3 Modeling

3.1
Characteristics of modeling

Longitudinal grid of the beam:
We have 3 nodes and two elements (POU_D_EM).

With
C
B

The concrete part of the cross section of the beam is with a grid (AFFE_SECT) while steels are given directly in the form of 4 specific fibres in AFFE_CARA_ELEM (AFFE_PONCT).

Two grids of the concrete part are tested in the case of load 1. The fine grid consists of 120 fibres and the coarse grid consists of 16 fibres:

Note:

***The problem being 2D, only one fibre in the width could seem sufficient
(multi-layer), but that would result in having null terms in the matrix of rigidity
(the own inertia of fibres not being taken into account) and with an error at the time of the resolution of
system of equations.***

3.2 Functionalities tested

Orders

CREA_MAILLAGE
CREA_GROUP_MA

AFFE_MODELE
GRID
“MECHANICAL”
“POU_D_EM”

DEFI_MATERIAU
“ELAS”

AFFE_MATERIAU
GROUP_MA

MATER
AFFE_CARA_ELEM
BEAM
GROUP_MA

SECTION

ORIENTATION
GROUP_MA

CARA
“ANGL_VRIL”

AFFE_SECT
GROUP_MA

MAILLAGE_SECT

TOUT_SECT
“YES”

COOR_AXE_POUTRE

NAME

AFFE_FIBRE
GROUP_MA
“SURFACE”

CARA

VALE

COOR_AXE_POUTRE

NAME

AFFE_CHAR_MECA
MODEL

DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO

GRAVITY

TEMP_CALCULEE

MECA_STATIQUE
MODEL

CHAM_MATER

CARA_ELEM

EXCIT
CHARGE

CALC_ELEM
REUSE

RESULT

MODEL

CHAM_MATER

CARA_ELEM

OPTION
EFGE_ELNO_DEPL

EXCIT

CALC_NO
REUSE

RESULT

OPTION
EFGE_NOEU_DEPL

4 Results

4.1
Loading case 1

Reference
Modeling Ar
Relative error %
Arrow
(fine grid)
2,2735 10-3 2,2740
10-3 0,02
Arrow

(coarse grid)
2,2735 10-3 2,2956
10-3 1,0
(1)
Sharp effort

(supports A)

5000
2500
0,0 (2)
Bending moment

(Medium) 1,25
104 6,25
103 0,0
(2)

1) Calculations are carried out without taking into account the own inertia of each fibre. Results show that it is not nevertheless very useful to hold account of it because the difference between one coarse grid and a fine grid is not obvious.
The grid of the section does not need to be very fine to have precise results (in elasticity).
2) Option EFGE_NOEU_DEPL used to calculate the efforts generalized with the nodes does one average of the generalized efforts of all the elements connected to the node. In our case, we have 2 superimposed elements of beam (for the concrete, for steel), the efforts calculated are thus divided by 2.
If one adds the values with efforts by element (EFGE_ELNO_DEPL) of the element concrete and with the element steel, one finds the theoretical values well.

Note:

If one makes a calculation of arrow by taking O (middle height) like reference axis to the place elastic center (COOR_AXE_POUTRE), the relative error on the arrow is 0,2% here (bus it center elastic is practically with middle height (see 1.2.1).

4.2
Loading case 2

Reference
Modeling Ar
Relative error %
Arrow
(fine grid)
7,900 10-4 7,902
10-4 0,02

4.3
Loading case 3

Reference
Modeling Ar
Relative error %
Lengthening 5,00
10-3 5,00
10-3 0,0
Efforts 0,00
0,00
0,0

5
Summary of the results

The results obtained are in concord with the results of reference.

Code_Aster ®
Version
5.7

Titrate:
SSLL112 - Arch circular under uniform pressure

Date:
20/08/02
Author (S):
Key J.M. PROIX
:
V3.01.112-A Page:
1/4

Organization (S): EDF/AMA

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.112

SSLL112 - Arch circular under uniform pressure

Summary:

This test makes it possible to check the internal efforts on the curved model of beam POU_C_T.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.7

Titrate:
SSLL112 - Arch circular under uniform pressure

Date:
20/08/02
Author (S):
Key J.M. PROIX
:
V3.01.112-A Page:
2/4

1
Problem of reference

1.1 Geometry

1.1.1 Arch circular

R
p
y
B
With
X

Appear 1.1.1-a

Ray: R = 1 m

1.2
Properties of materials

Young modulus:

E = 2. 1011 Pa
Poisson's ratio:
= 0.3

1.3
Boundary conditions and loading

Boundary condition:

DX = DY = DZ = DRX = 0 on point A
DY = DZ = 0 on the point B

Loading: Force distributed

p = 100N/m on AB

2
Reference solutions

2.1
Method of calculation used for the reference solutions

The beam of the figure [Fgure 1.1.1-a] checks the equilibrium equations (plane problem).

dN
FD
DM
V =
, N+
y = - p R,
+R V =
0
y
D
D
y

D

(p: normal constant loading divided into any point of the beam).
NR (), Vy (), Mz () indicate the efforts (normal, edge and moment bending) in a point of the vault expressed in the local reference mark.

Their integration with the limiting conditions:

V ()
0 = 0, M ()
0 =0
y
Z

give:

V =

-

y ()
0, M () = 0, NR () = p.
R

2.2
Results of reference

Interior efforts for = 0°, 6°, 42° and 60°.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Report/ratio n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation beams ASTER"

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

The model is composed of 30 elements curved beam of Timoshenko.

3.2
Characteristics of the grid

It consists of 30 elements POU_C_T.

3.3 Functionalities tested

Orders

AFFE_CARA_ELEM
BEAM
SECTION
RING
CALC_ELEM
OPTION
EFGE_ELNO_DEPL
SIGM_ELNO_DEPL
AFFE_CHAR_MECA
FORCE_POUTRE
VY

4
Results of modeling A

4.1 Values tested

Type of effort
Reference
Aster Variation
(%)
Vy (0°) 0.0000
5.E-5
5.E-5
Vy (6°) 0.0000
5.E-5
5.E-5
NR (60°) 1.000E+02
9.99E+01
0.1
MFZ (42°) 0.0000
3.93E05
3.93E05

5
Summary of the results

The normal effort in the vault (only effort not no one) is calculated with a good precision (0,1%) for adopted modeling.

FORMA06 - TP beam of the formation post treatment

Summary:

The objective of this T.P. is to use the possibilities of POSTPROCESSING available in Code_Aster in the case of a modeling of the BEAMS type.

It is about a gantry with side connections made up of a linear elastic material. In this T.P, one is interested with the following operators of postprocessing:

· operators allowing to define groups of entities of the grid type: DEFI_GROUP (definition and handling of groups of nodes and meshs),
· total operators allowing to enrich the concepts results: CALC_ELEM for the calculation of fields with the elements and CALC_NO for the calculation of the fields to the nodes,
· impressions: IMPR_RESU (impression of the results to the formats RESULT, IDEAS, GIBI),
· localised examinations: POST_RELEVE_T to raise of values on lines and calculation of derived quantity,
· layout of curve: IMPR_COURBE to visualize the evolution of a size according to space.

1
Problem of reference

The study relates to a side gantry with connection (see [Figure 1-a]).

DC
DD GG
AA
BB
y
EE
X

Appear 1-a

Beam
Length
Moment of inertia
The beams are square sections on side 0.01m:
AB
L
With =
-

1 10 4 m
AB = 4 m
IAB = 1 10-8m4
12
AB
1
With
=
-
1 10 4 m
AC
L
AD
AC = 1m
IAC =
10-8m4
12
-4

1
With
= 1 10 m
AC
AD
stable-lad = 1m
I AD=
10-8m4
12
With
=
-
1 10 4 m
AE
1
AE
L AE = 2m
IAE =
10-8m4
12

Finally to note that G is in the middle of DA.

1.1
Material properties

Isotropic linear elastic material:
E= 2 1011 Pa
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

1.2
Boundary conditions and loadings

1) Points
C: articulated (U = v
C
C =)
0
2) Specific force in G: F = 10666.66 NR
3) Force set out again on AD: p = 1000.N/m
4) Points BB, DD and EE embedded

F
P

Appear 1.2-a

1.3
Reference solution

One poses:
I.E.(internal excitation) Year
K Year =

lAn
with N = BB, DC, DD or EE
3
K = K
+ K
+ K
+ K
AB
AD
AE
AC
4

K
R
year
Year = K
with N = BB, DC, DD or EE
2
FlAD
plAB
1
C = +
-

8
12
· Rotation in AA:
C1
=

4K
· Moment in AA:
2
pl
M
AB

= +
+ R.
AB
AB
1
C
12
Fl
M
AD
= -
+ R.
AD
AD
1
C
8
M
= R.
AE
AE
1
C
M
= R.
AC
AC
1
C

1.4 References bibliographical

[1]
Guide VPCS - Edition 1990.

2 Modeling With

Modeling A corresponds to the statement of the TP Poutre.

2.1 Characteristics of modeling

5 elements for the section AG

5 elements for the section GD

20 elements for section AE

10 elements for the section AC

20 elements for section AB

2.2 Characteristics of the grid

80 elements POU_D_T

81 nodes

4
54
55
56
57
58

59
60
61
62
5 7 8
9 10 3 11 12 13 14 1 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 2
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
6

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
6.3

Titrate:
FORMA06 - TP Poutre formation post treatment

Date:
14/10/02
Author (S):
NR. TARDIEU *Key*

2.3 Functionalities tested

Orders

AFFE_MODELE
POU_D_T

AFFE_CHAR_MECA
FORCE_POUTRE

FORCE_NODALE

AFFE_CARA_ELEM
BEAM
SECTION:
“RIGHT-ANGLED”

3 Results of modeling A

3.1 Values tested

Not	***Size and unit***	***Reference***	***Aster***	*%* ***difference***
GG	*Z, rotation (rad)*	*3.32217E04*	*3.32217E04*	*0.*

---

4 Modeling B

Modeling B corresponds to corrected TP Poutre.

4.1 Characteristics of modeling

5 elements for the section AG

5 elements for the section GD

20 elements for section AE

10 elements for the section AC

20 elements for section AB

4.2 Characteristics of the grid

80 elements POU_D_T

81 nodes

4
54
55
56
57
58
59
60
61
62
5 7 8
9 10 3 11 12 13 14 1 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 2
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
6

6.3

Titrate:
FORMA06 - TP Poutre formation post treatment

Date:
14/10/02
Author (S):
***NR. TARDIEU** Key*
:
V3.01.114-A Page:
7/8

4.3 Functionalities tested

Orders

AFFE_MODELE
POU_D_T
AFFE_CHAR_MECA
FORCE_POUTRE
FORCE_NODALE
AFFE_CARA_ELEM
BEAM
SECTION:
"RIGHT-ANGLED"
DEFI_GROUP
UNION
NOEUD_ORDO
CALC_ELEM
EFGE_ELNO_DEPL
SIPO_ELNO_DEPL
EFGE_ELNO_CART
CALC_NO
EFGE_ELNO_DEPL
SIPO_ELNO_DEPL
EFGE_ELNO_CART
IMPR_RESU
FORMAT
RESULT

CASTEM
POST_RELEVE_T
OPERATION
EXTRACTION
EXTRACTION
IMPR_COURBE
FORMAT
AGRAF

5
Results of modeling B

5.1 Values tested

Not
Size and unit
Reference
***Aster** %*
difference
GG
Z, rotation
3.32217E04 3.32217E04
0.
(rad)

6
Summary of the results

The results obtained with Code_Aster are in concord with the reference solution.
The recovery in this case test of the command file of the TP on the post treatment of the beams allows to make sure that this file remains in agreement with the evolutions of syntax of the code.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
V3.01.116 document

SSLL116 - Lattice reinforced 3D

Summary:

This test relates to the study of a lattice made up of hurled beams, in linear static analysis.

The lattice is modelled with elements linear (SEG2) and subjected to a specific loading and the effect of gravity.

There is a modeling with a first geometry, then a modeling with bars of reinforcement.

This test is an example with didactic aiming since it shows the construction of the solution by finite elements rather to use MECA_STATIQUE directly.

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/03/008/A

Code_Aster ®
Version
7.1

Titrate:
SSLL116 - Lattice articulated 3D

Date
:

1
Problem of reference

1.1 Geometry

2,8

Y

Z
21

7

X

With

7
0,7

1,05

The lattice consists of annular beams of sections everywhere (R=0.05, ep=0.02), except on the part "crane", made up of circular sections of two sizes: R=0.05 for the full rounds and R=0.07 for the hatched round.
Point A is in the middle of the final stem.

1.2
Material properties

Isotropic linear elastic material:

E = 1.962 E11 Pa; =0.3

1.3
Boundary conditions and loadings

The base of the lattice is embedded.

Loadings

Vertical nodal force in a:
Fy = 20E6 NR
Field of gravity (according to X)
G = 9.81 m/s ²

2
Reference solution

2.1
Results of reference

Displacements and rotations of node A (DEPL).
The results calculated in this case test result from a former execution of Aster. It is a case test of nonregression.

3 Modeling With

3.1 Characteristics of modeling

2,8

Y

Z
21

7

X

With

7
0,7

1,05

.
Modeling POU_D_T
.
No reinforcements

3.2
Characteristics of the grid

The grid is obtained by ***GMSH****.*

A number of nodes:
247
A number of meshs:
267

3.3 Functionalities
tested

Orders Options

PRE_GMSH

LIRE_MAILLAGE

DEFI_MATERIAU ELAS

AFFE_MATERIAU ALL

AFFE_MODELE
“MECHANICAL” “POU_D_T”

DEFI_VALEUR

AFFE_CARA_ELEM
BEAM “RINGS”

AFFE_CHAR_MECA DDL_IMPO

FORCE_NODALE

CALC_MATR_ELEM “RIGI_MECA”

CALC_VECT_ELEM “CHAR_MECA”

NUME_DDL MATR_RIGI

ASSE_MATRICE

ASSE_VECTEUR

FACT_LDLT

RESO_LDLT

DEFUFI

IMPR_RESU “GMSH”

TEST_RESU “NON_REGRESSION”

4

Results of modeling A

4.1 Values
tested

Loading Value
tested
Aster
Force concentrated vertical in A
Displacement of A Dx
7,20564x101

Displacement of A Dy
2,02277x100

Displacement of A Dz
1,12417x100

Rotation of A Drx
9,88004x101

Rotation of A Dry
1,83637x101

Rotation of A Drz
1,12592x101

4.2 Remarks

It is seen that the not-symmetry of the arrow of the lattice involves displacements according to Z, although
force applied is it according to Y and X only (force of gravity)
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/03/008/A

Code_Aster ®
Version
7.1

Titrate:
SSLL116 - Lattice articulated 3D

Date
:

5 Modeling
B

5.1
Characteristics of modeling

2,8

Y

Z

21
7

X

With

7
0,7

1,05

•
Modeling POU_D_T
•
Bars of reinforcement

5.2
Characteristics of the grid

The grid is obtained by GMSH.

A number of nodes:
265
A number of meshs:
287

5.3 Functionalities
tested

Orders Options

PRE_GMSH

LIRE_MAILLAGE

DEFI_MATERIAU ELAS

AFFE_MATERIAU ALL

AFFE_MODELE
"MECHANICAL" "POU_D_T"

DEFI_VALEUR

AFFE_CARA_ELEM
BEAM "RINGS"

AFFE_CHAR_MECA DDL_IMPO

FORCE_NODALE

CALC_MATR_ELEM "RIGI_MECA"

CALC_VECT_ELEM "CHAR_MECA"

NUME_DDL MATR_RIGI

ASSE_MATRICE

ASSE_VECTEUR

FACT_LDLT

RESO_LDLT

DEFUFI

IMPR_RESU "GMSH"

TEST_RESU "NON_REGRESSION"

6
Results of modeling B

6.1 Values
tested

Loading Value
tested
Aster
Force concentrated vertical in A

Displacement of A Dx
6,61627x101

Displacement of A Dy
1,82145x100

Displacement of A Dz
2,6628x101

Rotation of A Drx
8,48048x101

Rotation of A Dry
1,68397x101

Rotation of A Drz
9,43511x102

6.2 Remarks

The reinforcements made it possible to decrease displacements of the arrow of the lattice.

7
Summary of the results

This example shows a way of carrying out the "didactic" calculation of manner while building explicitly vectors and matrices necessary for a standard calculation by finite elements.
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HT-66/03/008/A

Code_Aster ®
Version
5.0

Titrate:
SSLL400 - Non-prismatic beam, subjected to specific efforts
Date:
03/05/02
Author (S):
J.M. PROIX, m.t. BOURDEIX, P. HEMON, O. WILK
Key: V3.01.400-A Page: 1/18

Organization (S): EDF/AMA, IAT St CYR, CNAM

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
V3.01.400 document

SSLL400 - Non-prismatic beam, subjected
with efforts specific or distributed

Summary:

This test be resulting from the validation independent of version 4 of the models of doors.

This test allows the checking of calculations of beam right-hand sides in the linear static field. (a modeling
with elements of beams POU_D_E, right beam of EULER).

One calculates simultaneously 3 beams of the different sections: section rings, right-angled, and general. These
beams are subjected to efforts specific or distributed.

The values tested are displacements and rotations, the efforts generalized, and the constraints.
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HT-66/02/001/A

1
Problem of reference

1.1 Geometry

1.1.1 Right beam of variable circular section

Z
y
X
Appear 1.1.1-A

Length
: 1 m

Ray with embedding: 0,1 m
Ray at the end
: 0,05 m
free

1.1.2 Right beam of variable rectangular section

y
X
Z

S1
S
1
Appear 1.1.2-A

Length
: 1 m

with embedding: Hy = 0,05 m
Hz = 0,10 m
at the loose lead: Hy = 0,05 m
Hz = 0,05 m

1.1.3 Right beam of variable general section

Z
y
S1
S2
X

Appear 1.1.3-A

Length
: 1 m

with embedding: To = 10-2 m ²
Iy = 8,3333 10-6 m4
at the loose lead: To = 2,510-3 m ²
Iy = 5,20833 10-7 m4
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HT-66/02/001/A

1.2
Properties of materials

Young modulus:
E = 2. 1011 Pa
Poisson's ratio: = 0,3
Density:
= 7800 Kg.m-3

1.3
Boundary conditions and loading

Boundary condition:

Embedded end: DX = DY = DZ = DRX = DRY = DRZ = 0

Loading:

On the right beam of variable circular section and on the right beam of rectangular section variable, one applies successively:

Loading case
Nature
1
a specific effort following X at the loose lead, Fx = 100 NR
2
a specific effort following Y at the loose lead, Fy = 100 NR
3
one specific moment around axis X at the loose lead, MX = 100 m.N
4
one specific moment around axis Z at the loose lead, Mz = 100 m.N

5
a distributed load on the whole of the beam, fx = 100 N.m-1
6
a distributed load on the whole of the beam, fy = 100 N.m-1

To the right beam of variable general section, one applies:

Loading case
Nature
7
an effort of gravity according to Z with G = 9,81m.s2

2
Reference solutions

2.1
Method of calculation used for the reference solutions

2.1.1 Section
circular

2.1.1.1 Beam subjected to a specific tractive effort Fx

The equilibrium equation is:

(U

X
EA X)
0 with
(
With X)

To 1 C
X
X =
=
+
1
L
With

and C =
2 - 1,
A1
NR (L) = Fx

While integrating twice [R3.08.01], we obtain displacements according to the force applied, that is to say:

L F
X

U (X) =
X
E WITH L + C X,
1

and thus at the end L of the beam:

L
U (L) =
F
E WITH
With X
1
2

The efforts intern are given by:

U
NR (X) = EA (X)

(X) = F

X
X

and constraints by:

NR (X)
xx =

With (X)

2.1.1.2 Beam subjected to a specific bending stress Fy

The equilibrium equation, under the assumption of Euler, is given by the equation:

2
2
4
v

X
I.E.(internal excitation)

(X)
= 0 with I (X) = I 1+ C
2
X
Z

2
Z
1
X
Z

L

1

I 4
2
Z
and C =

1,

I -
1
Z
V (L) = F
y
y.

We solve the equation by integration by taking account of the law of behavior modified
2v
MF
MF = I.E.(INTERNAL EXCITATION)
Z
Z
Z
+ V = 0
x2 and the equilibrium equation X
y

Four successive integrations, by holding account for the calculation of the constants of integration that:

2v

I.E.(internal excitation)

(X)
(L) = V
- (L) = -

F
X
Z

x2
y
y

2v
I.E.(INTERNAL EXCITATION) (L)
(L)
Z
= 0

x2

v () =
0
0
X
v ()
0 = 0

lead to the expression of v (X):

F L2
2
y
X (L
3
- X + 2 cx)
v (X) = +

E I
2

6
Z
(L + cx)
1

and with the expression of Z (X)

2
2
2
2
2
-
+
-
+
y
F L
X (6 L Lx
3
6 L cx cx 2 C X)
Z (X) = +

.
E I
3
6
Z
(L
+ cx)
1

The efforts intern are given by:

V (X) = F
y
y
MF (X) = F (L -

X)
Z
y
and constraints by:

R (X)
xx (X) = M Z
F (X) Iz (X)

V (X)

y
xy =
(
(not of coefficient of correction dcisaillement in assumption of Euler)
With X)

2.1.1.3 Beam subjected to one specific torque MX

The movement is given by the equation:

X 4
G I (X
X
)
0 with I (X)

I
1 C
X
p

X
p
p

=
=
+
1
L
1
I p 4
and C =
2
,

1

I -
p1
M (L) = M
X
X
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V3.01 booklet: Linear statics of the linear structures
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After integration, and by taking account of the fact that:

G I (L
X
)
(L) = M
p

,
X
X
and ()

X 0 = 0

we obtain the expression of X (X):

2
2
2
L M
X 3 L + 3 L cx + C X
X
(
)

.
X (X) = 3G I
3
p1
(L+cx)

We must also have for the internal efforts and the constraints:

M (X) = M
X
X
M (X)
(X)
X
=
R X
xy
I (X)
( )
T
p
M (X)
(X)
X
=
R X
xz
I (X)
( )
T
p

2.1.1.4 Beam subjected to one specific bending moment My

The reasoning to find the solution analytical is the same one as previously. We use
2w
MFy
law of behavior M (X) = - I.E.(internal excitation) (X
y
y
)
- V = 0. Calculation
x2 and the equilibrium equation X
Z
constants of integration differs: there are V
L
Z () = 0 and M
(L) = M
F

y.
y

The expression of W (X) is obtained:

L M
2
y
X (3 L + 2cx)
W (X) =

,
6th I
2
y
(L + cx)
1

and the expression of y (X):
L M
X
2
2 2
y
(3 L + 3Lcx + C X)
y (X) =

3rd I
3
.
y1
(L + cx)

One must also have for the internal efforts and the constraints:

V (X
Z
) = 0
MF (X) = My
y

R (X)
(X) = MF (X)
xx

y
I (X)
y

2.1.1.5 Beam subjected to a tractive effort regularly distributed fx

Balance is described by the equation

U

X 2
EA (X)
=
F
with
(
With X)

To 1 C
X
X
X

-
=
+
1

L
1

To 2
and C = 2
- *1.*
A1

By integrating first once this equation, we obtain:

U
E With (X)
= - F X + C
X
X
1 .

The condition limits NR (L) = 0 implies C
F L
1 =
X
. We thus have:

U
(L-x)
= **-**

F
X
X E With (X)

that is to say:

(L X)
U (X) = F
dx + C
X E With (X)
2

c2 is given so that U ()
0 = .
0

Taking everything into account, we have:

L
2
2
C X + C X + (L + C X) Log
L F
L + C X
U X
X
( ) =
.
E With c2
L + C X
1

U
The efforts intern are deduced from the law of behavior NR (X) = E A (X):
X
NR (X) = F (L - X
X
),

and the constraints are given by:

( )
F (L - X)

NR X
X
xx (X) =
=
With (X)

X 2
With +
1
(A - WITH
2
1)

L
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2.1.1.6 Beam subjected to a bending stress regularly distributed fy

On the basis of the equilibrium equation:

2
2
4
v

X
E I (X)
= - F
with I (X) = I
1+ C
2
X
Z

2
y
Z
1
X
Z

L

1

I 4
2
Z
and c=

1,

I -
1
Z

we carry out four successive integrations. The determination of the constants of integration is made starting from the following limiting conditions:

V (L
y
) = 0
M (L
Z
) = 0
v ()

0 = 0
X
v ()
0 = 0

The analytical expression for v (X) and (Z) in the presence of a loading distributed is, taking everything into account:

- F L3
v (X) =
y
[- 6L2 cx + x2
2
4
3
3
4
5
9

3
2
2
2
4
2
(- Lc - Lc) + X (- C + C - c) +
12 I.E.(internal excitation) C (L + cx)
z1

X

Log 1 + C
(6L3 12L2cx 6Lc2x2)

L
+
+

+ 3
(
L F X
X)
y
2
2
2
Z
=
3
3
3
1
3 [L - Lx + Lcx + X (- C + c)]
6EI (L + cx)
z1

The efforts intern are given by:

V (X) = F (L - X
y
y

)
1
and
MF (X) =
F (L - X) 2
Z
y
2

constraints by:

V (X)

y
xy (X) = A (X)

R (X)
(X) = MF (X)
xx
Z
Iz (X)

2.1.2 Section
rectangular

2.1.2.1 Beam subjected to a specific tractive effort Fx

The equilibrium equation is:

U
X
EA (X)
= 0 with
(
With X)
A1 (A
With
2
1)
X
X
=
+
-
L
NR (L) = F

X

While integrating twice, and by taking account of the fact that:

U
E WITH (L)
(L) = F,
X
X
(
U)
0 = ,
0

for the determination of the constants of integration, we obtain the analytical expression of U (X), that is to say
:

F L

X
U X
X
( ) =
Log 1 + C

.
WITH E C

L
1

For the internal and forced efforts, we have:

NR (X) = Fx
NR (X)

xx =
(
With X)

2.1.2.2 Beam subjected to a specific bending stress Fy

The movement is given by the equation:

2
2
3
v

X
E I (X)
= 0 with I (X) = I 1+ C
2
X
Z

2
Z
1
X
Z

L

1
I 3
2
Z
and C =

1,

I -

1
Z
V (L) = F
y
y.

The same reasoning that for the circular section leads to the following result:

L
2
2
3 2
2
2 L cx + C X - C X + 2 L (L + cx) Log

F L
L + cx
y

v (X) = - the 2nd I c3
Z
(L + cx)
1

F L2
y
X (2L - X + cx)
(X)
Z
=
.
2EI

2
Z
(L + cx)
1

We must have for the internal efforts and the constraints:

V (X) = F
y
y
M (X) = F (L - X)
F
y
Z
H (X) M (X)
(X)
y
Fz

xx
=
2I (X)
Z
V (X)
(X)
y
xy
= (Ax)

2.1.2.3 Beam subjected to one specific torque MX

The movement is given by the equation:

X 3
G I (X
X
)
0 with I (X)

I
1 C
X
p

X
p
p

=
=
+
1
L
1
I
p
3

and c=
2
,
1

I -
p1
M (L) = M
X
X.

By the same reasoning as the beam with circular section, we obtain the analytical expression of ()

X X:

L M X X (2 L + cx)

(X)

.

X

= 2 I

2

p G (L + cx)

1

I

p and I

are calculated according to formulas' given in the reference material [R3.08.01].

1

p2

The internal efforts and the constraints are given by:

M (X) = M

X

X

M (X)

(X)

X

=

R X

xy

=

I (X)

( )

T

xz

p

2.1.2.4 Beam subjected to one specific bending moment My

The same reasoning is taken again that previously, the analytical expressions are obtained following for W (X) and (X)

y

:

L M x2
y
W (X) = - 2nd Iy (L + cx)
1

L M X (2L + cx)
(
y
X)
y
=
,
2
2nd I y (L + cx)
1

---

for the efforts:

V (X
Z
) = 0

MF (X) = M
y
y

and for the constraints:

H (X) MF (X)

Z
y
xx (X) =

2 I y (X)

2.1.2.5 Beam subjected to a tractive effort regularly distributed fx

The equilibrium equation is:

U

X
EA (X)
F
with A (X)

To 1 C
X
X
X

= -
=
+
1
L
With

and c= 2 -.
1
A1

After two integrations and by taking account of the fact that:

NR (L) = 0 to determine the first constant of integration,

and U ()
0 = 0 to determine the second,

we obtain the analytical expression of U (X):

- L F

L

U X
X
( ) =
C X +
2
(L+ Lc) Log

E With C
L + C X
1

The efforts intern are known by the following expression:

NR (X) = F (L - X
X
)

and constraints by:
F (L - X)

X
xx (X) =

With (X)

2.1.2.6 Beam subjected to a bending stress regularly distributed fy

The equilibrium equation is:

2
2
3
v

X
I.E.(internal excitation) (X)
= - F
with I (X) = I
1 + C
2

X
Z

2
y
Z
z1
X

L

1

I 3
Z 2
and c=

1.

I -
z1

We integrate successively four times this equation. The constants of integration are calculated by taking account of the fact that:

V (L

y
) = 0
MF (L
Z
) = 0
v
( )

0 = 0
X

v ()
0 = 0

The analytical result for the arrow and rotation in L is as follows:

L3 F
v
y
(X) =
X 6 L C + 4 L c2 + x2 5c2 + 2 c3 - c4
4th I c4
Z
(L + cx) [(
)
(
)
1
+ (
L
6L2 + 4L2c + 8Lcx + 4Lc2 X + 2c2 x2) Log L + cx

3
(
L F
X)
y
3
2
2
3
4
Z
=

2
+ 2
+
3
+ 2 -
3
2 [X (Lc
Lc) X (C
C
c)]
4EI C (L + cx)
z1
+ (
L
2L2 + 4Lcx + 2c2 x2) Log
.
L + cx

The efforts intern are given by the following expressions:

V (X) = F (L - X
y
y
)
1
MF (X) =
F (L - X) 2
Z
y
,
2

constraints by:

V (X)

y
xy (X) = A (X)

MF Z (X) H

y
xx (X) =
Iz (X) 2

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Code_Aster ®
Version
5.0

Titrate:
SSLL400 - Non-prismatic beam, subjected to specific efforts
Date:
03/05/02
Author (S):
J.M. PROIX, m.t. BOURDEIX, P. HEMON, O. WILK
Key: V3.01.400-A Page: 13/18

2.1.3 Section general

2.1.3.1 Beam subjected to the forces of gravity

The efforts of gravity are applied along axis Z. The movement of the beam induced by these efforts is thus a movement of inflection in the plan (X O Z).

The equilibrium equation is given by the expression:

2
2w
E I (X)
= A (X) G
2
X
y

2
X
1 2
4 3
4
linear weight
2
with
(

X
With X) = 1
With 1 + C

L
1

2
With
2
c=
- 1

1
With
4

X
and I (X) = I
y
y1 1 + D

L
1
I
y2 4
D =

1.

I -
y1

By integrating first once, we obtain the shearing action intern:

V X = -
With X G dx + C
Z ()
( )

1

C1 is given so that V (L)
Z
= 0 .

We obtain:
L With G
3
1

X

3
V
X =
- 1 + C
(1 C
Z ()
) .
C
3

L +
+

By integrating second once, we obtain the internal bending moment:

M (X) = V (X) dx + C
y
Z
.
2

C2 is calculated so that M (L)
y
= 0 .

We obtain:

With G

2

2
2 L C X
M
X
1
2
2
2 2
6
8
3
4
2

y () =
(L X) L + L C + L C + Lcx + Lcx +
.
2

2
2
12 L

+ C X

---

y
We calculate then rotation starting from the law of behavior = E I (X
y

) .
X

M (X
y
)
We thus have (X) =
dx + C
E I (X
y
)
3

with such as (0) = 0.

W
The arrow W (X) is given starting from the relation of Euler: y = -.
X

We calculate W (X) by integration of y (X):

W (X) = -
(X) + C
y
4

with C4 such as W ()
0 = 0.

The analytical expressions of y (X) and W (X) are not retranscribed here because they are much too much heavy. They were calculated, like the preceding ones, by the formal computation software MATHEMATICA.

2.2
Results of reference

· Déplacements and rotations at the loose lead
· Interior Efforts at the two ends
· Contraintes at the two ends

2.3

Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
Report/ratio n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation beams ASTER"

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

---

3 Modeling With

3.1 Characteristics of modeling

The model is composed of 10 elements right beam of Euler.

S1 section: *variable circular section*

with embedding,
R1 = 0.1 m (full section)
in the loose lead, R2 = 0.05 m (full section)

S2 section: *variable rectangular section*

with embedding,
Hy1 = 0.05 m
Hz1 = 0.10 m
in the loose lead, Hy2 = 0.05 m
Hz2 = 0.05 m

S3 section: *variable general section*

with embedding,
A1 = 102 m ²
Iy1 = 8.3333 106 m4
at the loose lead,
A2 = 2.5.103 m ²
Iy2 = 5.20833 107 m4

3.2
Characteristics of the grid

3 sections X 10 elements POU_D_E

3.3
Functionalities tested

Orders

AFFE_CARA_ELEM
BEAM
SECTION
RING

RECTANGLE

GENERAL

MECA_STATIQUE
OPTION
EFGE_ELNO_DEPL

SIGM_ELNO_DEPL

AFFE_CHAR_MECA FORCE_NODALE
FX

FY

MX

MY

FORCE_POUTRE
FX

FY

GRAVITY

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

4
Results of modeling A

4.1 Values tested

Loading case
Section
Identification
Reference
***Aster** Variation*
%
1 S1
U (L)
3.1831E08
3.1831E08
0.00E+00

N (0)
1.0000E+02
1.0000E+02
0.00E+00

N (L)
1.0000E+02
1.0000E+02
0.00E+00

xx (0)
3.1831E+03 3.1831E+03
0.00E+00

xx (L)
1.2732E+04 1.2732E+04
0.00E+00
2 S1
v (L)
4.2441E06
4.2441E06
0.00E+00

Z (L)
8.4882E06 8.4882E06
0.00E+00

vy (0) 1.0000E+02
1.0000E+02 0.00E+00

vy (L) 1.0000E+02
1.0000E+02 0.00E+00

mfz (0) 1.0000E+02
1.0000E+02 0.00E+00

mfz (L) 0.0000E+00
2.0008E11 0.00E+00

xx (0)
1.2732E+05 1.2732E+05
0.00E+00

xx (L)
0.0000E+00 2.0380E07
0.00E+00

xy (0)
3.1831E+03 3.1831E+03
0.00E+00

xy (L)
1.2732E+04 1.2732E+04
0.00E+00
3 S1
X (L)
3.8621E05 3.8621E05
0.00E+00

MX (0) 1.0000E+02
1.0000E+02 0.00E+00

MX (L) 1.0000E+02
1.0000E+02 0.00E+00

xy (0)
6.3661E+04 6.3661E+04
0.00E+00

xy (L)
5.0929E+05 5.0929E+05
0.00E+00

xz (0)
6.3661E+04 6.3661E+04
0.00E+00

xz (L)
5.0929E+05 5.0929E+05
0.00E+00
4 S1
W (L)
8.4882E06
8.4882E06
0.00E+00

y (L)
2.9708E05 2.9708E05
0.00E+00

vz (0) 0.0000E+00
2.9103E10 0.00E+00

vz (L) 0.0000E+00
0.0000E+00 0.00E+00

mfy (0) 1.0000E+02
1.0000E+02 0.00E+00

mfy (L) 1.0000E+02
1.0000E+02 0.00E+00

xx (0)
1.2732E+05 1.2732E+05
0.00E+00

xx (L)
1.0185E+06 1.0185E+06
0.00E+00
5 S1
U (L)
1.2296E08
1.2335E08
0.323

N (0)
1.0000E+02
1.0000E+02
0.00E+00

N (L)
0.0000E+00
9.6633E13
0.00E+00

xx (0)
3.1831E+03 3.1831E+03
0.00E+00

xx (L)
0.0000E+00 1.2303E10
0.00E+00
6 S1
v (L)
1.3486E06
1.3486E06
0.001

Z (L)
2.1220E06 2.1220E06 0.003

vy (0) 1.0000E+02
1.0000E+02 0.00E+00

vy (L) 0.0000E+00
1.8195E10 0.00E+00

mfz (0) 5.0000E+01
5.0000E+01 0.00E+00

mfz (L) 0.0000E+00
2.1245E12 0.00E+00

xx (0)
6.3662E+04 6.3662E+04
0.00E+00

xy (0)
3.1831E+03 3.1830E+03
0.

Loading case
Section
Identification
Reference
***Aster** Variation*
%
1 S2
U (L)
1.3862E07
1.3865E07
0.022

N (0)
1.0000E+02
1.0000E+02
0.00E+00

N (L)
1.0000E+02
1.0000E+02
0.00E+00

xx (0)
2.0000E+04 2.0000E+04
0.00E+00

xx (L)
4.0000E+04 4.0000E+04
0.00E+00
2 S2
v (L)
1.8969E04
1.8546E04
-2.232

Z (L)
3.0238E04 2.9465E04 2.556

vy (0) 1.0000E+02
1.0000E+02 0.00E+00

vy (L) 1.0000E+02
1.0000E+02 0.00E+00

mfz (0) 1.0000E+02
1.0000E+02 0.00E+00

mfz (L) 0.0000E+00
8.0035E11 0.00E+00

xx (0)
2.4000E+06 2.4000E+06
0.00E+00

xx (L)
0.0000E+00 3.8417E06
0.00E+00

xy (0)
2.0000E+04 2.0000E+04
0.00E+00

xy (L)
4.0000E+04 4.0000E+04
0.00E+00
3 S2
X (L)
8.3506E04 7.8827E04 5.603

MX (0) 1.0000E+02
1.0000E+02 0.00E+00

MX (L) 1.0000E+02
1.0000E+02 0.00E+00

xy (0)
1.5600E+06 1.5600E+06
0.00E+00

xy (L)
4.0371E+06 3.8400E+06 4.882

xz (0)
1.5600E+06 1.5600E+06
0.00E+00

xz (L)
4.0371E+06 3.8400E+06 4.882
4 S2
W (L)
1.2000E04
1.2001E04
0.014

y (L)
3.600E04 3.6012E04 0.034

vz (0) 0.0000E+00
3.2014E10 0.00E+00

vz (L) 0.0000E+00
0.0000E+00 0.00E+00

mfy (0) 1.0000E+02
1.0000E+02 0.00E+00

mfy (L) 1.0000E+02
1.0000E+02 0.00E+00

xx (0)
1.2000E+06 1.2000E+06
0.00E+00

xx (L)
4.8000E+06 4.8000E+06
0.00E+00
5 S2
U (L)
6.1370E08
6.1463E08
0.151

N (0)
1.0000E+02
1.0000E+02
0.00E+00

N (L)
0.0000E+00
1.8758E12
0.00E+00

xx (0)
2.0000E+04 2.0000E+04
0.00E+00

xx (l/2)
1.3333E+04 1.3333E+04
0.00E+00

xx (L)
0.0000E+00 7.5033E10
0.00E+00
6 S2
v (L)
6.8626E05
6.7302E05
-1.929

Z (L)
9.4847E05 9.2730E05 2.232

vy (0) 1.0000E+02
1.0000E+02 0.00E+00

vy (L) 0.0000E+00
4.3661E10 0.00E+00

mfz (0) 5.0000E+01
5.0000E+01 0.00E+00

mfz (L) 0.0000E+00
2.3042E11 0.00E+00

xx (0)
1.2000E+06 1.2000E+06
0.00E+00

xx (L)
0.0000E+00 1.1060E06
0.00E+00

xy (0)
2.0000E+04 2.0000E+04
0.00E+00

xy (L)
0.0000E+00 1.7464E07
0.00E+00
7 S3
W (L)
3.8259E05
3.8259E05
0.00E+00

y (L)
5.7388E05 5.7387E05 0.003

vz (0) 4.4633E+02
4.4635E+02 0.004

mfy (0) 1.7535E+02
1.7535E+02 0.00E+00

4.2 Remarks

Modeling being made in beams of Euler, coefficients of shearing ky = kz = 1.

5
Summary of the results

The results obtained confirm that elements POU_D_E with variable section present a good degree of reliability.

For the circular section, the results all are exact with the nodes (one finds the properties of the element with constant section) except for the efforts distributed where the effect of the smoothness of discretization fact of feeling.

For a rectangular section and a general section, it is necessary to discretize finely to have one correct solution.

Organization (S): EDF/IMA/MMN, IAT St CYR

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.402

SSLL402 - Dynamometric ring

Summary:
This test makes it possible to check in linear elasticity the calculation of the interior efforts and the constraints on a beam
curve.
A modeling makes it possible to test the curved elements of Timoshenko (POU_C_T).
The reference solution is analytical and the results obtained are of very good quality.

1
Problem of reference
1.1 Geometry
Circular ring
F

B
X
y
G
Y
R
C
With

0
X
D
F
Appear 1.1-a
R = 2 m
The section (full) is a circle of radius 0,01 Mr.
1.2
Properties of materials
Young modulus:
E = 2. 1011 Pa
Poisson's ratio: = 0.3
1.3
Boundary conditions and loading
Boundary condition:
DX = DY = DZ = DRX = 0 on point A
DY = DZ = 0 on the point C
Loading:
on B, F = 1 NR,
on D, F = -1 NR.

V3.01.402-A Page:
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2
Reference solutions
2.1 Method of calculation used for the reference solutions
:
analytical

On the section (A, B) 0 < <

, we have:
2
F
F
FR
NR =
cos, Vy = -
sin, M = -
1 -

+

Z
(cos)
.
2
2
2

On the section (B, C)
< <

2

, we have:
F
F
FR
NR = -
cos, Vy =

sin, M = -
1 +

+

Z
(cos)
.
2
2
2

By the use of the law of behavior connecting M to the rotation of the normal and given that this last is null in A and out of B, we have:

2

M D = 0,
O
- 2
from where:
= M =
M
=

F R
With
C
2

2.2
Results of reference

Interior efforts for = 0°et 90°.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Report/ratio n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation beams Aster"

---

3 Modeling
With

3.1
Characteristics of modeling

The model is composed of 4 elements curved beam of Timoshenko.

3.2
Characteristics of the grid

It consists of 4 elements POU_C_T.

3.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
BEAM
SECTION
RING
[U4.24.01]
CALC_ELEM
OPTION
EFGE_ELNO_DEPL
[U4.31.01]
SIGM_ELNO_DEPL
AFFE_CHAR_MECA
FORCE_NODALE
FY
[U4.25.01]

Version
4.0
Titrate:
Dynamometric SSLL402 Rings
Date: 01/12/98
Author (S)
:
J.M. PROIX, m.t. BOURDEIX, P. HEMON, O. WILK
Key:
V3.01.402-A Page:
5/6
4
Results of modeling A
4.1 Values
tested
4.1.1 Interior effort with = 0°
Reference
Aster
Variation %
NR
5.000E01
5.000E01
0.0000
Vy
0.0000
0.0000
*0.0000 **
MFz
3.6338E01
3.6338E01
0.0000
** Absolute deviation*
4.1.2 Interior effort with = 90°
Reference
Aster
Variation %
NR
0.0000
0.0000
*0.0000 **
Vy
5.0000E01
5.000E01

0.0000
MFz
6.3662E01
6.3662E01
0.0000
****Ecart absolute***
4.1.3 Constraint
with
= 0°
Reference
Aster
Variation %
SIXX
4.6426E+05
4.6426E+05
0.0000
SIXY
0.0000
0.0000 *
0.0000
**** Absolute deviation***
4.1.4 Constraint
with
= 90°
Reference
Aster
Variation %
SIXX
8.1056E+05
8.1056E+05
0.0000
SIXY
1.7683E+03
1.7683E+03
0.0000
4.2 Remarks
Symmetry compared to axis (A, C) implies the nullity of the shearing action T in A and C. balance
F
according to OY of the half-ring (A, B, C) imposes in A and C a normal effort equal to
. Symmetry by
2
report/ratio with the axis (B, D) implies that the moments in A and C are equal in absolute value and of direction

opposites.
4.3 Parameters
of execution
Version: 4.02.13
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU to use:
4 seconds

5
Summary of the results
The results agree with the analytical solution and make it possible to validate the calculation of the efforts
interns (EFGE_ELNO_DEPL) and of constraints (SIGM_ELNO_DEPL) by the elements of beams curves (POU_C_T).

Author (S):
J.M. PROIX, m.t. BOURDEIX, P. HEMON, O. WILK
Key: V3.01.403-A Page: 1/6

Organization (S): EDF/IMA/MMN, IAT St CYR

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.403

SSLL403 - Buckling of a beam under the effect of its actual weight

Summary:

This test makes it possible to validate in linear elasticity the loading due to the forces of gravity for a modeling of right beam type of Euler (POU_D_E). It also allows the implementation and the validation of the calculation of stamp geometrical rigidity.

The reference solution is analytical and the results considered to be satisfactory.

1 Problem of reference

1.1 Geometry

With
Z
0
X
total reference mark

Appear 1.1-A

Rectangular section: Hy = 0.01 m, Hz = 0.01 m
Length: L = 1 m

1.2 Properties of materials

Young modulus:
E = 2. 1011 Pa
Poisson's ratio: = 0,3
Density:
= 7800 kg/m3

1.3 Boundary conditions and loading

Boundary condition:

Embedded end (0): DX = DY = DZ = DRX = DRY = DRZ = 0.

Loading:

Force gravity: p weight per unit of length with G = (0 0 -9,81) (given in total reference mark).

2
Reference solutions

2.1
Method of calculation used for the reference solutions

In local reference mark, X following axis OA of the beam, the bending moment, with X-coordinate X, has for
expression:

L
M
(X) = p
[v () - v (X)]D
Fy

.
X

Arrow v (X) satisfied thus the equation:

L
L
D 2v

E I
= p
() - ( ) = -
() + (-) ( )

2
[v
v X] D
p
v
D
L X v X
Z dx

X
X

By deriving the two members, one obtains the differential equation:

D 3v
p
FD
+
(L - X)
= 0 .
dx3
E I
dx
Z

FD
The function v' (X) =
satisfied the linear and homogeneous differential equation with the second order:
dx

D 2v'
p
+
(L - X) v' = 0,
dx2
E Iz

who can be solved using the functions of Bessel.

One finds the value of the linear weight then criticizes equalizes with:

E I
p
Z
C = 7 837
,
.
L3

The analytical solution gives numerically:

-
10 8
p
11
3
C = 7 837
,
2 10 ·
= 1 3061667
,
10 .
12

2.2
Results of reference

The value criticizes multiplier:
C
P
C =
Sg

2.3

Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
Report/ratio n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation beams Aster"
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

---

3 Modeling With

3.1 Characteristics of modeling

The model is composed of 10 elements right beam of Euler.

3.2 Characteristics of the grid

It consists of 10 elements POU_D_E.

3.3 Functionalities tested

Orders

Keys
AFFE_CARA_ELEM
BEAM
SECTION
RECTANGLE
[U4.24.01]
AFFE_CHAR_MECA GRAVITY

[U4.25.01]
CALC_CHAM_ELEM SIEF_ELGA_DEPL

[U4.61.01]
MODE_ITER_SIMULT METHOD
JACOBI

[U4.52.02]

4
Results of modeling A

4.1 Values
tested

Eigenvalue of the system (K + KG) X = 0:

Reference
Aster Variation
%

-170.701 -170.0005
-0.408

4.2 Notice

Since p
S G
C =
, (S G represents linear prestressing), we have like
critical loading:

p
NR m
C =
-
1300 84
1
,
.

4.3 Parameters of execution

Version: 4.02.13

Machine: CRAY C90

Obstruction memory:
8 MW
Time CPU to use:
5.8 seconds

---

5 Summary of the results

The results are very close to the analytical solution (variation: 0,4% per 10 elements). This variation is
function of the smoothness of discretization being given assumptions used for rigidity
geometrical (cf [R3.08.01]). This thus validates this type of loading for the buckling of Euler.

Intentionally white left page.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLL404 - Buckling of an arch

Date:
23/09/02
Author (S):
J.M. PROIX, F. SOULIE Key
:
V3.01.404-A Page:
1/6

Organization (S): EDF/AMA, SAMTECH

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
V3.01.404 document

SSLL404 - Buckling of an arch

Summary

The applicability of this test is the analysis of stability of the structures. The studied structure is an arch
bent by moments applied at the two ends; it is modelled by elements of beams
right-hand sides. The goal is to calculate the breaking values of the moments.

The interest of this test lies in the following aspects:

· calculation of a geometrical matrix of rigidity for elements POU_D_E.
· test of modal methods MODE_ITER_SIMULT and MODE_ITER_INV of stability
· presence of close eigenvalues

The calculated clean loads are compared with values obtained analytically for a model of
beam of Euler-Bernoulli.

In this test, one also validates the RAYLEIGH option of order MODE_ITER_INV.

---

1 Problem of reference

1.1 Geometry

B
y
Y
H X
M
y
B
R
With
X
M

Radius of curvature
R = 0.3 m
Height of the profile
H = 0.015 m
Width of the profile
B = 0.002 m
Section
S = bh
the 1st inertia of inflection
IX = bh3/12
the 2nd inertia of inflection
IY = hb3/12
Inertia of torsion
J = hb3/3

1.2
Properties of materials

Young modulus
E = 7. E 10 N/m ²
Poisson's ratio
= 0.3
Modulus of rigidity
G = E/2 (1+)

1.3
Boundary conditions and loading

The beam Bi-is supported. One prevents the torsion of the section at ends A and B. to respect the assumptions of the ideal model taken as reference, it is important that the moment is constant and that the normal effort is null along the beam. This is why free it is left displacement U according to X at the point B. the boundary conditions are:

At point a: U = v = W = 0; Y = 0

At point b: v = W = 0; X = 0

The initial state of stress which makes it possible to carry out the analysis of stability is obtained by imposing one
bending moment around axis Z:

At points A and b: M = 1 Nm

1.4 Conditions
initial

Without object in static analysis of stability.

2
Reference solution

2.1

Method of calculation used for the reference solution

The reference solution is obtained analytically for a beam of Euler-Bernoulli. Aspects theoretical are developed in the reference [bib1].

By using the notations of the paragraph [§1], the values criticize are given by the expression:

I.E.(INTERNAL EXCITATION) + GJ
I.E.(INTERNAL EXCITATION) - GJ 2
I.E.(INTERNAL EXCITATION) GJ
M
X
X
±
4n2
X
= -
N
CR
1 2
, 3
, ,....
R

R

+
=
2
2
R2

The plus sign corresponds to positive moments such as they are indicated on the figure of [§1.1].

2.2
Results of reference

The first 5 critical loads are classified by order of increasing module.

Mode Moment criticizes (Nm)

1 2.86074
2 8.63207
3 -8.78382
4 14.4147
5 -14.5551

With Code_Aster, one finds the opposites of these critical loads (what is logical compared to formulation of the problem to be solved).

2.3
Uncertainty on the solution

Analytical solution

2.4 References
bibliographical

[1]
TIMOSHENKO Stephen P., MANAGES James Mr., Theory of Elastic Stability, McGraw-Hill, International Edition, 1963, pp. 313-318.

---

3 Modeling

With

3.1
Characteristics of modeling

Y, DY
19
1
X, DX

The arch is with a grid by means of elements of right beam of type POU_D_E.

Boundary conditions:

At point A such as X = R, Y = 0:

DX = DY = DZ = 0 and RY = 0

At the point B such as X = 0, Y = R:

DY = DZ = 0 and X-ray = 0

For the static analysis, unit moments around Z are defined in nodes 1 and 19.

3.2
Characteristics of the grid

A number of nodes: 19
A number of meshs: 18 POU_D_E

3.3 Functionalities
tested

Orders

AFFE_MODELE
AFFE
MODELING
"POU_D_E"

AFFE_CHAR_MECA

DDL_IMPO

AFFE_CARA_ELEM
BEAM

CALC_MATR_ELEM
OPTION
“RIGI_GEOM”

“RIGI_MECA”
MODE_ITER_SIMULT
METHOD
“SORENSEN”

CALC_FREQ
OPTION
PLUS_PETITE'

NMAX_FREQ

MODE_ITER_INV
CALC_FREQ
OPTION
“NEAR”

CHAR_CRIT

CALC_MODE
OPTION
RAYLEIGH

4
Results of modeling A

Critical load

4.1
MODE_ITER_SIMULT with METHOD = “SORENSEN”

Identification
Reference
Code_Aster %
difference
N° critical load
(multiplied by -1)
1 -2.86074
-2.75137
3.823
2 -8.63207
-8.30613
3.776
3
8.78382 8.39554 4.420
4 -14.4147
-13.93216
3.348
5
14.5551 14.01104 3.738

4.2
MODE_ITER_INV with OPTION = “NEAR”

Identification
Reference
Code_Aster %

difference
N° critical load
(multiplied by -1)
1 -2.86074
-2.75137
3.823
2 -8.63207
-8.30613
3.776
3 8.78382
8.39554
4.420
4 -14.4147
-13.93216
3.348
5 14.5551
14.01104
3.738

5
Summary of the results

The methods of Sorensen and the iterations opposite give identical and satisfactory results since the maximum change with the analytical solution is lower than 4.5%.On recalls than the solution analytical takes into account the curve of the structure.

Elements MEPOUCT could not be used in this test because the calculation of the matrix of rigidity geometrical is not available for this type of element.

Organization (S): EDF/AMA, EDF/MMC

Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
Document: V3.01.501

SSLL501 - Piping VVP.
Comparison Aster-SYSPIPE

Summary:

This test makes it possible to check the elements of beam for the calculation of line of piping real, in particular them
elements of curved beam POU_C_T. Calculation is static, elastic, linear.

The reference solution is numerical (code SYSPIPE).
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLL501- Piping VVP. Comparison Aster-SYSPIPE

1
Problem of reference

1.1 Geometry

This test is extracted from a study, carried out by the Department MTC, which related to modeling of an industrial piping (line VVP of stage CPY). It gave place to comparisons between Code_Aster and code SYSPIPE of FRAMATOME [bib2]

N50
N1

Overall length L = 57.766 m

Co-ordinates of the points (in m):
N1 -2.2621E+03 2.0129E+04 1.6700E+04
N26
1.6260E+04 -1.7089E+03 1.8320E+04
N2
-2.2348E+03 1.9961E+04 1.6700E+04
N27
1.6121E+04 -3.3058E+03 1.8320E+04
N3
-2.0514E+03 1.8836E+04 1.6700E+04
N28
1.6120E+04 -3.3077E+03 1.8320E+04
N4
-1.8550E+03 1.7631E+04 1.6700E+04
N29
1.6053E+04 -4.0826E+03 1.8320E+04
N5
-6.1086E+02 1.6598E+04 1.7300E+04
N30
1.5943E+04 -4.4919E+03 1.8320E+04

N6
7.9481E+02 1.6827E+04 1.8107E+04
N31
1.5664E+04 -5.0899E+03 1.8320E+04
N7
1.5780E+03 1.6757E+04 1.8320E+04
N32
1.5331E+04 -5.8032E+03 1.8320E+04
N8
3.0228E+03 1.6302E+04 1.8320E+04
N33
1.4816E+04 -6.9089E+03 1.9540E+04
N9
6.0461E+03 1.5349E+04 1.8320E+04
N34
1.4816E+04 -6.9089E+03 2.0525E+04
N10
6.0480E+03 1.5348E+04 1.8320E+04
N35
1.4816E+04 -6.9089E+03 2.2030E+04
N11
6.8360E+03 1.5100E+04 1.8320E+04
N36
1.4816E+04 -6.9089E+03 2.2830E+04
N12
7.1690E+03 1.4935E+04 1.8320E+04
N37
1.4816E+04 -6.9089E+03 2.4710E+04
N13
9.6094E+03 1.3227E+04 1.8320E+04
N38
1.4816E+04 -6.9089E+03 2.6590E+04
N14
1.0878E+04 1.2338E+04 1.8320E+04
N39
1.4816E+04 -6.9089E+03 2.8005E+04
N15
1.1561E+04 1.1860E+04 1.8320E+04
N40
1.4816E+04 -6.9089E+03 2.8010E+04
N16
1.1861E+04 1.1560E+04 1.8320E+04
N41

1.4816E+04 -6.9089E+03 2.8015E+04
N17
1.2899E+04 1.0078E+04 1.8320E+04
N42
1.4816E+04 -6.9089E+03 2.9530E+04
N18
1.2900E+04 1.0076E+04 1.8320E+04
N43
1.4816E+04 -6.9089E+03 3.0530E+04
N19
1.4376E+04 7.9679E+03 1.8320E+04
N44
1.4816E+04 -6.9089E+03 3.0780E+04
N20
1.4921E+04 7.1906E+03 1.8320E+04
N45
1.3710E+04 -6.3933E+03 3.2000E+04
N21
1.5100E+04 6.8067E+03 1.8320E+04
N46
1.3594E+04 -6.3392E+03 3.2000E+04
N22
1.5345E+04 5.8901E+03 1.8320E+04
N47
1.0757E+04 -5.0164E+03 3.2000E+04
N23
1.6235E+04 2.5702E+03 1.8320E+04
N48
1.0621E+04 -4.9531E+03 3.2000E+04
N24
1.6481E+04 1.6537E+03 1.8320E+04
N49
9.5162E+03 -4.4374E+03 3.0780E+04
N24
1.6517E+04 1.2316E+03 1.8320E+04
N50
9.5162E+03 -4.4374E+03 2.9938E+04

Characteristics of the sections:

.
Right parts:
- R= 406.4 mm, EP=32.mm
- Mesh 1 (pipe Steam Generator), R = 410.mm, EP = 38.mm;
- Mesh 49 (exit Br), R = 444.4mm, EP = 70.mm;
.
Elbows:
- meshs: (M2 M6 M18 M21 M26 M30 M35 M39 M44 M46): R = 406.4mm; EP = 34.mm;
- Coefficient of flexibility for all the elbows, cflex = 6.032;
- Rays of bending of the elbows: 1220mm

1.2
Material properties

E = 1.8604E+5 MPa (with 287°C)
Alpha = 12.81e-6 °C1; = 0.3

1.3
Boundary conditions and loadings

.
Displacement imposed on node 50 (mesh, side Steam Generator)
dx = 46.466mm;
Dy = -30.494mm;
dz = 76.mm;
null rotations: drx=dry=drz=0
.
The N1 node is embedded:
dx=dy=dz=drx=dry=drz=0

2
Reference solution

2.1
Method of calculation used for the reference solution

This test is extracted from a study, carried out by the Department MTC, which related to modeling of an industrial piping (line VVP of stage CPY). It gave place to comparisons between Code_Aster and code SYSPIPE of FRAMATOME [bib1]. The reference solution is numerical (code SYSPIPE).

2.2
Results of reference

Inflection and torques to the nodes N50, N48 N44, N16 and N2

Net Noeud
*|MT| MF=RACINE (MY*MY+MZ*MZ)*
M1 N50
41.084
95.294
M2 N48
91.024
83.743
M3 N48

91.024
83.738
M6 N44
11.992
102.100
M7 N44
11.992
102.104
M34 N16
0.356
58.870
M35 N16
0.355
58.868
M48 N2
6.114
97.174
M49 N2
6.114
97.174

2.3
Uncertainty on the solution

Numerical solution, obtained with identical data and comparable elements. One can thus to estimate the precision at 1%.

2.4 References
bibliographical

[1]
P.LE DELLIOU, P.HORNET.
Handbook of Validation
V3.01 booklet: Linear statics of the linear structures
HT-66/02/001/A

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3 Modeling
With

3.1
Characteristics of modeling

10 POU_C_T
39 POU_D_T

3.2
Characteristics of the grid

A number of nodes: 50
A number of meshs and type: 49 SEG2

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM BEAM
NET
RING

AFFE_CARA_ELEM DEFI_ARC
NET
CENTER

AFFE_CARA_ELEM DEFI_ARC
NET

COEF_FLEX
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

TEMP_CALCULEE

FORCE_NODALE
NODE

“MECHANICAL” AFFE_MODELE “POU_D_T”

“MECHANICAL” AFFE_MODELE “POU_C_T”

DEFI_MATERIAU ELAS

4
Results of modeling A

4.1 Values
tested

|MT|

Net Noeud Reference Aster % difference
M1 N50 41.084
41.083 0.002
M2 N48 91.024
91.023 0.001
M3 N48 91.024
91.023 0.001
M6 N44 11.992
11.992 -0.003
M7 N44 11.992
11.992 -0.003
M34 N16
0.356 0.355
0.3
M35 N16
0.355 0.355
0.3
M48 N2
6.114 6.114
0.001
M49 N2
6.114 6.114
0.001

*MF=RACINE (MY*MY+MZ*MZ)*

Net Noeud Reference
***Aster** %*
difference
M1 N50 95.294
95.293 0.001
M2 N48 83.743
83.741 0.002
M3 N48 83.738
83.741 -0.003
M6 N44 102.100

102.099 0.001
M7 N44 102.104
102.099 0.005
M34 N16
58.870 58.870
0.001
M35 N16
58.868 58.870
0.003
M48 N2
97.174 97.172
0.003
M49 N2
97.174 97.172
0.003

4.2 Parameters of execution

Version: 5.5

Machine: SGI/ORIGIN 2000 R10000
Obstruction memory:
16 Mo
Time CPU To use: 3s

5 Summary of the results

The results are in very good agreement with reference SYSPIPE. They validate the use of the elements POU_D_T and POU_C_T for calculations of lines of industrial pipings subjected to thermal and mechanical loadings.

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
Document: V3.02.100

SSLP100 - Stick in static substructure

Summary:

static Under-structuring: condensation of the matrices of rigidity and the loadings.
Linear behavior.
Plane model.
2 Modelings:
Model · a: "ordinary" plan: it is the reference solution.
· B: models with substructures.
Interest:
· under-structuring on two levels,
· rotation of the macronutrients and the loadings (following or not),
· calculation of the fields inside the macronutrients.
The results of B are identical to those of A with a margin of 105.

1
Problem of reference

1.1 Geometry

y
E
N27
N19
G
N25
N17
C
P2
4
N11
N8
F
P3
D
H
45° 45°
P4
45°
O
X
With
B
4
I
P1
N33
J
1
3

1.2

Material properties

E = 15. Pa

= 0.3

1.3

Boundary conditions and loadings

· *[GH]: U + v = 0; N8, N17 and N25: U = v = 0; J: U = 2.0*

· *loading case 1: pressure distributed on ADFH p = 10.0*

· *loading case 2: N11, N19, N27, N33, P1: Fy = -20.0*

1.4 Conditions

initial

Without object.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

This problem does not have a reference solution.
Modeling A is used as reference for modeling B.

2.2 Results of reference

Displacements U and v at the points P1, P2, P3, P4.

2.3 Uncertainty on the solution

The solution of "reference" depends on the space discretization of the model; this is why grid is drawn in [§1.1].
Modeling B must respect this grid to lead to the same results as A.

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3 Modeling

With

3.1

Characteristics of modeling

24 elements QUAD4, modeling: “D_PLAN”

E
20
19
27
18
P2
17
C
G
12
28
25
9
16
26
15
23
11
6
8
24
13
14
21
3
5

F P3
H 22
2
D
1
4
7
10 **P4**
O
With
B
30
32
34
36
29
31
33
35
I
P1
J

3.2
Characteristics of the grid

A number of nodes: 36.
A number of meshs and types: 24 QUAD4

4

Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference
P1 U
1.88327
P1 v
2.59224 102
P2 U
8.27372 102
case of
P2 v
8.27372 102
charge
P3 U
2.70375 101
n° 1
P3 v
5.69552 101
P4 U
5.17703 101
P4 v
5.43387 101
P1 U
1.71883
P1 v
6.04367
P2 U
4.60196 102
case of
P2 v
4.60196 102
charge
P3 U
2.26903 101
n° 2
P3 v
6.14296 101
P4 U
9.57110 101

P4 v
2.53878
4.2
Contents of the file results
Displacements
4.3 Parameters
of execution
Version:
3.02
Machine:
CRAY C90
System:
8.0 UNICOS
Obstruction memory:
8 megawords
Time CPU To use:
4 seconds
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HI-75/96/016 - Ind A

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5 Modeling
B
5.1
Characteristics of modeling
E
G
C
P2
F
H

P3 D
B
O
With
P4
I
J
P1

The initial grid my (level -2 of the under-structuring) contains only the 12 QUAD4 of IJBA and ABCD.

The macr_elem_stat (S_1) is defined starting from the elements of ABCD. This macr_elem_stat is digest on the nodes of AB and CD (level -2).

C
D
C
With
B
D
I
With
B
my
J
S_1

The grid ma_123 of level -1 is defined while making turn 2 S_1 times to represent the crown ABCEGHFDA.

E

C
G
G
F
D
H
H
With
B
With
B
ma_123
S_123
The macr_elem_stat S_123 is defined starting from substructures ABCD, DCEF and FEGH. It macr_elem_stat is condensed on the nodes of AB and GH.
The grid mag0 is defined by the macr_elem_stat S_123.
The final grid mag (level 0) is defined by the grid mag0 which one assembles (ASSE_MAILLAGE) with the initial grid my to recover the meshs of IJBA.
The resolution is then made on this final grid, then one calculates displacements inside macr_elem_stat using operator DEPL_INTERNE.
G
H
With
B
G
mag
H
With
B
mag0
I
J
5.2
Characteristics of the grid
A number of nodes: 20.
A number of meshs and types: 12 QUAD4
5.3 Functionalities
tested
Orders
Keys
MARCR_ELEM_STAT
DEFINITION
OUTSIDE

RIGI_MECA
[U4.44.01]
DEFI_MAILLAGE
DEFI_MAILLE
RECO_GLOBAL
DEFI_NOEUD
[U4.12.04]
AFFE_MODELE
AFFE_SOUS_STRUC
[U4.22.01]
ASSE_MAILLAGE
[U4.12.02]
DEPL_INTERNE
[U4.65.01]
CALC_VECT_ELEM
SOUS_STRUC
[U4.41.02]
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HI-75/96/016 - Ind A

6
Results of modeling B
6.1 Values
tested
Identification
Reference
Aster
% difference
P1 U
1.88327

1.88327
^{2} 105
P1 v
2.59224 102
2.59224 102
^{2} 105
P2 U
8.27372 102
8.27372 102
^{2} 105
P2 v
8.27372 102
8.27372 102
^{2} 105
P3 U
2.70375 101
2.70375 101
^{2} 105
P3 v
5.69552 101
5.69552 101
^{2} 105
P4 U
5.17703 101
5.17703 101
^{2} 105
P4 v
5.43387 101
5.43387 101
^{2} 105
P1 U
1.71883
1.71883
^{2} 105
P1 v
6.04367
6.04367
^{2} 105
P2 U
4.60196 102
4.60196 102
^{2} 105
P2 v

4.60196 102
4.60196 102
² 105
P3 U
2.26903 101
2.26903 101
² 105
P3 v
6.14296 101
6.14296 101
² 105
P4 U
9.57110 101
9.57110 101
² 105
P4 v
2.53878
2.53878
² 105

6.2
Contents of the file results

Displacements.

6.3 Parameters
of execution

Version:
3.02
Machine:
CRAY C90
System:
8.0 UNICOS
Obstruction memory:
8 megawords
Time CPU To use:
9 seconds

7
Summary of the results

The precision of the results obtained (error ² 105) is natural because the static under-structuring is one "exact" method (in infinite numerical precision).

Version
7.2

Titrate:
SSLP101 - Rate of refund of energy in plane constraints
Date:
11/05/04
Author (S):
X. DESROCHES *Key*
:
V3.02.101-D Page:
1/10

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
Document: V3.02.101

SSLP101 - Rate of refund of energy
in plane constraints

Summary:

It is about a test of breaking process in statics for a two-dimensional problem. One is considered plate fissured in plane constraints, the functionalities tested are:

.

the rate of refund of energy G,

.

the rate of refund of energy calculated starting from the calculation of the coefficients of constraints K1 and K2.

The interest of the test is to compare the traditional value of G and the value of G (IRWIN) obtained starting from K1 and
K2. It also makes it possible to test the invariance of calculation compared to the crowns of integration.

This test contains 3 different modelings: the modeling A which treated calculation of the Integral of Rice is not
more supported since Version 3.

1
Problem of reference

1.1 Geometry

Rectangular plate with emerging crack OC.
For reasons of symmetry, the model is tiny room to the half-structure y 0.

Y
I

v
H
U
With
O
C
X
has

Height plates: H = 250 mm

Width plates: I = 100 mm

Depth fissures: have = 37.5 mm (OC)

1.2
Material properties

E = 200000 MPa = 0.3
Assumption of the plane constraints.

1.3
Boundary conditions and loadings

·
Constraint imposed in Y = H:
= 1 MPa
·
Displacement for the edge CA defined by: has X L and y = 0
v = 0.
·
Not fixes a:
U = v = 0.

For modeling C one replaces the constraint imposed by a pressure on the lips of fissure.

2
Reference solution

2.1
Method of calculation used for the reference solution

Reference solution of BROWN & STRAWLEY [bib1]:

J = F 2 has 2/E with F = 1 98
.
has
mm

in

2

and E

in

N/mm

2.2
Results of reference for G

Results of reference G =
2 × ×
×
-5 =
-

198
37 5 0 510
2 309310 3
.
.
.
.

I
The formula G (IRWIN) =
(2 2
K1 + K2) led, like K
0, with K
,
21 491
E
2 =
1 =

2.3
Results of reference for the derivative of G

While varying the Young modulus and the Fy loading, one notes that:

2
G
G = F
with
3

310
.
2
-
=
that is to say
=
F

2

Y
Y

F
Y

G

G
G =
with =
.
460 is
= -
E
E

E

2.4 Reference bibliographical

[1]
Special BROWN-STAWLEY ASTM Technical Publication n° 410 (1966)

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3 Modeling
B

3.1
Characteristics of modeling

Ray
Center C

Ymax
Ymin
Xmin
Xmax

One calculates the field then the rate of refund of energy G, the coefficients of K1 constraints and K2, the rate of refund of energy obtained by the formula of IRWIN, the direction of propagation of the crack.

3.2
Characteristics of the grid

A number of nodes: 673

A number of meshs and types: 112 meshs QUAD8 and 142 meshs TRIA6

3.3 Functionalities
tested

Orders

MECHANICAL AFFE_MODELE
C_PLAN
ALL
AFFE_CHAR_MECA

MECA_STATIQUE

CALC_THETA THETA_2D

CALC_G_THETA

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HT-66/04/005/A

Code_Aster ®
Version
7.2

Titrate:
SSLP101 - Rate of refund of energy in plane constraints
Date:
11/05/04
Author (S):
X. DESROCHES Key
:
V3.02.101-D Page:
5/10

4
Results of modeling B

4.1 Values
tested

The values tested are the rate of refund of energy calculated by the method théta and the rate of restitution of energy calculated by the formula of IRWIN starting from the coefficients of intensity of constraints
K1 and K2.

Identification Reference
Aster %
difference
Crown 1 G
2.3093 10-3 2.2994
10-3 4.
10-3

Crown 2 G
2.3093 10-3 2.2993
10-3 4.
10-3
Crown 3 G
2.3093 10-3 2.2993
10-3 4.
10-3
Crown 4 G
2.3093 10-3 2.2991
10-3 4.
10-3
Crown 5 G
2.3093 10-3 2.2981
10-3 5.
10-3
Crown 6 G
2.3093 10-3 2.2906
10-3 8.
10-3
Crown 1 G (IRWIN)
2.3093 10-3 2.2990
10-3 4.
10-3
Crown 2 G (IRWIN)
2.3093 10-3 2.2989
10-3 4.
10-3
Crown 3 G (IRWIN)
2.3093 10-3 2.2988
10-3 5.
10-3
Crown 4 G (IRWIN)
2.3093 10-3 2.2986
10-3 5.
10-3
Crown 5 G (IRWIN)
2.3093 10-3 2.2976
10-3 5.
10-3
Crown 6 G (IRWIN)
2.3093 10-3 2.2891
10-3 8.

10-3

4.2 Notice

1
The calculation of G, K1, K2, G (IRWIN) =
(2 2
1
K + K2) was carried out starting from 6 different fields,
E
correspondents each one with a circular ring centered out of C.

5 Modeling C

5.1 Characteristics of modeling

Ray
Center C

Ymax
Ymin
Xmin
Xmax

The loading differs:

- *one relieves the stress imposed in Y = H,*
- *one imposes a pressure p = 1 on the lips of the crack.*

5.2 Characteristics of the grid

A number of nodes: 673

A number of meshs and types: 112 meshs QUAD8 and 142 meshs TRIA6

5.3 Functionalities tested

Orders

MECHANICAL AFFE_MODELE
C_PLAN ALL
AFFE_CHAR_MECA

MECA_STATIQUE

CALC_THETA THETA_2D

CALC_G_THETA

6

Results of modeling C

6.1 Values tested

Values of G

Identification Reference Aster** % **difference
Crown 1 G
2.3093 10-3 2.2994
10-3 4.
10-3
Crown 2 G
2.3093 10-3 2.2993
10-3 4.
10-3
Crown 3 G
2.3093 10-3 2.2993
10-3 4.
10-3
Crown 4 G
2.3093 10-3 2.2991
10-3 4.
10-3
Crown 5 G
2.3093 10-3 2.2981
10-3 5.
10-3
Crown 6 G
2.3093 10-3 2.2906
10-3 8.
10-3
Crown 1 G (IRWIN)
2.3093 10-3 2.2990
10-3 4.
10-3
Crown 2 G (IRWIN)
2.3093 10-3 2.2990
10-3 4.
10-3
Crown 3 G (IRWIN)

2.3093 10-3 2.2988
10-3 5.
10-3
Crown 4 G (IRWIN)
2.3093 10-3 2.2986
10-3 5.
10-3
Crown 5 G (IRWIN)
2.3093 10-3 2.2976
10-3 5.
10-3
Crown 6 G (IRWIN)
2.3093 10-3 2.2891
10-3 8.
10-3

6.2 Notice

1
2
2
The calculation of G, K1, K2 and G (IRWIN) =
(K +
1
K2)

was carried out starting from the same fields
E

that for preceding modeling. The results are identical.

---

7 Modeling F

7.1 Characteristics of modeling

Ray
Center C

Ymax
Ymin
Xmin
Xmax

One applies successively:

- *a surface force Fy=1 in Y = H,*
- *a pressure p = 1 on the lips of the crack.*

and one calculates dG/dFy and dG/dp on 2 different crowns.

In the 2 cases one calculates dG/dE on the same crowns.

7.2 Characteristics of the grid

A number of nodes: 673

A number of meshs and types: 112 meshs QUAD8 and 142 meshs TRIA6

7.3 Functionalities tested

Orders

MECHANICAL AFFE_MODELE
C_PLAN ALL
AFFE_CHAR_MECA

MECA_STATIQUE

CALC_THETA THETA_2D

CALC_G_THETA_T SENSITIVITY

8
Results of modeling F

8.1 Values
tested

Identification Reference
***Aster** %*
difference
dg/dE, crown n°1
1.15E-8
1.149E-8
0.03
dg/dE, crown n°2
1.15E-8
1.149E-8
0.03
dg/dFy, crown n°1
4.6E-3
4.599E-3
0.03
dg/dFy, crown n°2
4.6E-3
4.599E-3
0.03
dg/dp, crown n°1
4.6E-3
4.599E-3
0.03
dg/dp, crown n°2
4.6E-3
4.599E-3
0.03

9
Summary of the results

The calculation of G and its derivative is not sensitive to the choice of the field of integration.

Organization (S): EDF/IMA/MMN

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
Document: V3.02.102

SSLP102 - Rate of refund of energy with initial deformations (Lagrangian propagation)

Summary

This test makes it possible to calculate the rate of refund of energy G for a static problem of mechanics in plane deformations with initial deformations by a Lagrangian method of propagation of crack and of to check the stability of the calculation of G with initial deformations on 4 different crowns of integration.

This test contains a modeling in plane deformations.

Version
4.0
Titrate:
SSLP102 Rate of refund of energy with initial deformations
Date:
19/01/98
Author (S):
G. DEBRUYNE
Key:
V3.02.102-A Page:
2/6

1 ***Problem of reference***

1.1 Geometry

It is about a rectangular plate with side crack (one represents only half of the structure).

y
I
B
D
H
With
O
C
X
has

Height plates: H = 200.
Width plates: I = 100.
Length fissures: has = 50.

1.2 ***Material properties***

Young modulus:
E= 2.104 MPa
Poisson's ratio:
= 0.3
We place ourselves on the assumption of the plane deformations.

1.3 ***Boundary conditions and loadings***

· Déplacements for A < X < I: y = 0. : v = 0.
0 < X < I: y = H.: v = 0.
· Point fixes b: U = v = 0.
· Initial Déformations: (=
=
=

xx
yy zz F (X))

2
Reference solution
2.1
Method of calculation used for the reference solution

The results of reference result from a test WILSON and YU [bib1] or from a calculation of J (integral from
Rice) in thermoelasticity in the cards of the ECA [bib2] whose characteristics are as follows:
=
-
5 10 6/° C
T (X) = 2 To X/L
To =
°
100 C
E = 20.000MPa, = 0 3
.
One thus imposes
=
=
= 1 =
xx
yy zz F
2 To X/L

2.2
Results of references

The result for J in card ECA (Code CASTEM 2000) is J = 0.390 kgf/mm (not indication on contours).
The results resulting from WILSON and YU vary for five different contours:
1
0.392
2
0.362
3
0.369
4
0.361
5
0.371

2.3 References bibliographical

[1]
The Uses of J-Integrals in thermal stress ace problems - International Newspaper of Fracture (1979) WILSON and YU.
[2]
Breaking process, methods numerical for engineer IPSI 18 November 20, 1986, card-index validation CASTEM pp 47-48
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HI-75/96/016 - Ind A

---

3 Modeling With

3.1 Characteristics of modeling

Y
0

With
X
F (X)
5.10-4
X
50.
The initial deformations are such as:

3.2
Characteristics of the grid

A number of nodes: 853
A number of meshs and types: 359 TRIA6 and 27 QUAD8

3.3 Functionalities
tested

Orders
Keys
AFFE_CHAR_MECA
EPSI_INIT
[U4.25.01]
CALC_MATR_ELEM
RIGI_MECA_LAGR
[U4.41.01]
CALC_VECT_ELEM
[U4.41.02]
CALC_G_THETA
OPTION
CALC_G_LAGR
[U4.63.03]

4
Results of modeling A
4.1 Values
tested
J Reference
G
Identification
J: CASTEM
WILSON and YU
Aster
% difference
contour 1
*0.195**
0.196
0.180
9 %
contour 2
0.181
0.180
0.5 %
contour 3
0.184
0.180
2 %
contour 4
0.180
0.180
0 %
** not of indication on contour corresponding to this value.*

4.2 Remarks

It is necessary to multiply by 2 the rough results since one accounted for 1 half-structure (in one half-crown).

The method of calculation used for this result (ECA) is the integral J. the results of J resulting from WILSON and YU are close to the Aster result (less than 2%) except for crown 1 (or contour 1 in the case of J).

The classification of contours or the crowns corresponds to an order ascending of the ray of these the last

4.3 Parameters
of execution

Version: 3.06
Machine: CRAY C90
System: UNICOS
8.0

Obstruction memory:
8 megawords
Time CPU To use:
22 seconds
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
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---

5 Summary of the results

The variation of the results of G with the values of 5 data in WILSON and YU is less than 2% except for smallest contour where the variation reaches 9%. No indication of contour is mentioned for the single value indicated in card CASTEM, this value is very close to that of WILSON and YU for smallest contour. The invariance of G following the crown is excellent for Aster calculation.
Let us note the difference in modeling between this test where deformations directly are imposed initial and results of reference where these deformations are induced by an imposed temperature.
The grid corresponds to this case test is also appreciably finer than that used for results of reference.

Organization (S): EDF/IMA/MMN

Handbook of Validation

V3.02 booklet: Linear statics of the plane systems

Document: V3.02.103

SSLP103 - Calculation of the coefficients of intensity of

constraints *KI* and *KII* for a circular plate
fissured in linear elasticity
Summary
It is about a test of breaking process in static linear elasticity for a two-dimensional problem. One consider a circular plate fissured (with a tilted crack of 30 degrees compared to the axis of X-coordinates) for which one calculates:
· coefficients of intensity of constraints *KI* and *KII*,
· the rate of refund of energy G starting from the formula of IRWIN.
The interest of the test is to know the analytical solution which gives the coefficients of intensity of constraints and
to have a tilted crack.
This test includes/understands a modeling which treats successively the plane strains and the plane stresses
(elements of continuous mediums).
The numerical results do not deviate more than 1 to 2% from the values of reference.
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HI-75/96/016 - Ind A

---

1 Problem of reference

1.1 Geometry

It is about a circular plate of ray 0A = 100 mm, with a tilted crack of 30 degrees by report/ratio with the x-axis.

Y
30°
0
X
With

1.2 Material properties

The characteristics of material are as follows:
E = 200.000 MPa
= 0.3

1.3
Boundary conditions and loadings

Displacements are imposed on the contour of the plate. They result from the analytical solution singular in mixed mode (with *KI* = 2. and *KII* = 1.).

2
Reference solution

2.1
Method of calculation used for the reference solution

Y
x2
M
R

x1

O
X

In plane strains or plane stresses, the distribution of displacements is given in it locate (0, x1, x2) by:

1 +
R

U
=
K cos (*K* - cos) +

K
sin
(*K* cos 2)
1

E
I
II
2
2

2
-
+

1 +
N

U =
K sin
(*K* - cos) -

K
cos
(*K* cos 2)
2

E
I
II
2
2

2

+
-

with *K* = 3 - 4 in plane deformations
3 -
K = 1+ in plane constraints
U

= cos *u1* - sin *U*
X
2
or in the reference mark (O, X, Y) by: *U*
= sin *u1* + cos *U*
Y
2
On the contour of the plate, one a: R = 0A = 100 Misters.
One chooses to take *KI* = 2. and *KII* = 1. and to impose displacements on the contour of the plate circular.

2.2
Results of reference

KI = 2.
KII = 1.
G = 2.275 105
in plane deformations
G = 2.5 105
in plane constraints

2.3 References
bibliographical

[1]
Breaking process H.D. BUI Fragile - ED. Masson 1978
Handbook of Validation
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HI-75/96/016 - Ind A

Code_Aster ®
Version
3
Titrate:
SSLP103 Calculation of *K I* and *KII* for a fissured circular plate
Date:

3 Modeling
With

3.1
Characteristics of modeling

Calculation is carried out in plane constraints (C_PLAN) then in plane deformations (D_PLAN).

0
With

3.2
Characteristics of the grid

A number of nodes: 737

A number of meshs and types: 204 meshs QUAD8, 30 meshs TRIA6

3.3 Functionalities
tested

Orders		Keys
CALC_G_THETA	CALC_K_G	U4.63.03
CALC_G_THETA	CALC_G	U4.63.03

4
Results of modeling A
4.1 Values
tested

The values tested are the coefficients of intensity of constraints *KI* and *KII* and the rate of refund of energy G calculated by the formula of IRWIN:

Identification
Reference
Aster
% difference
Plane constraints
K
2.0
2.0067
0.33
I
K
1.0
0.9877
1.23
II
G
2.5 10-5
2.5213 10-5
0.85
Plane deformations
K
2.0
2.0030
0.15
I
K
1.0
0.9960
0.39
II
G
2.275 10-5
2.2968 10-5
0.96

4.2 Remarks

(1 - 2) 2 2
The formula of IRWIN gives:

G =
(*K* +K
I
II)
in plane deformations
E
1
2
2
and
G =
(*K* +K
I
II)
in plane constraints
E
Calculations are carried out with a crown of lower integration of ray 10.0 and ray superior 20.0.

4.3 Parameters of execution

Version: 3.06
Machine: CRAY C98
System: UNICOS
8.0
Obstruction memory:
8 MW
Time CPU To use:
22 seconds

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5 Summaries of the results

Numerical values of the coefficients of intensity of constraints and the rate of refund of energy do not deviate more than 1 to 2% from the values of reference, which is satisfactory.
The grid could be improved, in particular in the vicinity of the bottom of crack.

Organization (S): EDF-R & D /MMC

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
Document: V3.02.105

SSLP105 - Excavation of a circular tunnel in
a linear elastic solid mass

Summary:

This test constitutes an example of implementation of a total methodology for simulation two-dimensional of the digging and the supporting of a circular gallery in an underground solid mass with Code_Aster.

To validate the step on the basis of simple analytical solution, one is brought to make assumptions restrictive on the geometry of the problem, the behavior of materials (elastic linear) and the field of constraint initial (isotropic). The reference solution is given by the method known as "convergence containment", traditional for this type of modeling 2D.

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HT-26/03/023/A

1
Problem of reference

1.1 Geometry

It is about a circular tunnel of section, covered by a concrete ring, which one excavates in one solid mass of ground. The two materials are supposed to be elastic linear.

Z
18,20 m
y
B
0,30 m
1,50 m
X
20 m
With
20 m

1.2
Properties of material

The materials are elastic linear.

1.2.1 Ground

Es = 4 GPa
S = 0,3

1.2.2 Concrete

Eb = 20 GPa
B = 0,2

V3.02.105-A Page:
3/8

1.3
Initial conditions, boundary conditions and loadings

The constraints in the solid mass are supposed initially isotropic (xx = yy = zz = 0).
method used to simulate the excavation and the installation of supporting is the method known as "convergence-containment" presented for example in [bib1] and [bib2].

The guiding principle rests on a reduction in the nodal reactions generated at the edge of the future one
gallery by the initial state of stresses. This operation is indicated by name "déconfinement". When déconfinement the value reached which corresponds to the conditions of building site which one wishes to model, one carries out the simulation of the installation of concrete supporting
at the edge of the gallery.

Solid mass of ground
Solid mass of ground
Excavation of
Pose
Initialization of
gallery
coating concrete
constraints
Calculation of the reactions
nodal
1
2
3
4

The boundary conditions and the loading are summarized in the following table. Phases correspond to those of the diagram above, the edges are composed with the nodes identified on the diagram of the paragraph [§ 3.1] and between brackets the name of the groups of mesh or node of file .com m).

Edges
Phase 1
Phase 2
Phase 3

Phase 4
N0N1 (in
DY = 0
DY = 0
-
-
no_bas1)
N1N2
DY = 0
DY = 0
-
DY = 0
(bas_bet)
N2N3
DY = 0
DY = 0
DY = 0
DY = 0
(no_bas2)
N3N4
DX = 0
DX = 0
DX = 0
DX = 0
(no_droit)
N4N5
=
MPa
=
MPa
=
MPa
=
MPa
(ma_haut)
yy
5
-
yy
5
-
yy
5

-
yy
5
-
N5N6
DX = 0
DX = 0
DX = 0
DX = 0
(no_left2)
N6N7
DX = 0
DX = 0
-
DX = 0
(no_left_bet)
N7N0 (in
DX = 0
DX = 0
-
-
no_left1)
N6N2 (edge)
-
-
Nodal reactions
-
corresponding to
déconfinement
N7N1 -
-
-
Free
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
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2
Reference solution

2.1
Method of calculation

2.1.1 Behavior of the ground

That is to say the rate of déconfinement, which represents the relative position of the section of tunnel considered
compared to the coal face. In the method "convergence - containment", one replaces the future ground excavated by a tensor of the constraint are equivalent, which one cause a drop in the intensity via for
to simulate the digging and the distance of the coal face.

Coal face
Tunnel
= 0
0
= 1
(-).
0
=

The solution of the problem is thus similar to that of the infinitely thick tube charged by a pressure intern of intensity (1) .0 and by an external pressure of intensity 0 (see [bib3] for the detail of calculations).

Constraints radial, orthoradiale as well as radial displacement with the wall of the tunnel in springy medium subjected toa rate of déconfinement are as follows

R
. 2

0
R = 1
.

2

R

R
. 2
= 1+
0

2 .

R

R2
0

UR =.
.

R
G
2

E
G is the modulus of rigidity given by the following relation: G =
.

2 (1+)
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V3.02 booklet: Linear statics of the plane systems
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Code_Aster ®
Version
6.5

Titrate:
SSLP105 - Excavation of a circular tunnel in an elastic solid mass
Date:
09/09/03
Author (S):
A. COURTEOUS *Key*
:
V3.02.105-A Page:
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2.1.2 Behavior of supporting

Supporting will be opposed to the movement convergence natural of the tunnel and thus will apply one artificial containment with the rock.

Either Ks the stiffness of supporting, it is given by the following relation if it is considered that it supporting is comparable to a thin tube (B is the Poisson's ratio of the concrete):

= (E
K
B
S

- 2
1 B) E R

K
If K
S
S =
represent the relative rigidity of the concrete compared to the solid mass and
2 G
D
the rate of
déconfinement with the installation of supporting, then radial constraints and orthoradiales thus

that radial displacement in wall are given by [bib1]:

= ks
0
R
(1 - D)

1+ ks

K
=
S
(1+
0
D)

1+ ks

0

1+ D

R =
K
U
S
R

1+ ks
2 G

2.2 Sizes and results of reference

One tests the following sizes on the level of the wall at points A and B of the figure of the 1.1, at the moment where déconfinement is total:

· radial constraint: yy of A or zz out of B;
· constraint orthoradiale: zz of A or yy out of B;
· radial displacement: uy of A or uz out of B.

2.3
Uncertainties on the solution

None. Exact analytical result.

2.4 References
bibliographical

[1]
The calculation of the tunnels by the method convergence-containment, Mr. Panet, Presses of the ENPC 1995
[2]
How to simulate the digging of a tunnel with Code_Aster? Principle of the method, implementation and validation, A. Courtois, R. Saidani, P. Sémété, note EDF HT-25/02/045/A - 2002
[3]
Mechanics of the continuous mediums, volume 2, J. Salençon, ED. Ellipses - 1988
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HT-26/03/023/A

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3 Modeling
With

3.1
Characteristics of modeling

Modeling 2D in plane deformations.

y
N4
N5
N6
N7
X
N0
N1
N2
N3

3.2
Characteristics of the grid

A number of nodes:
8477
A number of meshs:
3304 of type QUAD 8

3.3 Functionalities
tested

The objective of this case test is to test a method more than one quite precise functionality of Code_Aster, also the following table presents the principal orders which structure the file of orders.

Orders

Comments
CREA_CHAMP
Initialization of the constraints geostatics (here isotropic 5 MPa in
compression)
STAT_NON_LINE Blocking of the nodes of the gallery for calculation of the reactions
nodal to inject to simulate déconfinement
CREA_CHAMP
Recovery of the nodal reactions
STAT_NON_LINE Re-injection of the nodal reactions
Intermediate STAT_NON_LINE Calculation to pass from a model without mesh
representing the voussoirs concrete with a model with meshs them

representative (see [bib2])
STAT_NON_LINE progressive Déconfinement of the solid mass

3.4
Sizes tested and results

After the installation of the coating (urgent final), one tests the components and with the nodes N2 and N6
xx
yy
as well as radial displacement in these points (DX for N2, DY for N6).

Reference
Aster *Difference*
(%)
Node N2

xx
-1,52821.106 -1,53154.106 0,218
yy
-8,47179.106 -8.52772.106 0,660
DX -1,6925.10-3 -1,6684.10-3 -1,422
N6 node

xx
-8,47179.106 -8,41147.106 -0,712
yy
-1,52821.106 -1,52943.106 0,080
DY -1,6925.10-3 -1.7184.10-3 1,529

4
Summary of the results

The values obtained with Code_Aster are in agreement with the values of the analytical solution of reference.

Date:
23/09/02
Author (S):
J.** Key **Mr. PROIX
:
V3.02.303-A Page:
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Organization (S): EDF/AMA

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
Document: V3.02.303

SSLP303 - Plate cantilever charged with sound
end

Summary:

The goal of the test is to validate key word FORCE_CONTOUR, starting from a load applied at the end of one
plate.
The problem is dealt with in plane constraints.

1
Problem of reference

1.1 Geometry

P

Z

H

C
F
D

X

With

B
E

L

Not E = medium of AB
not F = medium of cd.

Length: L = 1 m

Width: L = 0.1 m

Thickness: H = 0.005 m

h3l
Moment of inertia of section: lY =
= 1.042 X 10-9 m4
12

1.2
Material properties

Young modulus: E = 2.1 X 1011 Pa

Poisson's ratio: v = 0.3

1.3
Boundary conditions and loadings

· Encastrement of edge AD (U = v = 0).

· Charge of resultant P = 85 NR, applied to edge BC (constant linear load).

1.4
Boundary conditions and loadings

Without object for the static analysis.
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HT-66/02/001/A

2
Reference solution

2.1
Method of calculation used for the reference solution

The value of the field of displacement v, at the loose lead of the plate (edge BC) is given by:

PL3
vL =
(neglected shearing)
3EIY

from where vL = 0.129 m

The stress field xx of inflection is given by:

PH
xx =
(L - X) on edge AB
2lY

that is to say xx = 2.04 X 108 (L - X) (Pa)

2.2
Results of reference

· Déplacement vL of the nodes B and C

· Contraintes xx with nodes A and B and E

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
S. TIMOSHENKO, Resistance of Materials, 1st part. Polytechnic bookshop
CH. Béranger, Paris, 1947. p 169 to 168

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3 Modeling
With

3.1
Characteristics of modeling

C-PLAN, meshs TRI6 and QUAD8

y, v

Meshs QUAD8
Meshs TRI6

F

C
D

X, U

With

B

E

Not E = medium of AB not F = medium of CD

Cutting: 100 elements according to the length

2 elements according to the thickness

Boundary conditions:
on AD DDL_IMPO:
(GROUP_NO: encast
DX: 0.
DY:
0.)

Loading:
on BC FORCE_CONTOUR:
(GROUP_MA: bord_ch
FY: 170000.)

Name of the nodes:
Not A = N1
Not D = N403
Not B = N455
Not E = N201
Not C = N756
Not F = N352

3.2
Characteristics of the grid

A number of nodes: 905

A number of meshs and types: 100 QUAD 8, 200 SORTED 6, 208 SEG 3

3.3 Functionalities
tested

Orders

AFFE-MODELE
"MECHANICAL"
"C_PLAN"
ALL
AFFE_CHAR_MECA
DDL-IMPO
GROUP_NO
FORCE_CONTOUR
GROUP_MA
CALC_CHAM_ELEM
OPTION
"SIGM_ELNO_DEPL"

Titrate:
SSLP303 - Plate cantilever at its end

Date:
23/09/02
Author (S):
J. Key Mr. PROIX
:
V3.02.303-A Page:
5/6

4
Results of modeling A

4.1 Values
tested

Localization
Type of value
Reference
Aster
% difference
Points B, C
vL (m)
0.129 0.1295 0.4
Not A
xx (Pa)
2.04 108 2.08
108
2.1
Not E
xx (Pa)
1.02 108
1.015 108
0.5

4.2 Remarks

The variation with the analytical solution of beam type or hurled plate, is due to the size of the grid could be tiny room with a finer grid.

Handbook of Validation

V3.02 booklet: Linear statics of the plane systems
HT-66/02/001/A

5
Summary of the results

This test, based on a solution of hurled plate, is treated in 2D (forced plane) in order to validate the loading of edge (key word FORCE_CONTOUR). The solution obtained is close to the solution analytical (0.4% of difference on displacements) and thus this type of modeling validates.

Organization (S): EDF-R & D /AMA, CETIM

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
V3.02.304 document

SSLP304 - Orthotropic square plate in traction
uniaxial out of the axes of orthotropism

Summary:

This test represents the static calculation of a square plate, out of orthotropic elastic material, of which axes othotropie are tilted 30 degrees compared to the basic edge, subjected to a uniaxial traction. It allows to validate the good taking into account of orthotropic elastic materials and the change of associated reference mark.
4 modelings are used: C_PLAN with meshs QUAD8 and TRIA6, in a first reference mark, C_PLAN in a second reference mark, COQUE_3D with meshs QUAD9 and TRIA7, in small displacements and COQUE_3D in great displacements. Displacements and the constraints obtained are compared with a reference solution analytical.

The first two modelings of this test result from the validation independent of version 3 of Code_Aster (linear static batch).

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

A square plate, made up of a tilted orthotropic material of 30 degrees compared to edge AB.

y

D
C

B

y
L

With
B
X

B

With B = 1 m, unspecified thickness (plane constraints), angle of orthotropism: = 30 degrees.

1.2
Properties of materials

The properties of materials constituting the plate are:

orthotropic rubber band:
E_L = 4.E10 Pa
E_T = 1.E10 Pa
G_LT = 0.45E10 Pa
G_TN = 0.35E10 Pa
NU_LT = 0.075

The axis L is tilted 30 degrees compared to AB.

1.3
Boundary conditions and loadings

· At point a: DX = 0, DY = 0
· At point b: DX = 0,

· Linear Chargement distributed: Fx = 104 Pa on BC
· Linear Chargement distributed: Fx = -104 Pa on DA

1.4 Conditions
initial

Without object.
Handbook of Validation

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution, obtained with the assumption of uniaxiality of the constraints:

(X, y)

xx
= F
(X, y)
X
xy
=
(X, y)
yy
=
(X, y)
zz
= 0

maybe in the reference mark (A, L, T):

(X, y) = c2F, (X, y) = s2F
(X, y) = - csF
LL
X
TT
X
LT
X

By the orthotropic law of behavior elastic, by using conventions of Code_Aster in what relate to NU_LT, (cf document of use of order DEFI_MATERIAU [§3.5.2]), one obtains directly (see for example [bib1]):

(X, y) Fx
=
xy
, (X, y) = -
F, 2
X
(X, y) =
F
xx
E
yy
X
E
xy
X
E
X
X
X

with:

1
4
4
C

S
1

1
1
1
xy
4
4

2 2
=
+
+ C S
- 2 LT
LT
= (C + S)
- c2s2
+
-

E ()
E
E
G
E
E ()
E
E
E
G
X
X
L
T
LT
T
T
L
T
LT

2
2

y
C
S

= - Cs
-
+

(

2
2
C - S)
1
2
LT -
Ex

( )
E
E
E
2
L
T

G
T
LT
with
C = cos
S = sin

As the deformations are uniform in the plate one obtains, by integration, displacements in the reference mark (A, X, y):

U (X, y) =. X
X
xx

U (X, y) =. y + 2. X
y
yy
xy

2.2
Results of reference

Displacements in the reference mark (A, X, y) (in m):

Not B
C
D
U
0.
5.917 10-7 5.917
10-7
X
U
-2.292 10-7 -5.028
10-7 -7.319
10-7
X

Constraints in the reference mark related to the orthotropism:

(X, y) = 7500Pa, (X, y) = 2500Pa, (X, y) = 4330.127Pa
LL
TT
LT

2.3
Uncertainty on the solution

Analytical solution

2.4 References
bibliographical

[1]
GAY D: "Composite Materials"; 3rd edition, Hermès

3 Modeling
With

3.1
Characteristics of modeling

Modeling C_PLAN. The plate is turned from -30 degrees around Z, i.e. axis X total is colinéaire with the axis of orthotropism L. the boundary conditions and loadings, to apply in locate (A, X, y) related to the plate, are thus projected on the total reference mark (A, X, Y) (use of LIAISON_DDL in B).

3.2 Characteristics of the grid

A number of nodes: 391

A number of meshs and types: 50 QUAD8, 100 TRIA6

3.3 Functionalities tested

Orders

AFFE-MODELE
"AFFE"
MODELING = "C_PLAN"
AFFE_CARA_ELEM
SOLID MASS
ANGL_REP = 0
AFFE_CHAR_MECA_F FORCE_CONTOUR FX,
FY
AFFE_CHAR_MECA_F LIAISON_DDL

DEFI_MATERIAU ELAS_ORTH

MODI_REPERE
DEFI_REPERE
LOCATE = "USER"

3.4 Values tested

Value Identification Reference
Aster %
difference
Ux (c) = Ux (D)
DX (C)
5.917 10-7 5.9167
10-7
0.007
Uy (B) DY
(B)
-2.292 10-7 -2.2916
10-7
0.01
Uy (C) DY
(C)
-5.028 10-7 -5.0279
10-7
0.001
Uy (D)
DY (D)
-7.319 10-7 -7.3196
10-7
0.008
Sigma LL
SIXX (any point)
7500
7500.4
0.006
Sigma TT
SIYY (any point)
2500
2500.3
0.01
Sigma LL
SIXY (any point)
4300.127
433.06
0.01

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4 Modeling B

4.1 Characteristics of modeling

Modeling C_PLAN. The plate is parallel to the total axes, i.e. total axis X is colinéaire with axis X. It is thus the axis of orthotropism L which is to be directed (using the MASSIVE key word of AFFE_CARA_ELEM).

4.2 Characteristics of the grid

A number of nodes: 391

A number of meshs and types: 50 QUAD8, 100 TRIA6

4.3 Functionalities tested

Orders Key word factor
Key word
AFFE_MODELE

AFFE
MODELING = “C_PLAN”
AFFE_CARA_ELEM
SOLID MASS
ANGL_REP = 30
AFFE_CHAR_MECA_F FORCE_CONTOUR
FX,
FY
DEFI_MATERIAU ELAS_ORTH

MODI_REPERE
DEFI_REPERE
LOCATE = “USER”

4.4 Values
tested

Value Identification
Reference
Aster %
difference
Ux (c) = Ux (D)
DX (C)
5.917 10-7 5.9167

10-7
0.006
Uy (B) DY
(B)
-2.292 10-7 -2.29166
10-7
0.015
Uy (C) DY
(C)
-5.028 10-7 -5.0277
10-7
0.005
Uy (D)
DY (D)
-7.319 10-7 -7.3194
10-7
0.006
Sigma LL
SIXX (any point)
7500
7500
0.
Sigma TT
SIYY (any point)
2500
2500
0.
Sigma LL
SIXY (any point)
4300.127
4330.127
0.

4.5 Remarks

Pace of the deformation: nonsymmetrical because of the orthotropism.

5 Modeling C

5.1 Characteristics of modeling

Modeling COQUE_3D. The plate is parallel to the total axes, i.e. total axis X is colinéaire with axis X. It is thus the axis of orthotropism L which is to be directed (using the MASSIVE key word of AFFE_CARA_ELEM). The grid is identical to that of modeling B.

5.2 Characteristics of the grid

A number of nodes: 541

A number of meshs and types: 50 QUAD9, 100 TRIA7

5.3 Functionalities tested

Orders Key word factor
Key word
AFFE_MODELE
AFFE

MODELING = “COQUE_3D”
AFFE_CARA_ELEM
HULL
ANGL_REP = 30
AFFE_CARA_ELEM
HULL
THICK = 1
AFFE_CHAR_MECA_F FORCE_ARETE
FX,
FY
DEFI_MATERIAU ELAS_ORTH

5.4 Values
tested

Value Identification
Reference Aster %
difference
Ux (c) = Ux (D)
DX (C)
5.917 10-7 5.9167
10-7
0.006
Uy (B) DY
(B)
-2.292 10-7 -2.29166
10-7
0.015
Uy (C) DY
(C)
-5.028 10-7 -5.0277
10-7
0.005
Uy (D)
DY (D)
-7.319 10-7 -7.3194
10-7
0.006
Sigma LL
SIXX (any point)
7500
7500

0.
Sigma TT
SIYY (any point)
2500
2500
0.
Sigma LL
SIXY (any point)
4300.127
4330.127
0.

---

6 Modeling D

6.1 Characteristics of modeling

Modeling COQUE_3D in great displacements. The plate is parallel to the total axes, i.e. total axis X is colinéaire with axis X. It is thus the axis of orthotropism L which is to be directed (using the MASSIVE key word of AFFE_CARA_ELEM). The grid is identical to that of modeling B.

6.2
Characteristics of the grid

A number of nodes: 541

A number of meshs and types: 50 QUAD9, 100 TRIA7

6.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING = "COQUE_3D"
AFFE_CARA_ELEM
HULL
ANGL_REP = 30
AFFE_CARA_ELEM
HULL
THICK = 1
AFFE_CHAR_MECA_F FORCE_ARETE
FX,
FY
DEFI_MATERIAU ELAS_ORTH

STAT_NON_LINE COMP_ELAS
DEFORMATION=' GRENN_GR'

6.4 Values
tested

Value Identification
Reference Aster %
difference
Ux (c) = Ux (D)
DX (C)
5.917 10-7 5.9167
10-7
0.006
Uy (B) DY
(B)

-2.292 10-7 -2.29166
10-7
0.015
Uy (C) DY
(C)
-5.028 10-7 -5.0277
10-7
0.005
Uy (D)
DY (D)
-7.319 10-7 -7.3194
10-7
0.006
Sigma LL
SIXX (any point)
7500
7499.99
0.001
Sigma TT
SIYY (any point)
2500
2499.93
0.003
Sigma LL
SIXY (any point)
4300.127
4329.99
0.007

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7 *Summary of the results*

The results of four modelings are very close to the analytical solution: to the maximum 0.015 % of variation for 4 modelings.

This test thus validates the taking into account of orthotropic elasticity.

Organization (S): EDF/AMA

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
Document: V3.02.305

SSLP305 - Thin disc in support under load concentrated

Summary:

The purpose of the test is to validate the calculation of the potential energy in linear elasticity.

Only one axisymmetric modeling is presented.

The reference solution is analytical.

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V3.02 booklet: Linear statics of the plane systems
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:

SSLP305 - Thin disc in support under concentrated loading

Date:
23/09/02
Author (S):
J. Key Mr. PROIX
:
V3.02.305-A Page:
2/6

1
Problem of reference

1.1 Geometry

Z

H

With

C
B
X

Diameter: = 0.5 m

Thickness: H = 0.005 m

1.2
Material properties

Young modulus: E = 2.1 X 1011 Pa

Poisson's ratio: v = 0.3

1.3
Boundary conditions and loadings

· Appui on the edge (W = 0)

· Charge concentrated at point a: P = 350 NR

1.4 Conditions
initial

Without object for the static analysis.

2
Reference solution

2.1
Method of calculation used for the reference solution

· The value of axial displacement in the center of disc (not A) is given by:

P 2 3 + v
WA =
X

64 D 1 +
v

Eh3
where D =
-

v2
12 1
(
)

· The value of the potential energy (with balance) is given by:

1
Ep = PW
2
has

· The absolute value of the potential energy by radian is:

1 PW
E
has
p =

2

2

2.2
Results of reference

· Déplacement at point a:
WA = 0.4596 X 103 m

· Potential Energie by radian:
ep = 0.012799 Nm/rd

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
R.J. ROARK and W.C. YOUNG Formulated for stress and strain, 5th edition, New York,
Mc Graw-Hill, 1975

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3 Modeling
With

3.1
Characteristics of modeling

It is an axisymmetric modeling.

Y

With
D

X
G
B

Limiting conditions:

out of B
DDL_IMPO: (GROUP_NO: B
DY: 0.)
on AG
DDL_IMPO: (GROUP_NO: lAG
DX: 0.)

Loading:

in A
FORCE_NODALE: (GROUP_NO: With
FY:
-55.704)

Name of the nodes:
A=N1
B = N755
D = N858
G = N201

Cutting:
100 elements according to the ray

2 elements according to the thickness

3.2
Characteristics of the grid

A number of nodes: 905

A number of meshs and types: 100 QUAD 8, 200 SORTED 6, 208 SEG 3

3.3 Functionalities
tested

Orders
AFFE_MODELE
“MECHANICAL”
“AXIS”
ALL
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
FORCE_NODALE
GROUP_NO
POST_ELEM
ENER_POT

4
Results of modeling A

4.1 Values
tested

Localization
Type of value
Reference
Aster
% difference
Not A
WA (m)
-0.4596 10-3
-0.4617 10-3
0.46

ep (Nm/rd)
-1.2799 10-2
-1.2859 10-2
0.47

4.2 Remarks

· The value of the load required is brought back to a sector of 1 radian. Consequently, the value potential energy given on the file result corresponds to the deformation of this sector (with the sign near).

· Option ENERPOT calculates in fact a deformation energy:

1
E = U T KU
D
who is identical to the potential energy with the sign near:
2

1
1
1
E = U T KU - U T F = - U T F = - U T KU
p
(bus KU = F)
2
2
2

5
Summary of the results

These good results on the displacement and the deformation energy (variation similar of 0,5% with analytical reference solution) show that the calculation of this energy is correct. To approach still better the value of reference, it would be necessary to discretize the grid more.

Titrate:
SSLP310 - Biblio_18. Crack pressurized in an unlimited plane field
Date:
05/11/02
Author (S):
S. GRANET, I. CORMEAU, B. KURTH
Key: V3.02.310-A Page: 1/10

Organization (S): EDF-R & D /AMA, CS IF

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
V3.02.310 document

SSLP310 - Biblio_18. Crack pressurized in one unlimited plane field

Summary:

This test results from the validation independent of version 3 in breaking process.

It is about a two-dimensional test in statics (plane strains or stresses) which aims at checking of G and KI under loading by pressure distributed not uniform on the lips, in unlimited medium. One also check the nullity of KII with option CALC_K_G.

The behavior of the structure is elastic linear isotropic.

The case test includes/understands only one plane modeling 2D in which one studies the influence of the parameter C intervening in the loading.

Titrate:
SSLP310 - Biblio_18. Crack pressurized in an unlimited plane field
Date:
05/11/02
Author (S):
S. GRANET, I. CORMEAU, B. KURTH
Key: V3.02.310-A Page: 2/10

1
Problem of reference

1.1 Geometry

y
p (X, c)
X
-1
1

One considers the rectilinear crack -1 X 1 in the unlimited plane field.

1.2
Properties of material

The material is elastic linear homogeneous of Young E and Poisson's ratio modulus.
E = 1000 Mpa, = 0,3

1.3
Boundary conditions and loadings

The loading car-being balanced, the model is limited to the half space y 0.

Boundary conditions

Linear relation UX (- 1,0) + UX (1,0) = 0

Condition of symmetry UY = 0 for X -1, X 1 and y = 0.

Loading n° 1

p (X) = 1

Loading n° 2

p (X, c) = exp (cx) where C is a parameter

Loading n° 3

p (X, c) = HS (cx) where C is a parameter

Loading n° 4

p (X, c) = CH (cx) where C is a parameter

Loading n° 5

p (X, c) = cos (cx) where C is a parameter

2
Reference solution

2.1
Method of calculation used for the reference solution

Exact calculation symbolic system using software MAPLE V [bib1].

2.2
Results of reference

Loading n° 1

K (X =)
1 =
I

Loading n° 2

K (X = 1, c) = (I
where I and I are related to Bessel modified of first
0 (c) + I1 (C
I
))
0
1
species of indices 0 and 1 [bib2].

Loading n° 3

K (X = 1, c) = I

1 (C
I
)

Loading n° 4

K (X = 1, c) = I

0 (C
I
)

Loading n° 5

K (X = 1, c) = J
where J is related to Bessel of first species of index 0 [bib2].
0 (C
I
)
0

In all the cases of loading

K 2
G

I
=
in plane constraints
E

(1 - 2) K2

G
I
=
in plane deformations
E

2.3 References bibliographical

[1]
There the evaluation of stress intensity factors for is simple ace under parametric loading. Technical notes. N.I. IOKADIMIS and G.T. ANASTASSELOS. Computers and Structures, 51, n°6, 791-794, 1994.
[2]
Handbook of mathematical functions, Chapter 9. Mr. ABRAMOWITZ and I.A. STEGUN (Editors). United States Dept. of Commerce, National Office of Standards.
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3 Modeling
With

3.1
Characteristics of modeling

The model is limited to the half space y 0 and the finished area - X
X X
,
max
max
0 y ymax with X = y = 15.
max
max

It consists of 578 quadrangles with 8 nodes and 1699 triangles with 6 nodes.
It comprises 5230 nodes.

One uses the hyphotèse plane constraints.

3.2
Characteristics of the grid

Use of procedure FISS2D_V1.

The topological parameters concerning refinement around the bottom of crack are:

· *nc = 4 (a number of crowns)*
· *NS = 8 (a number of sectors)*
· *NT = 1 (a number of crowns of déraffinement)*

The radiant fine grid is limited at the right end of the crack.
The partly current density of the grid of the crack is selected in order to be able to discretize suitably the loading p (X, c).

3.3 Functionalities tested

Calculation of the rate of refund of energy G by the method THETA for various crowns.

Orders

DEFI_FOND_FISS
MELTS
GROUP_NO

NORMAL

CALC_THETA
THETA_2D
GROUP_NO

CALC_G_THETA_T
SYME_CHAR

CALC_K_G

4
Results of modeling A

4.1 Values
tested

Crown 0 (triangles)

Rinf = 0 mm, Rsup = 0,02 mm

Identification Reference
Aster *%*
difference
G, loading n°1
3,14158E-3
3,04077E-3
-3,209
KII, loading n°1
0
0
0

KI, loading n°1
1,77245
1,6559
-6,574

G, loading n°2, c=1
1,05349E-2
1,01411E-2
-3,738
KII, loading n°2, c=1
0
0
0
KI, loading n°2, c=1
3,24576
3,03108
-6,614
G, loading n°2, c=5
8,356742
7,9065
-5,387
KII, loading n°2, c=5
0
0
0
KI, loading n°2, c=5
91,41522
85,4189
-6,559

G, loading n°3, c=1
1,00344E-3
9,6006E-4
-4,323
KII, loading n°3, c=1
0
0
0

KI, loading n°3, c=1
1,00172
0,93505
-6,655
G, loading n°3, c=5
1,86052
1,760148
-5,395
KII, loading n°3, c=5
0
0
0
KI, loading n°3, c=5
43,13380
40,33829
-6,481

G, loading n°4, c=1
5,03571E-3
4,86064E-3
-3,477
KII, loading n°4, c=1
0
0
0
KI, loading n°4, c=1
2,24404
2,09602
-6,596
G, loading n°4, c=5
2,331095
2,20566
-5,381
KII, loading n°4, c=5
0
0
0
KI, loading n°4, c=5
48,28142
45,08068
-6,629

G, loading n°5, c=1
1,839487E-3
1,78707E-3
-2,849
KII, loading n°5, c=1
0
0
0
KI, loading n°5, c=1
1,356277
1,267569
-6,541
G, loading n°5, c=2,4048255577
0
4,1738E-8
-
KII, loading n°5, c=2,4048255577
0
0
0
KI, loading n°5, c=2,4048255577
0
2,0383E-3
-

Crown 1 (quadrangles)

Rinf = 0,02 mm, Rsup = 0,04 mm

Identification Reference
Aster
% difference
G, loading n°1
3,14158E-3
3,1669E-3
0,807
KII, loading n°1
0
0
0
KI, loading n°1
1,77245
1,78079
0,471

G, loading n°2, c=1 1,05349E-2
1,056655E-2
0,30
KII, loading n°2, c=1
0
0
0
KI, loading n°2, c=1
3,24576
3,256597
0,334
G, loading n°2, c=5
8,356742
8,25545
-1,212
KII, loading n°2, c=5
0
0
0
KI, loading n°2, c=5

91,41522
91,528
0,123

G, loading n°3, c=1
1,00344E-3
1,000804E-3
-0,263
KII, loading n°3, c=1
0
0
0
KI, loading n°3, c=1
1,00172
1,003475
0,175
G, loading n°3, c=5
1,86052
1,83815
-1,202
KII, loading n°3, c=5
0
0
0
KI, loading n°3, c=5
43,13380
43,2091
0,175

G, loading n°4, c=1 5,03571E-3
5,06348E-3
0,552
KII, loading n°4, c=1
0
0
0
KI, loading n°4, c=1
2,24404

2,25312
0,405
G, loading n°4, c=5
2,331095
2,302636
-1,221
KII, loading n°4, c=5
0
0
0
KI, loading n°4, c=5
48,28142
48,3188
0,078

G, loading n°5, c=1 1,839487E-3
1,86066E-3
1,152
KII, loading n°5, c=1
0
0
0
KI, loading n°5, c=1
1,356277
1,363914
0,563
G, loading n°5, c=2,4048255577
0
3,98377E-8
-
KII, loading n°5, c=2,4048255577
0
0
0
KI, loading n°5, c=2,4048255577
0
4,721938E-3
-
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Crown 2 (quadrangles)

Rinf = 0,04 mm, Rsup = 0,06 mm

Identification Reference
Aster
% difference
G, loading n°1
3,14158E-3
3,1678E-3
0,835
KII, loading n°1
0
0
0
KI, loading n°1
1,77245
1,78075
0,468

G, loading n°2, c=1 1,05349E-2
1,056949E-2
0,328
KII, loading n°2, c=1
0
0
0
KI, loading n°2, c=1

3,24576
3,256529
0,332
G, loading n°2, c=5
8,356742
8,257967
-1,182
KII, loading n°2, c=5
0
0
0
KI, loading n°2, c=5
91,41522
9,1527E1
0,123

G, loading n°3, c=1
1,00344E-3
1,001087E-3
-0,234
KII, loading n°3, c=1
0
0
0
KI, loading n°3, c=1
1,00172
1,0034589
0,174
G, loading n°3, c=5
1,86052
1,838717
-1,172
KII, loading n°3, c=5
0
0
0
KI, loading n°3, c=5
43,13380
43,2088
0,174

G, loading n°4, c=1 5,03571E-3
5,064887E-3
0,579
KII, loading n°4, c=1
0
0
0
KI, loading n°4, c=1
2,24404
2,25307
0,402
G, loading n°4, c=5
2,331095
2,30333
-1,191
KII, loading n°4, c=5
0
0
0
KI, loading n°4, c=5
48,28142
48,31838
0,077

G, loading n°5, c=1 1,839487E-3
1,86117E-3
1,179
KII, loading n°5, c=1
0
0
0
KI, loading n°5, c=1
1,356277
1,363877
0,560
G, loading n°5, c=2,4048255577
0
4,0008E-8

-
KII, loading n°5, c=2,4048255577
0
0
0
KI, loading n°5, c=2,4048255577
0
4,711869E-3
-

Crown 3 (quadrangles)

Rinf = 0,06 mm, Rsup = 0,08 mm

Identification Reference
Aster
% difference
G, loading n°1
3,14158E-3
3,16794E-3
0,839
KII, loading n°1
0
0
0
KI, loading n°1
1,77245

1,78078
0,471

G, loading n°2, c=1 1,05349E-2
1,05699E-2
0,333
KII, loading n°2, c=1
0
0
0
KI, loading n°2, c=1
3,24576
3,2566
0,334
G, loading n°2, c=5
8,356742
8,25837
1,177
KII, loading n°2, c=5
0
0
0
KI, loading n°2, c=5
91,41522
91,5293
0,125

G, loading n°3, c=1
1,00344E-3
1,001132E-3
-0,230
KII, loading n°3, c=1
0
0
0
KI, loading n°3, c=1
1,00172
1,003481

0,176
G, loading n°3, c=5
1,86052
1,838809
-1,167
KII, loading n°3, c=5
0
0
0
KI, loading n°3, c=5
43,13380
43,20984
0,176

G, loading n°4, c=1 5,03571E-3
5,065103E-3
0,584
KII, loading n°4, c=1
0
0
0
KI, loading n°4, c=1
2,24404
2,25312
0,405
G, loading n°4, c=5
2,331095
2,303447
-1,186
KII, loading n°4, c=5
0
0
0
KI, loading n°4, c=5
48,28142
48,31948
0,079

G, loading n°5, c=1 1,839487E-3
1,86124E-3
1,183
KII, loading n°5, c=1
0
0
0
KI, loading n°5, c=1
1,356277
1,363907
0,563
G, loading n°5, c=2,4048255577
0
4,00631E-8
-
KII, loading n°5, c=2,4048255577
0
0
0
KI, loading n°5, c=2,4048255577
0
4,71155E-3
-

4.2 Remarks

Constant 2,4048… is first zero of the function of Bessel J.

0

Crown 0 (surrounding the bottom of crack consists of triangles) gives poor results compared to the other crowns.

The relative variations maxima between crowns 1,2 and 3 for G and KI are given below for various loadings.

Loading 1 Loading 2 Loading 3 Loading 4 Loading 5
Variation on G
0,03%
0,03% 0,03% 0,03% 0,03%
Variation on KI 0,002% 0,002% 0,002% 0,002% 0,002%

The variations on G and KI are negligible.

Comment on the results of the loading n°5 with C = 2,4048….

The loading n°5 can be compared in order of magnitude with the loading n°1. Indeed, the amplitude loading n°5 is worth 1 and its resultant is worth 1,14 to compare with the unit constant value loading n°1.

The absolute deviation for the loading n°1 and crowns it n°1 is of:

· 2,53E-5 for G
· 8,34E-3 for KI

For the loading n°5, the Aster values which are compared with a null value of reference are:

· 3,98E-8 for G
· 4,72E-3 for KI

The order of magnitude on the absolute deviations is similar for the two loadings. One can thus regard as correct the Aster results.

5
Summary of the results

Except for the results obtained on crown 0, calculations of K and G are very close to exact theoretical solution. Indeed, the variations are always lower than 1,2% for the calculation of G and

lower than 0,6% for the calculation of KI.

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
V3.02.311 document

SSLP311 - Biblio_65. Fissure central oblique in a finished rectangular plate, with two materials, subjected to uniform traction

Summary:

This test results from the validation independent of version 3 in breaking process.

It is about a two-dimensional test in statics with Bi-material in the presence of an internal crack of interface
oblique.

The behavior of the structure (Bi-material) is elastic linear isotropic.

The case test includes/understands four modelings in plane constraints in which the influence of the slope of
the crack is studied (4 cases).

1
Problem of reference

1.1 Geometry

One considers 4 values of the angle = 15°, 30°, 45° and 60°.
Other dimensions are selected such as H = 2W = 4a.
The value of A is worth 1.E-3 Mr.

1.2

Properties of materials

Material n° 1

Rubber band, linear, isotropic, Young modulus E1 = 2E+12 Pa and Poisson's ratio 1 = 0,3.

Material n° 2

Rubber band, linear, isotropic, Young modulus E2 = 2E+11 Pa and Poisson's ratio 2 = 0,3.

1.3
Boundary conditions and loading

· The loading being autoéquilibré, one is satisfied to block the 3 rigid modes:

UX = UY = 0 with the left lower corner of the complete model.
UY = 0 with the corner lower right of the complete model.

· On the lower edge, we impose UY = 0

· Chargement: uniform tension yy = 0 on the higher edge:

The value of 0 is worth 100MPa.

2
Reference solution

2.1
Method of calculation used for the reference solution

Method of the elements of border, with quadratic elements [bib1].

The calculation of KI and KII is carried out by an integral of contour (integral M [bib2]) in which the constraints and displacements calculated in the part intervene, as well as the constraints and displacements deduced from analytically definite asymptotic solutions, in which KI and KII are alternatively null. The calculation of K is also carried out by the method of virtual extension, as comparison.

2.2
Results of reference

Method

On the left-hand side

On the right-hand side

= 15°
= 30°
= 45°
= 60°
= 15°
= 30°
= 45°
= 60°
integral FI
1,0115 0,7868 0,5211 0,2770 1,1266 0,9910 0,7646 0,4919
MR. FII -0,4434
-0,6244
-0,6723
-0,5804
0,0862 0,2961 0,4056 0,4057
extension FI
1,0110 0,7864 0,5210 0,2769 1,1260 0,9904 0,7643 0,4919
virtual FII -0,4429
-0,6240
-0,6720
-0,5801
0,0865 0,2960 0,4055 0,4056

K J

In this table one a: F =
J = I, II
J
0 A

The relation between the total rate of restitution of energy G and Kj is written as follows [bib3]:

3 -

I
=
I = 1 2
,
I
1 + I
μ
I.E.(internal excitation)
=
I
(21+i)
1

1
1 2
1
=
ln

+

+

2
μ1μ2μ2μ1

1+
1
1
+

+
2

μ1
μ
=
2

CH
16
2 ()
G = (K2 + K2
I
II)

2.3
Uncertainty on the solution

Estimated at less than 0,1%.

2.4 References
bibliographical

[1]
Stress intensity Factor analysis of interface ace using boundary element method. Application of contour-integral method. NR. MIYAZAKI, T. IKEDA, T.SODA and T. MUNAKATA. Engng.Fract.Mechs., 45, n°5, 599-610, 1993.
[2]
Year analysis of interface aces between dissimilar isotropic materials using conservation integrals in elasticity. J.F. YAU and T.C. CHANG. Engng.Fract.Mechs., 20, 423-432, 1984.
[3]
Adhesive The strength of joints using the theory of aces. B. Mr. MALYSHEV and R.L. SALGANIK. Int.J.Fract.Mech., 1, 114-128, 1965.

3
Modelings A, B, C, D

3.1
Characteristics of modeling

Various modelings are identical to share the slope of the crack.

Complete grid for an angle of 60 °

Code_Aster ®
Version
5.0

Titrate:
SSLP311 - Biblio_65. Fissure central oblique in a plate
Date:
05/11/02
Author (S):
***S. GRANET**, I. CORMEAU, E. LECLERE*

ray
center

Zoom on the point of crack

The ray is worth 7.5E-5 Mr.

There are four crowns defined by order CALC_THETA:

crown 1: Rinf = 0.
Rsup = 1.875E-5m
crown 2: Rinf = 1.875E-5m
Rsup = 3.750E-5m
crown 3: Rinf = 3.750E-5m
Rsup = 5.625E-5m
crown 4: Rinf = 5.625E-5m
Rsup = 7.500E-5m

The direction of propagation is defined by: cos, sin

3.2
Characteristics of the grid

The grid consists of 10676 nodes and 4584 elements, including 1392 elements QUA8 and 3168 elements TRI6.

3.3 Functionalities
tested

Orders

AFFE_MODELE
MECHANICS
C_PLAN
ALL

MECA_STATIQUE

AFFE_CHAR_MECA
FORCE_CONTOUR

CALC_THETA
THETA_2D

CALC_G_THETA
OPTION
CALC_G

The calculation of KI and KII is not valid for a bimatériau.
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HT-66/02/001/A

4
Results of modeling A

4.1 Values
tested

Identification Reference
***Aster** %*
difference
Left end, = 15°

G, crown 1
9,67362E+1
9,2428E+1
-4,45
G, crown 2
9,67362E+1
9,6392E+1
-0,356
G, crown 3

9,67362E+1
9,6417E+1
-0,330
G, crown 4
9,67362E+1
9,6421E+1
-0,326
KI 5,6694E+6
-
-
KII
-2,4852E+6
- -
Right end, = 15°

G, crown 1
1,0125E+2
9,6763E+1
-4,33
G, crown 2
1,0125E+2
1,0093E+2
-0,315
G, crown 3
1,0125E+2
1,0095E+2
-0,295
G, crown 4
1,0125E+2
1,0095E+2
-0,291
KI 6,3145E+6
-
-
KII 4,8309E+5
-
-

5
Results of modeling B

5.1 Values
tested

Identification Reference
***Aster** %*
difference
Left end, = 30°

G, crown 1
8,0017E+1
7,6431E+1
-4,48
G, crown 2
8,0017E+1
7,9707E+1
-0,387
G, crown 3
8,0017E+1
7,9730E+1
-0,358
G, crown 4
8,0017E+1
7,9734E+1
-0,353
KI 4,4100E+6
-

-
KII
-3,499E+6
- -
Right end, = 30°

G, crown 1
8,48417E+1
8,1080E+1
-4,433
G, crown 2
8,48417E+1
8,4583E+1
-0,305
G, crown 3
8,48417E+1
8,4602E+1
-0,282
G, crown 4
8,48417E+1
8,4602E+1
-0,282
KI 5,5545E+6
-
-
KII 1,6596E+6
-
-

6
Results of modeling C

6.1 Values
tested

Identification Reference
***Aster** %*
difference
Left end, = 45°

G, crown 1
5,73826E+1
5,48161E+1
-4,473
G, crown 2
5,73826E+1
5,71687E+1
-0,373
G, crown 3
5,73826E+1
5,71865E+1
-0,342
G, crown 4
5,73826E+1
5,7189E+1
-0,337
KI 2,92076E+6
-
-
KII
-3,7682E+6
- -
Right end, = 45°

G, crown 1
5,94122E+1
5,7039E+1
-3,994
G, crown 2
5,94122E+1
5,9505E+1
0,157
G, crown 3
5,94122E+1
5,9516E+1
0,175
G, crown 4
5,94122E+1
5,9518E+1
0,179
KI 4,28557E+6
-

-
KII 2,27338E+6
-
-

7
Results of modeling D

7.1 Values
tested

Identification Reference
***Aster** %*
difference
Left end, = 60°

G, crown 1
3,28015E+1
3,10680E+1
-5,285
G, crown 2
3,28015E+1
3,24037E+1
-1,213
G, crown 3
3,28015E+1

3,24140E+1
-1,181
G, crown 4
3,28015E+1
3,24156E+1
-1,177
KI 1,55258E+6
-
-
KII
-3,2531E+6
- -
Right end, = 60°

G, crown 1
3,22436E+1
3,11825E+1
-3,291
G, crown 2
3,22436E+1
3,25321E+1
0,895
G, crown 3
3,22436E+1
3,25383E+1
0,914
G, crown 4
3,22436E+1
3,25398E+1
0,919
KI 2,75709E+6
-
-
KII 2,27394E+6
-
-

7.2 Remarks

To obtain G on the bottom of crack, one calculates the rate of refund of energy using the relation between G and Kj [bib3]:

=
= 2 076923
,
1
2
µ = 7 6923
,
E + 11
1
µ = 7 6923
,
E + 10
2
= -9 37742
,
E - 2
= 2 524488
,
E - 12
G = (2
2
K + K
I
II)

8
Summary of the results

The calculation of G is not precise on the first crown in all the cases of slope of the crack. With regard to the other crowns, the variations are about 0,4%. In the case of slope = 60° the variation exceeds 1%. As a whole the results are satisfactory for G.

The calculation of KI and KII is not available for a crack located at the interface of a bimatériau.

Titrate:
SSLP313 - Crack inclined in an unlimited plate

Date:
15/10/01
Author (S):
J.M.PROIX, I. CORMEAU, E. LECLERE Key
:
V3.02.313-A Page:
1/10

Organization (S): EDF/MTI/MMN, CS IF

Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
V3.02.313 document

SSLP313 - Crack inclined in a plate
unlimited, subjected to a uniform traction ad infinitum

Summary:

This test results from the validation independent of version 3 in breaking process.

One calculates KI, KII and the rate of refund of energy for a right crack, tilted of an angle, in one

large-sized plate subjected to a uniform traction. The model is two-dimensional in constraints plane. The material is elastic linear isotropic. This test of reference in 2D makes it possible to check separability
KI and KII in a mixed mode.
The reference solution, given for a theoretically unlimited field, is analytical.

In addition to the energy method (CALC_G_THETA), one tests the method of calculation of the factors of intensity
constraints by extrapolation of displacements (POST_K1_K2_K3). Modeling B makes it possible to test
this last method with a type of grid recommended (nodes mediums with the quarter) to obtain a solution
precise.
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HI-75/01/010/A

1
Problem of reference

1.1 Geometry

y
has
X
has

One allots an unspecified value to the slope, = 37 degrees.
One chooses has = 1.E-3 Mr.

1.2
Properties of material

The material is elastic linear isotropic, of Young E and Poisson's ratio modulus.
E = 2.E11 Pa, = 0.3.
Assumption of the plane constraints

1.3
Boundary conditions and loadings

.
Arbitrary limits of the field with a grid:
- xmax X xmax with xmax = 10a
- ymax y ymax with ymax = 20a

.
Boundary conditions:
In order to block the 3 plane rigid modes exclusively.
UX = UY = 0 with the left lower corner of the complete model.
UY = 0 with the corner lower right of the complete model.
On the lower edge, we impose UY = 0

.
Loading: uniform tension yy = 0 on the higher edge:
The value of 0 is worth 100MPa, in plane constraints.

2
Reference solution

2.1
Method of calculation used for the reference solution

Function of constraint of Airy.

2.2
Results of reference

K =
has
2
I
O cos
K =
has
II
O sin cos

1
G
=
(K 2 + K 2
ref.
) in plane constraints
E
I
II

2.3
Uncertainty on the solution

Exact analytical solution (Irwin) in unlimited medium.

2.4 References
bibliographical

[1]
Y. MURAKAMI Stress intensity factors handbook, box 4.2, page 188. The Society of Materials Science, Japan, Pergamon Press, 1987.

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3 Modeling
With

3.1
Characteristics of modeling

Complete model

After symmetrization and orientation

Initial block 2D

ray
center

The ray is worth 7,5E-5 m

3.2 Characteristics of the grid

The grid consists of 14888 nodes and 6674 elements, including 1392 elements QUA8 and 5282 elements TRI6.

3.3 Functionalities tested

Orders

MECHANICAL AFFE_MODELE
C_PLAN
ALL
AFFE_CHAR_MECA FORCE_CONTOUR

MECA_STATIQUE

CALC_THETA THETA_2D

CALC_G_THETA_T OPTION
CALC_G

CALC_G_THETA_T OPTION
CALC_K_G

POST_K1_K2_K3

4
Results of modeling A

4.1 Values
tested

4.1.1 Results obtained with CALC_G_THETA_T

Identification Reference
Aster

% difference
G 1.0019E+02
1.0126E+02
1.07
KI 3,5750E+6
3,6038E+6
0,81
KII 2,6939E+6
2,7003E+6
0,24

4.1.2 Results obtained with POST_K1_K2_K3

Identification Method Reference
Aster %
difference
K1_MAX 1
3.57E+06
3.54E+06
-1.04
K1_MIN 1
3.57E+06
3.19E+06
-10.72
K2_MAX 1
2.69E+06
2.62E+06
-2.82
K2_MIN 1
2.69E+06
1.92E+06
-28.62
G_MAX 1
1.00E+02
9.69E+01
-3.33
G_MIN 1
1.00E+02
6.94E+01
-30.70
K1_MAX 2
3.57E+06
3.51E+06

-1.76
K1_MIN 2
3.57E+06
3.33E+06
-6.79
K2_MAX 2
2.69E+06
2.61E+06
-3.12
K2_MIN 2
2.69E+06
2.25E+06
-16.49
G_MAX 2
1.00E+02
9.57E+01
-4.50
G_MIN 2
1.00E+02
8.08E+01
-19.32

4.2
Remarks on the 2 methods of POST_K1_K2_K3:

Two methods are programmed in POST_K1_K2_K3:

•
Method 1: one calculates the jump of the field of displacements squared and one divides it by R. Various values of K1 (resp. K2, K3) are obtained (except for a factor) by extrapolation in R =0 of the segments of right-hand sides thus obtained. If the solution were perfect (field asymptotic analytical everywhere), one should obtain a line. Actually, one is obtained curve, therefore values different of K1, K2, K3. In order to give an indication of quality of the result, one lists the values maximum and minimum obtained on the unit of discussed items (that one names here K1_MAX, K1_MIN, etc…)
•
Method 2: one traces the jump of the field of displacements squared according to R. Them approximations of K1 are (always except for a factor) equal to the slope of the segments connecting the origin at the various points of the curve. There still, one obtains various values of K1, K2, K3.et one lists the values maximum and minimum obtained on the unit of the points treaties (named K1_MAX, K1_MIN, etc…)
•
To provide to compare the solution obtained with that provided by CALC_G_THETA_T, one calculate G starting from K1 and K2 by the formula of Irwin, which gives G_MAX and G_MIN.

4.3 Parameters of execution

Version: 5.3

Machine: SGI/ORIGIN 2000

*Obstruction memory:
128 Mo
Time CPU To use: 22 seconds
Handbook of Validation
V3.02 booklet: Linear statics of the plane systems
HI-75/01/010/A*

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5 Modeling B

5.1 Characteristics of modeling

Even form of grid that previously, but modification of the co-ordinates of the nodes mediums edges touching the bottom of crack, to move them with the quarter of these edges (method of Barsoum).

This modification of the co-ordinates of the nodes is carried out by an accessible procedure GIBI in *to card-index data of grid (SSLP313B.datg).*

5.2
Characteristics of the grid

The grid consists of 14888 nodes and 6674 elements, including 1392 elements QUA8 and 5282 elements TRI6.

5.3
Functionalities tested

Orders

MECHANICAL AFFE_MODELE
C_PLAN
ALL
AFFE_CHAR_MECA FORCE_CONTOUR

MECA_STATIQUE

CALC_THETA THETA_2D

CALC_G_THETA OPTION
CALC_G

CALC_G_THETA OPTION
CALC_K_G

POST_K1_K2_K3

Titrate:

SSLP313 - Crack inclined in an unlimited plate

6
Results of modeling B

6.1 Values
tested

6.1.1 Results obtained with CALC_G_THETA_T

Identification	*Reference*	*Aster*	*% difference*
G	*1.0019E+02*	*1.0135E+02*	*1.16*
KI	*3,5750E+6*	*3.6033E+06*	*0.79*
KII	*2,6939E+6*	*2.6996E+06*	*0.21*

6.1.2 Results obtained with POST_K1_K2_K3

Identification	*Method*	*Reference*	*Aster*	*% difference*
K1_MAX	*1*	*3.57E+06*	*3.6089E+06*	*0.95*
K1_MIN	*1*	*3.57E+06*		

3.5995E+06
0.69
K2_MAX 1
2.69E+06
2.7035E+06
0.36
K2_MIN 1
2.69E+06
2.6944E+06
0.02
G_MAX 1
1.00E+02
1.0142E+02
1.23
G_MIN 1
1.00E+02
1.0120E+02
1.01
K1_MAX 2
3.57E+06
3.6027E+06
0.78
K1_MIN 2
3.57E+06
3.5344E+06
-1.14
K2_MAX 2
2.69E+06
2.6927E+06
-0.05
K2_MIN 2
2.69E+06
2.6478E+06
-1.71
G_MAX 2
1.00E+02
1.0115E+02
0.96
G_MIN 2
1.00E+02
9.7512E+01
-2.67

6.2
Remarks on the 2 methods of POST_K1_K2_K3:

Two methods are programmed in POST_K1_K2_K3:

·
Method 1: one calculates the jump of the field of displacements squared and one divides it by R. Various values of K1 (resp. K2, K3) are obtained (except for a factor) by extrapolation in R =0 of the segments of right-hand sides thus obtained. If the solution were perfect (field asymptotic analytical everywhere), one should obtain a line. Actually, one is obtained curve, therefore values different of K1, K2, K3. In order to give an indication of quality of the result, one lists the values maximum and minimum obtained on the unit of discussed items (that one names here K1_MAX, K1_MIN, etc…)
·
Method 2: one traces the jump of the field of displacements squared according to R. Them approximations of K1 are (always except for a factor) equal to the slope of the segments connecting the origin at the various points of the curve. There still, one obtains various values of K1, K2, K3.et one lists the values maximum and minimum obtained on the unit of the points treaties (named K1_MAX, K1_MIN, etc…)
·
To provide to compare the solution obtained with that provided by CALC_G_THETA_T, one calculate G starting from K1 and K2 by the formula of Irwin, which gives G_MAX and G_MIN.

6.3 Parameters
of execution

Version: 5.3

Machine: SGI/ORIGIN 2000

Obstruction memory:
128 Mo
Time CPU To use: 19 seconds

7
Summary of the results

With this choice of the limits of the field of calculation, we obtain variations of about 1% on coefficients KI and KII, and on the rate of refund of energy G.

With regard to method POST_K1_K2_K3, the results are further away from the reference with a standard grid (from 1% to 30% of variation), on the other hand, with a grid of the type Barsoum (nodes mediums with the quarter on the sides), recommended for this type of method, the differences are included/understood between 3% and +1.2%, which is relatively precise.

Titrate:
SSLS07 - Thin cylinder under uniform axial loading

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.007

SSLS07 - Thin cylinder under axial loading
uniform

Summary:

The purpose of this test from guide VPCS (SSLS 07/89) is to validate a linear loading (FORCE_POUTRE) in
axisymmetric modeling.

One will use for that the 2 orders: AFFE_CHAR_MECA (modeling A) and AFFE_CHAR_MECA_F (modeling B).

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

Code_Aster ®
Version
6.5

Titrate:
SSLS07 - Thin cylinder under uniform axial loading

Date

1
Problem of reference

1.1 Geometry

Average radius: Ro =
1m
Thickness
: H
= 0.02 m
Height
: L
= 4 m
Internal ray: IH =
Ro h/2

1.2
Material properties

Young modulus
: E = 2.1 X 1011 Pa
Poisson's ratio: = 0.3

1.3
Boundary conditions and loadings

- *Axial displacement no one at the low end (U = 0) + conditions of symmetry*
- *Uniform axial loading per unit of length Q = 10000 N/m, applied at the high end*

1.4 Conditions
initial

2
Reference solution

2.1
Method of calculation used for the reference solution

Q
Axial stress:
=
11

H
Circumferential constraint:
0
22 =

qL
Lengthening of the cylinder: U X =

Eh
Q R

Radial displacement: U

O
R = -

Eh

2.2
Results of reference

11 = 5 X 105 Pa
U X = 9.52 X 106 m
U R = 7.14 X 107 m

2.3
Uncertainty on the solution

Analytical solution.

2.4 Reference
bibliographical

[1]
Guide VPCS Edition 1990 (SSLS 07/89)
[2]
R.J. ROARK and W.C. YOUNG: Formulated for stress and strain, 5th edition, New York,
Mc Graw-Hill, 1975

---

3 Modeling With

3.1 Characteristics of modeling

AXIS, T6 meshs and Q8

Position of the points:

- *E, F with middle height*
- *G, H, I remote Ro of the axis*

Cutting:
100 elements according to the height

1 element in the thickness

Limiting conditions: DY = 0 on AB

Loading:
Force distributed = 500 000 on CD

Name of the nodes:

Not A = N1
Not C = N452
Not E = N201
Not G = N51
Not I = N503
Not B = N101
Not D = N504

Not F = N203
Not H = N202

3.2
Characteristics of the grid

A number of nodes: 553
A number of meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

3.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “AXIS”
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_CONTOUR
GROUP_MA
CALC_CHAM_ELEM OPTION
“SIGM_ELNO_DEPL”

4
Results of modeling A

4.1 Values
tested

Standard localization
of
value Reference Aster
% difference
Points G, H, I
ur (m)
-7.14 10-7
-7.14 10-7 0.
Points C, D, I
ux (m)
9.52 10-6
9.52 10-6 0.
Points A, B, C, D, E,
22 (Pa)
0.
10-6
-
F, G, H, I
Points A, B, C, D, E,
11 (Pa)
5. 10-5
5.00 105 0.
F, G, H, I

4.2 Notice

The Fy value provided corresponds to the pressure p = q/h.

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

---

5 Modeling B

5.1 Characteristics of modeling

AXIS, T6 meshs and Q8

Position of the points:

- *E, F with middle height*
- *G, H, I remote Ro of the axis*

Cutting: 100 elements according to the height

1 element in the thickness

The load is broken up in the following way:

- *charge q1 varying linearly of 0 in D with 10000 N/m out of C field of* ***U1*** *displacements*
- *charge q2 varying linearly of 10000 N/m in D with 0 out of C field of* ***U2*** *displacements*

The results are given separately for each field ***U1*** *and* ***U2****.*

Name of the nodes:

Not A = N1
Not C = N452
Not E = N201
Not G = N51
Not I = N503
Not B = N101
Not D = N504
Not F = N203
Not H = N202

5.2
Characteristics of the grid

A number of nodes: 557
A number of meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

5.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “AXIS”
ALL
AFFE_CHAR_MECA_F FORCE_CONTOUR
GROUP_MA

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

CALC_CHAM_ELEM OPTION
“SIGM_ELNO_DEPL”

Titrate:
SSLS07 - Thin cylinder under uniform axial loading

Date
:
01/10/03
Author (S):
***X. DESROCHES** Key*
:
V3.03.007-A Page:
7/8

6
Results of modeling B

6.1 Values
tested

Fields Standard Localization
of Reference
Aster
% difference
value
U1
Not G (N51)
ur (m)
-3,583. 10-7
-3,5833. 10-7
0,009
Not H (N202)
-3,583. 10-7
-3,5833. 10-7
0,009
Not I (N503)
-1,012. 10-6
-1,0116. 10-7
-0,036

Not C (N452)
ux (m)
4,896. 10-6
4,8963. 10-6

0,007
Not D (N504)
4,658. 10-6
4,6583. 10-6
0,006
Not I (N503)
4,777. 10-6
4,7774. 10-6
0,009
U2
Not G
ur (m)
-3,559. 10-7
-3,5595. 10-7
0,015
Not H
-3,559. 10-7
-3,5595. 10-7
0,015
Not I
2,973. 10-7
2,9735. 10-7
0,017

Not C (N452)

4,627. 10-6
4,6275. 10-6
0,001
Not D (N504)
4,865. 10-6
4,8655. 10-6
0,011
Not I (N503)
4,746. 10-6
4,7464. 10-6
0,008

7
Summary of the results

Key word FORCE_CONTOUR used starting from 2 orders AFFE_CHAR_MECA and AFFE_CHAR_MECA_F provides right results.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.009

SSLS09 - Thin cylinder under actual weight

Summary:

This test from guide VPCS (SSLS 09/89) aims to test a voluminal loading (here the weight clean), in axisymmetric analysis, by using key word FORCE_INTERNE.

One will use for that the two orders: AFFE_CHAR_MECA (modeling A) and AFFE_CHAR_MECA_F (modeling B).

Modeling C tests the incompressible elements by using the key word GRAVITY on a loading equivalent.

1
Problem of reference

1.1 Geometry

Average radius: R
= 1m
Thickness
: H
= 0.02 m
Height
: L
= 4 m

1.2
Material properties

Young modulus
: E = 2.1 X 1011 Pa
Poisson's ratio: = 0.3
Voluminal weight
: = 7.85 X 104 N/m3

1.3
Boundary conditions and loadings

.
Axial displacement no one at the low end (U = 0) + conditions of symmetry
.
Actual weight, according to the axis, direction + X

2
Reference solution

2.1
Method of calculation used for the reference solution

In a point of co-ordinate X:

- X-ray

· radial displacement: U R =

E
x2

· axial displacement: U X =

2nd
R

· rotation of a generator:
-
=

E
· axial stress:

= X

11

· circumferential constraint:
0
22 =

2.2
Results of reference

· Axial Déplacement high end: U X = 2.99 X 106 m
· Radial Déplacement low end: U R = 4.49 X 107 m
· = 1.12 X 107 rad
· 11 = 3.14 X 105 Pa, at the low end
·
0
22 =
. everywhere

2.3
Uncertainty on the solution

Analytical solution.

2.4 Reference
bibliographical

[1]
Guide VPCS Edition 1990 (SSLS 09/89)
[2]
R.J. ROARK and W.C. YOUNG: Formulated for stress and strain, 5th edition, New York,
Mc Graw-Hill, 1975

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3 Modeling
With

3.1
Characteristics of modeling

AXIS, T6 meshs and Q8

Position of the points:

- ***E, F with middle height***
- ***G, H, I remote R of the axis***

Cutting:
100 elements according to the height

1 element in the thickness

Limiting conditions: DY = 0 on AB

Loading:
Constant voluminal force equalizes to 78500.

Name of the nodes:

Not A = N1
Not C = N452
Not E = N201

Not G = N51
Not I = N503
Not B = N101
Not D = N504
Not F = N203
Not H = N202

3.2
Characteristics of the grid

A number of nodes: 553
A number of meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

3.3 Functionalities
tested

Orders

"MECHANICAL" AFFE_MODELE "AXIS"
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
FORCE_INTERNE
CALC_CHAM_ELEM OPTION
"SIGM_ELNO_DEPL"

4
Results of modeling A

4.1 Values tested

Standard localization
of
value Reference Aster
% difference
Points C, D, I
ux (m)
2.99 10-6
2.99 10-6 0.
Not G
ur (m)
-4.49 10-7
-4.42 10-7 -1.5
Not G
11 (Pa)
-3.14 105
-3.14 105 0.
Points A, B, G
22 (Pa)
0. <
40
-

4.2 Remarks

· The values of 22 data are not significant.
· Taking into account the grid (1 element in the thickness), the results are completely satisfactory.

---

5 Modeling B

5.1 Characteristics of modeling

AXIS, T6 meshs and Q8

Position of the points:

- *E, F with middle height*
- *G, H, I remote R of the axis*

Cutting:
100 elements according to the height

1 element in the thickness

Limiting conditions: DY = 0 on AB

Loading:
Voluminal force in the form of a constant function defined in y = 0, 3, 6.

Name of the nodes:

Not A = N1
Not C = N452

Not E = N201
Not G = N51
Not I = N503
Not B = N101
Not D = N504
Not F = N203
Not H = N202

5.2
Characteristics of the grid

A number of nodes: 553
A number of meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

5.3 Functionalities
tested

Orders

"MECHANICAL" AFFE_MODELE "AXIS"
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

AFFE_CHAR_MECA_F FORCE_INTERNE

CALC_CHAM_ELEM
"SIGM_ELNO_DEPL"

6
Results of modeling B

6.1 Values
tested

Standard localization
of
value Reference Aster
% difference
Points C, D, I
ux (m)
2.99 10-6
2.99 10-6 0.
Not G
ur (m)
-4.49 10-7
-4.42 10-7 -1.5
Not G
11 (Pa)
-3.14 105
-3.14 105 0.
Points A, B, G
22 (Pa)
0. <
40
-

6.2 Remarks

· *The values of 22 data are not significant.*
· *The results are identical to those of modeling A.*

HT-66/05/005/A

---

7 Modeling C

7.1 Characteristics of modeling

AXIS_INCO, T6 meshs and Q8

Position of the points:

- *E, F with middle height*
- *G, H, I remote R of the axis*

Cutting:
100 elements according to the height

1 element in the thickness

Limiting conditions: DY = 0 on AB

Loading:
Gravity

Name of the nodes:

Not A = N1
Not C = N452
Not E = N201
Not G = N51
Not I = N503
Not B = N101
Not D = N504
Not F = N203
Not H = N202

7.2
Characteristics of the grid

A number of nodes: 553
A number of meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

7.3 Functionalities
tested

Orders

"MECHANICAL" AFFE_MODELE "AXIS_INCO" ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

AFFE_CHAR_MECA GRAVITY

STAT_NON_LINE
COMP_ELAS
RELATION = "ELAS"

CALC_ELEM OPTION
"SIEF_ELNO_ELGA"

8
Results of modeling C

8.1 Values tested

Standard localization
of
value Reference Aster
% difference
Points C, D, I
ux (m)
2.99 10-6
2.99 10-6 0.
Not G
ur (m)
-4.49 10-7
-4.42 10-7 -1.5
Not G
11 (Pa)
-3.14 105
-3.14 105 0.
Points A, B, G
22 (Pa)
0. <
40
-

8.2 Remarks

· The found values of 22 are not significant.
· The results are identical to those of modeling A and B.

9
Summary of the results

The use of a function for the definition of a constant density of volume charge is valid: results are identical, whether one uses one or the other of 2 orders AFFE_CHAR_MECA or AFFE_CHAR_MECA_F. An equivalent loading gravity gives the same results. Moreover, the incompressible elements give the same results (modeling C).

Key:
V3.03.020-D Page:
1/10
Organization (S): EDF/IMA/MMN, SAMTECH
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.020
SSLS20 - Cylindrical hull free pinch on board
Summary:
The test from guide VPCS, makes it possible to check the effect of a specific loading on a thin cylindrical hull
in linear elasticity. One compares the arrows with the point of application of the loading compared to one
modeling of the thin cylindrical hull in elements DKT and two modelings COQUE_3D (1/8 cylinder is represented).
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
Cylindrical SSLS20 Hull pinch on free board
Date:
01/12/98
Author (S):
P. MASSIN, A. LAULUSA
Key:
V3.03.020-D Page:
2/10
1
Problem of reference
1.1 Geometry
y
F
F
D
With
D
C
With
X

C
B
B
L
F
Z
R
L
eighth of cylinder
Length
L = 10.35 m
Ray
R = 4.953 m
Thickness
T = 0.094 m
1.2
Material properties
E = 10.5 106 Pa
= 0.3125
1.3
Boundary conditions and loadings
Specific force: F = 100. NR
F
With
B
F

2

Reference solution
2.1
Method of calculation used for the reference solution
The reference solution is that given in card SSLS20/89 of guide VPCS.
It was established by average of results of several software packages of calculation by the method of finite elements.
2.2
Results of reference
Displacement of point A following y: v = 0.1139
2.3
Uncertainty on the solution
2%
2.4 References
bibliographical
[1]
G. HORRIGMOE, P.G. BERGAN “Not linear analysis of free from shells by flat finite elements " Mathematics Computer in Applied Mechanics and Amsterdam Engineering, North Holland, vol. 16 (1978)

---

3 Modeling
With
3.1
Characteristics of modeling
Element of hull DKT
y
D
L
longitudinal twinge

= 3.7
X
30t
With
C
circumferential twinge 0. 5 R = 8.3
10 T
Z
B
Modeling of a eighth of cylinder
Cutting: 10 on AD and BC 15 on AB and cd. ==> 300 meshs TRIA3
Limiting conditions:
in all the nodes of arc AB
DDL_IMPO:
(GROUP_NO: AB DZ: 0. , DRX: 0. , DRY: 0.)
segment) AD)
(GROUP_NO: ADsansA DX: 0. , DRY: 0. , DRZ: 0.)
segment) BC)
(GROUP_NO: BCsansB DY: 0. , DRX: 0. , DRZ: 0.)
in A
(GROUP_NO: WITH DX: 0. , DRZ: 0.)
out of B
(GROUP_NO: B DY: 0. , DRZ: 0.)
Loading:
with node A
FORCE_NODALE:
(GROUP_NO: In Fy: 25.)
Name of the nodes:
Not A = NO176 Not C = NO1
Not B = NO11 Not D = NO166
3.2
Characteristics of the grid
A number of nodes: 176
A number of meshs and types: 300 TRIA3
3.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA

DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
Cylindrical SSLS20 Hull pinch on free board
Date:
01/12/98
Author (S):
P. MASSIN, A. LAULUSA
Key:
V3.03.020-D Page:
5/10
4
Results of modeling A
4.1 Values
tested
Not
Size and unit
Reference
Aster
% difference
With
displacement v (m)
0.1139
0.1128
0.54
4.2 Parameters
of execution
Version: 4.00.02
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords

Time CPU To use:
5.1 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
Cylindrical SSLS20 Hull pinch on free board
Date:
01/12/98
Author (S):
P. MASSIN, A. LAULUSA
Key:
V3.03.020-D Page:
6/10
5 Modeling
B
5.1
Characteristics of modeling
Element of hull COQUE_3D MEC3QU9H
y
D
L
longitudinal twinge
= 3.7
X
30t
With
C
circumferential twinge 0. 5 R = 8.3
10 T
Z
B
Modeling of a eighth of cylinder
Cutting: 4 on AD and BC 4 on AB and cd. ==> 16 meshs QUAD9
Limiting conditions:
in all the nodes of arc AB
DDL_IMPO:
(GROUP_NO: AB DZ: 0. , DRX: 0. , DRY: 0.)
segment) AD)

(GROUP_NO: ADsansA DX: 0. , DRY: 0. , DRZ: 0.)
segment) BC)
(GROUP_NO: BCsansB DY: 0. , DRX: 0. , DRZ: 0.)
in A
(GROUP_NO: WITH DX: 0. , DRZ: 0.)
out of B
(GROUP_NO: B DY: 0. , DRZ: 0.)
Loading:
with node A
FORCE_NODALE:
(GROUP_NO: In Fy: 25.)
Name of the nodes:
Not A = NO3 Not C = NO1
Not B = NO4 Not D = NO2
5.2
Characteristics of the grid
A number of nodes: 65
A number of meshs and types: 16 QUAD9
5.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“COQUE_3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]

Code_Aster ®
Version
4.0
Titrate:
Cylindrical SSLS20 Hull pinch on free board
Date:
01/12/98
Author (S):
P. MASSIN, A. LAULUSA
Key:
V3.03.020-D Page:
7/10
6
Results of modeling B
6.1 Values
tested
Not
Size and unit
Reference
Aster
% difference
With
displacement v (m)
0.1139
0.1136
0.26
6.2 Parameters
of execution
Version: 4.00.14
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
5.0 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/98/040 - Ind A

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7 Modeling

C

7.1

Characteristics of modeling

Element of hull COQUE_3D MEC3TR7H
y
D
L
longitudinal twinge
= 3.7
X
30t
With
C
circumferential twinge 0. 5 *R* = 8.3
10 *T*
Z
B
Modeling of a eighth of cylinder
Cutting: 5 on AD and BC 12 on AB and cd. ==> 120 meshs TRIA7
Limiting conditions:
in all the nodes of arc AB
DDL_IMPO:
(GROUP_NO: AB DZ: 0. , DRX: 0. , DRY: 0.)
segment) AD)
(GROUP_NO: ADsansA DX: 0. , DRY: 0. , DRZ: 0.)
segment) BC)
(GROUP_NO: BCsansB DY: 0. , DRX: 0. , DRZ: 0.)
in A
(GROUP_NO: WITH DX: 0. , DRZ: 0.)
out of B

(GROUP_NO: B DY: 0. , DRZ: 0.)
Loading:
with node A
FORCE_NODALE:
(GROUP_NO: In Fy: 25.)
Name of the nodes:
Not A = NO3
Not C = NO1
Not B = NO4
Not D = N02
7.2
Characteristics of the grid
A number of nodes: 275
A number of meshs and types: 120 TRIA7
7.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
"MECHANICAL"
"COQUE_3D"
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]

---

8 Results of modeling C

8.1 Values tested

Not	**Size and unit**	**Reference**	**Aster**	**% difference**
With	displacement v (m)	0.1139	0.1112	1.76

8.2 Parameters of execution

Version: 4.00.14
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
12.6 seconds

9
Summary of the results

With regard to the elements:

· DKT:

-
Suitable solution for a fine network.

-
To supplement later on:

-
by a less fine grid,

-
by an analysis of the constraints,

-
by 4 modelings (DKQ, DST, DSQ, Q4G).

· MEC3QU9H: very good solution obtained with a relatively coarse network.

· MEC3TR7H: to arrive at a suitable solution, that requires a fine grid, compared
with that for element MEC3QU9H. In the same way compared with element DKT, the number of nodes total is much more important.

Organization (S): EDF/IMA/MMN

Handbook of Validation

V3.03 booklet: Linear statics of the plates and hulls

Document: V3.03.027

SSLS27 - Bored or bent thin section

Summary:

The test, taken again guide VPCS, makes it possible to check the behavior of an embedded plane plate subjected to sound
loose lead with two nodal forces of the same sign (inflection) or of opposite sign (torsion).
The first loading constitutes an extension of the initial test for which a reference solution is given
in [bib3]. Only one modeling in element DKT.

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/96/028 - Ind A

1
Problem of reference

1.1 Geometry

Z
y
D
C
C
C
E
B
X
With
B
B
B

L
case 1
case 2
Length
L = 12 m
Width
B = 1 m
Thickness
T = 0.05 m

Co-ordinates of the points (in m):

With
B
C
D
E
X
0.
12.
12.
0.
12.
y
0.5
0.5
0.5
0.5
0.
Z
0.
0.
0.
0.
0.

1.2
Material properties

E = 1. 1011 Pa
= 0.25

1.3
Boundary conditions and loadings

Embedded side AD:
any point P such as xp = 0 (U = v = W = 0 X = y = Z = 0)
Loading: 2 loading cases
1) out of B and C: opposite forces parallel with axis Z

FzB = 1 NR
FzC = +1 NR
2) out of B and C: of the same forces feel parallel with axis Z
FzB = +1 NR
FzC = +1 NR
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/96/028 - Ind A

Code_Aster ®
Version
4.0
Titrate:
Thin SSL127 bored or bent Section
Date:
19/01/98
Author (S):
P. MASSIN, J.R. LEVESQUE
Key:
V3.03.027-C Page:
3/6

2
Reference solution

2.1
Method of calculation used for the reference solution

· Opposite Forces perpendicular to the plate [bib1], [bib2]
The reference solution is that given in card SSLS27/89 of guide VPCS:
Displacement of the point C: W = 35.37 107 m
· Of the same Forces feel perpendicular to the plate [bib3]
The formulation in beam of Euler gives a solution approached for a Poisson's ratio
.
F
3
Displacement of all the nodes on the side BC: *W* =
2 *L*
6th *Iz*

2.2
Results of reference

Displacement of the points B, C and E.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References

bibliographical
[1]
J. ROBINSON "Element evaluation. With set of assessment shares and standard tests" Proceedings of Finite Methods Element in the commercial Environment, vol. 1, (October 1978).
[2]
J.L. BATOZ, M.B. Quadrilateral TAHAR "Evaluation of new thin punt boundary element" International Newspaper for Numerical Methods in Engineering, vol. 18, John Wiley & Sounds (1982).
[3]
R.J. ROARK, W.C. YOUNG "Formulated for Stress and Strain" New York: Mc Graw-Hill, 5° edition, p 96.

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3 Modeling
With

3.1
Characteristics of modeling

Element of hull DKT

y
53
54
55
56
57
58
59
60
61

62
63
64
65
D
C
40
52
E
27
39
X
14
26
With
B
1
2
3
4
5
6
7
8
9
10
11
12
13
Cutting:
12 in length
4 in width ==>
96 meshs SORTED 3
with symmetry by report/ratio 0X centers
Twinge
transverse
b/4t = 5
longitudinal
L/12t = 20
Limiting conditions:
in all the nodes on the side AD
DDL_IMPO: (GROUP_NO: AD DX: 0. , DY: 0. , DZ: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)
Loading:

1) FORCE_NODALE (GROUP_NO: B Fz: 1.) (GROUP_NO: C Fz: +1.)
2) FORCE_NODALE (GROUP_NO: B, C) Fz: +1.))
Name of the nodes:
Not A = N1
Not C = N65
Not E = N39
Not B = N13
Not D = N53

3.2
Characteristics of the grid

A number of nodes: 65
A number of meshs and types: 96 TRIA3

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
HULL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
AFFE_MATERIAU
ALL
[U4.23.02]

5/6
4
Results of modeling A
4.1 Values
tested
Case of
Not
Size and unit
Reference
Aster
% difference
charge
B
3.537 106
3.5243 106
0.36
1
E
displacement W (m)
3. 1014
C
3.537 106
3.5243 106
0.36
B
1.0950 103
0.99
2
E
displacement W (m)
1.1059 103
1.0950 103
0.99
C
1.0950 103
0.99
Contents of the file results
Displacements with the nodes for each loading case.
4.2 Parameters
of execution
Version: 3.02.11
Machine: CRAY C98
System:

UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.5209 seconds

5
Summary of the results

· Suitable Solution for a fine network.
· To be supplemented later on by a less fine grid and to extend to other elements (DKQ, DST, DSQ, Q4G).

Organization (S): EDF/IMA/MMN, SAMTECH

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.100

SSLS100 - Plate circular embedded subjected
with a uniform pressure

Summary:

This problem allows a comparison between the solutions obtained and various elements of plate in elasticity
linear:

.
models of Coils-Kirchhoff (plate known as thin):
-
triangular surface mesh (TRIA3) DKT,
-
quadrangular surface mesh (QUAD4) DKQ,
-
linear mesh (SEG3) COQUE_AXIS,
.
models of Mindlin-Reissner (plate known as thick):
-

triangular surface mesh (TRIA3) DST,
-
quadrangular surface mesh (QUAD4) DSQ,
-
linear mesh (SEG3) COQUE_AXIS,
.
models of hulls thick: COQUE_3D (QUAD9 and TRIA7).

The same reference solution is treated with three forms of loadings: pressure, gravity and force-hull. The sizes observed are: displacements (translation/rotation), deformations and efforts generalized.

Modelings C and D were removed: resorption of modeling COQU_CYL.

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

1
Problem of reference

1.1 Geometry

y
C
B
E
F
O
D
With
X
1/4 of plate
Ray
R = 1 m
Thickness
T = 0.1 m

Co-ordinates of the points:

0 A B C D E F
X 0.
1.
2 / 2
0. 0.5
0.

0.4
y 0.
0.
2 / 2
1. 0.
0.5
0.4
Z 0
0.
0.
0.
0.
0.
0.

1.2
Material properties

E = 1 Pa
= 0.3
= 1 kg/m3

1.3
Boundary conditions and loadings

Embedding on the edge of the plate:
in all the points P such as COp = R: U = v = W = 0, X = y = Z = 0.

FORCE_COQUE
Uniform pressure
P = 1 N/m2
FORCE_COQUE
Charge distributed normal
F3 = 1 N/m2
GRAVITY
G = 10 m/s2 according to Z from where
FZ = WP = 1 N/m2

These three loadings lead to the same solution.

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

2
Reference solution

2.1
Method of calculation used for the reference solution

Two reference solutions are usable, for the calculation of the deformation:

.
the theory of LOVE-KIRCHHOFF, usually used for the plates known as "thin", that one will retain for modelings A, B, C, D, E and I,
.
the theory of MINDLIN-REISSNER, including the effects of shearing for the plates known as "thick", that one will retain for modelings F, G, H and J.
In any distant point of R of the center of the plate (R R), the arrow is expressed:
4
2
2

3
(
P R
R
R
E T
W R) = -
1-
1-

+ with D =
64D
R2
R2

(
12 1 - 2
)
16 T 2 1
with = 0 (- KIRCHHOFF COILS) or =
(REISSNER.
)
5 R 1 -
For the calculation of the moments the two theories lead to the same expressions:
P R2
R 2

P R2
R 2

M (R)
(3)
(1) M (R) =
(

1+ 3)
(1)
rr
=
+

16

R - +
16

R

- +

In the center of the plate:

4
4
(
P R
P R
W)
0
= -
(- KIRCHHOFF COILS) or (
W)
0
=
-
(1+) (REISSNER)
64D
64D

P R2
M ()
0
= M ()
0
= -
(1+

)
rr
16
Note:

Code_Aster calculates the moments with the nodes of each finite element in the reference mark of reference defined by the external normal and the reference axes defined on the hull (see AFFE_CARA_ELEM [U4.24.01]).
The value of moment Mxx (or Myy) in a node pertaining to several finite elements can to be regarded as being the average of the computed values on the elements which have this node jointly. This average can be obtained by procedure POST_RELEVE [U4.74.03].
For each node, one a: (M + M) = (M + M) = Sm
rr
xx
yy

for the point O
M
= M
= M
= M
xx
yy
rr

for the points A and D
M
= M
and
M
= M
xx
rr
yy

for the points C and E
M
= M
and
M
= M
xx

yy
rr
for the points B and F
M
= M
xx
yy
= (M + M
rr
)/2
2.2
Results of reference

Arrow and moments at the points O, A, B, C, D, E, F. Extraction of the average values of the components
M

and M
xx
yy of field "EFGE_ELNO_DEPL".

2.3 Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
TIMOSHENKO and WOINOWSKY-KRIEGER. Plates and hulls. Béranger edition, (1961).
[2]
BATOZ and DHATT. Modeling of the structures by finite elements. Hulls. Presses Univ. Laval, 1992.

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3 Modeling With

3.1 Characteristics of modeling

Element of hull DKT (modeling of a quarter of plate)

C

B
E
F
O
With
D

Limiting conditions:
DDL_IMPO
in all the nodes of the arc ABC
(GROUP_NO: ABC DX: 0. , DY: 0. , DZ: 0.)
DRX: 0. , DRY: 0. , DRZ: 0.)
in all the nodes of segment] OA [
(GROUP_NO: OA DY: 0. , DRX: 0. , DRZ: 0.)
in all the nodes of segment] OC [
(GROUP_NO: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(GROUP_NO: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Not O
meshs: M30, M33
Not A
meshs: M76
Not B
meshs: M39, M40, M51
Not C
meshs: M1
Not D
meshs: M55, M56, M65
Not E
meshs: M8, M17, M18
Not F
meshs: M34, M35, M37, M41, M46, M47, M48

3.2
Characteristics of the grid

A number of nodes: 50
A number of meshs and types: 76 TRIA3

3.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL
THICK

[U4.24.01]
ANGL_REP
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR
"MECHANICAL" AFFE_MODELE "DKT"
ALL
[U4.22.01]
CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

[U4.61.01]
"SIGM_ELNO_DEPL"
POST_RELEVE ACTION
OPERATION
"EXTRACTION"
[U4.74.03]

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

Code_Aster ®
Version
4.0

Titrate:
SSLS100 Plates circular embedded subjected to a pressure
Date:
22/12/98
Author (S):
***P. MASSIN**, D. BUI, A. LAULUSA Key*
:

V3.03.100-C Page:
5/24

4
Results of modeling A

4.1 Values
tested

Not Reference Aster %
difference
tolerance
Coil-Kirchhoff
O (
W R)
-170.6251 -169.32
-0.76
rel 1.102
D (
W R)
-95.9766 -95.76
0.23 rel 0.5 102
E (
W R)
-95.9766 -95.73
0.25 rel 0.5 102
F (
W R)
-78.897 -78.64
0.32 rel 0.5 102

Reference

Not
Mrr
M
Sm/2
O
-0.08125 -0.08125 -0.08125
With
+0.125 +0.0375 +0.08125
B
+0.125 +0.0375 +0.08125

C
+0.125 +0.0375 +0.08125
D
-0.02969 -0.05156 -0.04062
E
-0.02969 -0.05156 -0.04062
F
-0.01525 -0.04325 -0.02925

Aster

Not
Mxx
M yy
Sm/2
O
-0.08031 -0.08033 -0.08032
With
+0.1260 +0.0378 +0.0819
B
+0.08487 +0.08507 +0.08497
C
+0.03778 +0.1259 +0.08184
D
-0.03166 -0.05328 -0.04227
E
-0.05330 -0.03164 -0.04247
F
-0.02958 -0.02994 -0.02974

% difference *(with eps 10-14 and % difference on the absolute values)*

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-1.15 -1.14 -1.15
1.5
With
+0.81 +0.81 +0.81
1.
B

+4.46 +4.71 +4.58
5.
C
+0.75 +0.75 +0.75
1.
D
+6.65 +3.34 +4.55
7./3.5
E
+3.38 +6.58 +4.55
3.5/7.
F
+1.14 +2.35 +1.71
1.5

4.2 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 MW
Time CPU To use:
5.7 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

---

5 Modeling
B

5.1
Characteristics of modeling

Element of hull DKT (modeling of a quarter of plate)

C
B
E
F
O
With
D

Limiting conditions:
DDL_IMPO
in all the nodes of the arc ABC
(GROUP_NO: ABC DX: 0. , DY: 0. , DZ: 0.)
DRX: 0. , DRY: 0. , DRZ: 0.)
in all the nodes of segment] OA [
(GROUP_NO: OA DY: 0. , DRX: 0. , DRZ: 0.)
in all the nodes of segment] OC [
(GROUP_NO: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(GROUP_NO: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Not O
meshs: M1 m2
Not A
meshs: M248 M255
Not B
meshs: M292 M293 M296
Not C
meshs: M74 M75
Not D
meshs: M76 M108 M109

Not E
meshs: M34 M40 M41
Not F
meshs: M122 M123 M124 M148 M152 M153

5.2
Characteristics of the grid

A number of nodes: 170
A number of meshs and types: 296 TRIA3

5.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR
F3
GRAVITY

“MECHANICAL” AFFE_MODELE “DKT”
ALL
[U4.22.01]
CALC_CHAM_ELEM “EFGE_ELNO_DEPL”

[U4.61.01]
“SIGM_ELNO_DEPL”
POST_RELEVE ACTION
OPERATION
“EXTRACTION”
[U4.74.03]

6
Results of modeling B

6.1 Values
tested

Not Reference Aster %
difference
tolerance
Coil-Kirchhoff
O (
W R)
170.6251 170.8384 0.12 rel 0.5 102
D (
W R)
-95.9766 -96.1477 0.18
rel 0.5 102
E (
W R)
-95.9766 -96.2078 0.24
rel 0.5 102
F (
W R)
-78.897 -79.072 0.22

rel 0.5 102

Reference

Not
Mrr
M
Sm/2
O
-0.08125 -0.08125 -0.08125
With
+0.125 +0.0375 +0.08125
B
+0.125 +0.0375 +0.08125
C
+0.125 +0.0375 +0.08125
D
-0.02969 -0.05156 -0.04062
E
-0.02969 -0.05156 -0.04062
F
-0.01525 -0.04325 -0.02925

Aster

Not
Mxx
M yy
Sm/2
O
-0.08151 -0.08131 -0.08141
With
0.1282 0.04083 0.08451
B
0.08340 0.08340 0.08340
C
0.04085 0.12836 0.08460
D
-0.03037 -0.05249 -0.04143
E
-0.05259 -0.03043 -0.04151
F
-0.02981 -0.02988 -0.02985

% difference *(with eps 10-14 and % difference on the absolute values)*

Not
Mxx
M yy
Sm/2
Relative tolerance
O
0.33 0.07 0.19
0.5
With
2.62 8.88 4.02
3./9.
B
2.64 2.64 2.64
3.
C
8.95 2.69 4.13
9./3.
D
2.29 1.81 1.99
2.5
E
2.01 2.49 2.19
2.5
F
1.92 2.18 2.05
2.5

6.2 Parameters
of execution

Version: 4.00.02

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
9.5 seconds

---

7 Modeling
E

7.1
Characteristics of modeling

Element of hull DKQ (modeling of a quarter of plate)

C
1.0
B
0.5
E
0.0
O
D
With
0.0
0.5
1.0

Limiting conditions:
DDL_IMPO
in all the nodes of the arc ABC
(GROUP_NO: ABC DX: 0. , DY: 0. , DZ: 0.)

DRX: 0. , DRY: 0. , DRZ: 0.)
in all the nodes of segment] OA [
(GROUP_NO: OA DY: 0. , DRX: 0. , DRZ: 0.)
in all the nodes of segment] OC [
(GROUP_NO: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(GROUP_NO: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Not O
meshs: M1
Not A
meshs: M147
Not B
meshs: M98 M111
Not C
meshs: M14
Not D
meshs: M85 M99
Not E
meshs: M7 M8
Not F
meshs: M91 M92 M105

7.2
Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 147 QUAD4

7.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]

FORCE_COQUE
NEAR
F3
GRAVITY

"MECHANICAL" AFFE_MODELE "DKT"
ALL
[U4.22.01]
CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

[U4.61.01]
"SIGM_ELNO_DEPL"
POST_RELEVE ACTION
OPERATION
"EXTRACTION"
[U4.74.03]

8
Results of modeling E

8.1 Values
tested

Not Reference Aster %

difference
tolerance
Coil-Kirchhoff
O (
W R)
-170.6251 -171.00
0.22 rel 0.5 102
D (
W R)
-95.9766 -96.198 0.23
rel 0.5 102
E (
W R)
-95.9766 -96.198 0.23
rel 0.5 102
F (
W R)
-78.897 -79.06 0.20
rel 0.5 102

Reference

Not
Mrr
M
Sm/2
O
-0.08125 -0.08125
-0.08125
With
+0.125 +0.0375
+0.08125
B
+0.125 +0.0375
+0.08125
C
+0.125 +0.0375
+0.08125
D
-0.02969 -0.05156
-0.04062
E
-0.02969 -0.05156

-0.04062
F
-0.01525 -0.04325
-0.02925

Aster

Not
Mxx
M yy
Sm/2
O
-0.08162 -0.08162 -0.08162
With
0.1256 0.03768 0.08164
B
0.08141 0.08140 0.08141
C
0.03767 0.12557 0.08162
D
-0.03030 -0.05314 -0.04172
E
-0.05314 -0.03030 -0.04172
F
-0.02903 -0.02901 -0.02902

% difference *(with eps 1014 and % difference on the absolute values)*

Not
Mxx
M yy
Sm/2
Relative tolerance
O
0.46 0.46 0.46
0.5
With
0.49 0.49 0.49
0.5
B
0.2 0.2 0.2
0.5
C
0.45 0.45 0.45

0.5
D
2.06 3.07 2.71
2.5/3.5
E
3.07 2.06 2.71
3.5/2.5
F
-0.73 -0.83 -0.79
1

8.2 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
8.4 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

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9 Modeling
F

9.1
Characteristics of modeling

Element of hull DST (modeling of a quarter of plate)

C
B
E
F
O
With
D

Limiting conditions:
DDL_IMPO
in all the nodes of the arc ABC
(GROUP_NO: AB DX: 0. , DY: 0. , DZ: 0.)
DRX: 0. , DRY: 0. , DRZ: 0.)
in all the nodes of segment] OA [
(GROUP_NO: OA DY: 0. , DRX: 0. , DRZ: 0.)
in all the nodes of segment] OC [
(GROUP_NO: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(GROUP_NO: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Not O
meshs: M1 m2
Not A
meshs: M248 M255
Not B
meshs: M292 M293 M296
Not C
meshs: M74 M75
Not D
meshs: M76 M108 M109
Not E
meshs: M34 M40 M41
Not F
meshs: M122 M123 M124 M148 M152 M153

9.2
Characteristics of the grid

A number of nodes: 170
A number of meshs and types: 296 TRIA3

9.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR
F3
GRAVITY

"MECHANICAL" AFFE_MODELE "DST"
ALL
[U4.22.01]
CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

[U4.61.01]
"SIGM_ELNO_DEPL"
POST_RELEVE ACTION
OPERATION
"EXTRACTION"
[U4.74.03]

10 Results of modeling F

10.1 Values tested

Not Reference Aster %
difference tolerance
Reissner
O (
W R)
178.419 179.743 +0.74 rel 1.0 102
D (
W R)
101.82 102.60 +0.77 rel 1.0 102
E (
W R)
101.82 102.67 +0.84 rel 1.0 102
F (
W R)
84.198 84.83 +0.75 rel 1.0 102
Reference

Not
Mrr
M
Sm/2
O
-0.08125 -0.08125 -0.08125
With

+0.125 +0.0375 +0.08125
B
+0.125 +0.0375 +0.08125
C
+0.125 +0.0375 +0.08125
D
-0.02969 -0.05156 -0.04062
E
-0.02969 -0.05156 -0.04062
F
-0.01525 -0.04325 -0.02925
Aster

Not
Mxx
M yy
Sm/2
O
-0.08216 -0.08204 -0.08210
With
+0.12515 +0.04591 +0.08553
B
+0.08289 +0.08289 +0.08289
C
+0.04594 +0.12524 +0.08559
D
-0.03108 -0.05184 -0.04146
E
-0.05195 -0.03116 -0.04155
F
-0.02956 -0.02963 -0.02960

% difference *(with eps 1014 and % difference on the absolute values)*

Not
Mxx
M yy
Sm/2
Relative tolerance
O
+1.12 -0.97 +1.04
1.5/1.
With
+0.12 +22.44 +5.26

0.5/23.
B
+2.02 +2.02 +2.02
2.5
C
+22.52 +0.19 +5.34
23./0.5
D
+4.67 +0.54 +2.07
5./1.
E
+0.76 +4.94 +2.29
1./5.
F
+1.07 +1.33 +1.19
1.5

10.2 Contents of the file results

Values at the points of observation of displacements and moments realised.

10.3 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
9.2 seconds

11 Modeling G

11.1 Characteristics of modeling

Element of hull DSQ (modeling of a quarter of plate)

C
1.0
B
0.5
E
0.0
O
D
With
0.0
0.5
1.0

Limiting conditions:
DDL_IMPO
in all the nodes of the arc ABC
(GROUP_NO: ABC DX: 0. , DY: 0. , DZ: 0.)
DRX: 0. , DRY: 0. , DRZ: 0.)
in all the nodes of segment] OA [
(GROUP_NO: OA DY: 0. , DRX: 0. , DRZ: 0.)
in all the nodes of segment] OC [
(GROUP_NO: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O

(GROUP_NO: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Not O
meshs: M1
Not A
meshs: M147
Not B
meshs: M98 M111
Not C
meshs: M14
Not D
meshs: M85 M99
Not E
meshs: M7 M8
Not F
meshs: M91 M92 M105

11.2 Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 147 QUAD4

11.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR
F3
GRAVITY

"MECHANICAL" AFFE_MODELE "DST"
ALL
[U4.22.01]
CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

[U4.61.01]
"SIGM_ELNO_DEPL"
POST_RELEVE ACTION
OPERATION
"EXTRACTION"
[U4.74.03]
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

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12 Results of modeling G

12.1 Values
tested

Not Reference Aster %
difference tolerance
Reissner
O (
W R)
178.419 178.754 +0.19 rel 0.3 102
D (
W R)

101.82 102.015 +0.19 rel 0.3 102
E (
W R)
101.82 102.014 +0.19 rel 0.3 102
F (
W R)
84.198 84.318 +0.14 rel 0.3 102
Reference

Not
Mrr
M
Sm/2
O
-0.08125 -0.08125 -0.08125
With
+0.125 +0.0375 +0.08125
B
+0.125 +0.0375 +0.08125
C
+0.125 +0.0375 +0.08125
D
-0.02969 -0.05156 -0.04062
E
-0.02969 -0.05156 -0.04062
F
-0.01525 -0.04325 -0.02925
Aster

Not
Mxx
M yy
Sm/2
O
-0.08098 -0.08098 -0.08098
With
+0.12730 +0.04136 +0.08433
B
+0.08261 +0.08261 +0.08261
C
+0.04114 +0.12727 +0.08420
D
-0.03029 -0.05217 -0.04078

E
-0.05217 -0.03029 -0.04078
F
-0.03449 -0.03444 -0.03447

% difference (with eps 10-14 and % difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-0.33 -0.33 +0.33
0.5
With
+1.84 +10.31 +3.79
2./11.
B
+1.68 +1.68 +1.69
2.
C
+9.07 +1.82 +3.64
10./2.
D
+2.05 +1.19 +0.4
2.5/1.5
E
+1.19 +2.05 +0.4
1.5/2.5
F
+17.91 +17.74 +17.80
18

12.2 Contents of the file results

Values at the points of observation of displacements and moments realised.

12.3 Parameters
of execution

Version: 4.00.02

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
8.6 seconds

13 Modeling
H

13.1 Characteristics of modeling

Element of hull Q4G (modeling of a quarter of plate)

C
1.0
B
0.5
E
0.0
O
D
With

0.0
0.5
1.0

Limiting conditions:
DDL_IMPO
in all the nodes of the arc ABC
(GROUP_NO: ABC DX: 0. , DY: 0. , DZ: 0.)
D DRX: 0. , DRY: 0. , DRZ: 0.)
in all the nodes of segment] OA [
(GROUP_NO: OA DY: 0. , DRX: 0. , DRZ: 0.)
in all the nodes of segment] OC [
(GROUP_NO: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(GROUP_NO: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Not O
meshs: M1
Not A
meshs: M147
Not B
meshs: M98 M111
Not C
meshs: M14
Not D
meshs: M85 M99
Not E
meshs: M7 M8
Not F
meshs: M91 M92 M105

13.2 Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 147 QUAD4

13.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR
F3
GRAVITY

"MECHANICAL" AFFE_MODELE "DKT"
ALL
[U4.22.01]
CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

[U4.61.01]
"SIGM_ELNO_DEPL"
POST_RELEVE ACTION
OPERATION
"EXTRACTION"
[U4.74.03]
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

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14 Results of modeling H

14.1 Values
tested

Not Reference Aster %
difference tolerance
Reissner
O (
W R)
-178.419 -178.282 -0.08
rel 0.4 102
D (
W R)
-101.82 -101.532 -0.28
rel 0.4 102
E (
W R)
-101.82 -101.531 -0.28
rel 0.4 102
F (
W R)
-84.198 -83.91 -0.34
rel 0.4 102
Reference

Not
Mrr
M
Sm/2
O
-0.08125 -0.08125 -0.08125
With
+0.125 +0.0375 +0.08125
B
+0.125 +0.0375 +0.08125
C
+0.125 +0.0375 +0.08125
D
-0.02969 -0.05156 -0.04062
E
-0.02969 -0.05156 -0.04062
F
-0.01525 -0.04325 -0.02925

Aster

Not
Mxx
M yy
Sm/2
O
-0.08119 -0.08119 -0.08119
With
+0.11589 +0.03348 +0.07468
B
+0.07236 +0.07234 +0.07235
C
+0.03349 +0.11164 +0.07256
D
-0.02961 -0.05223 -0.04092
E
-0.05222 -0.02961 -0.04091
F
-0.02897 -0.02898 -0.02897

% difference (with eps 10-14 and % difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-0.07 -0.07 -0.07
0.1
With
-10.73 -10.73 -10.73
11.
B
-10.94 -10.96 -10.95
11.
C
-10.69 -10.69 -10.69
11.
D
-0.25 +1.3 +0.74
0.5/1.5
E

+1.29 -0.27 +0.74
1.5/0.5
F
-0.95 -0.92 -0.94
1.

14.2 Contents of the file results

Values at the points of observation of displacements and moments realised.

14.3 Parameters
of execution

Version: 4.00.02

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
8.4 seconds

15 Modeling
I

15.1 Characteristics of modeling

Axisymmetric element of hull SEG3, in theory of Coils-Kirchhoff: one does not consider modification of metric, coefficient A_CIS is worth 106.

y
p
O
D
With
X
0
0.5
1.0

Limiting conditions:

DDL_IMPO:

(NODE: WITH DX: 0. , DY: 0. , DRZ: 0.)
(NODE:
O

DRZ:
0.)

15.2 Characteristics of the grid

A number of nodes: 21
A number of meshs and types: 10 SEG3

15.3 Functionalities
tested

Orders

Keys
“MECHANICAL” AFFE_MODELE “COQUE_AXIS”

ALL
[U4.22.01]
AFFE_CARA_ELEM HULL
A_CIS

[U4.24.01]
MODI_METRIQUE
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
ALL

CALC_CHAM_ELEM "DEGE_ELNO_DEPL"

[U4.61.01]
"EFGE_ELNO_DEPL"
"SIEF_ELGA_DEPL"
"SIGM_ELNO_DEPL"
POST_RELEVE ACTION
NODE
"EXTRACTION"
[U4.74.03]

17/24

16 Results of modeling I

16.1 Values tested

Not Reference
Aster %
difference
tolerance
Coil-Kirchhoff
O arrow (
W R)
170.6251 169.759 0.51 rel 102
D arrow (
W R)
-95.9765 -95.0383
0.98 rel 102
D rotation (R)
255.940 257.120
0.46 rel 102

Not
Réfé rence
Aster
%
diff érence

Krr
maill

K
K xx
K yy
K xx
K yy
D
170.625 511.875 IJK
60.0456 514.124
0.44

KLM
265.473
514.361

0.49

moy
162.760
514.242
4.61
0.46

Not
Réfé rence
Aster
%
diff érence

M rr
maill

M
M xx
M yy
M xx
M yy
O 0.08125
-0.08125
STU
-0.08139
-0.08139
0.18
0.18
To +0.125
+0.0375
ABC
+0.10717
+0.03215
14.2
14.2
D 0.02969
-0.05156
IJK

-0.01962
-0.04873

5.8
KLM
-0.03844
-0.05439

-5.2
moy
-0.02903
-0.05156
2.21
0.00

Note:

One notes the good results obtained, except on Krr and M rr, which utilize derivative of a higher nature less better calculated by the element.

16.2 Contents of the file results

Generalized displacements, deformations and efforts and constraints with the nodes.

16.3 Parameters of execution

Version: 3.02.11

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 MW
Time CPU To use:
5.11 seconds

17 Modeling
J

17.1 Characteristics of modeling

Axisymmetric element of hull SEG3, in theory of Mindlin-Reissner: one does not consider modification of metric, coefficient A_CIS is worth 5/6.

y
p
O
D
With
X
0
0.5
1.0

Limiting conditions:

DDL_IMPO:

(NODE: WITH DX: 0. , DY: 0. , DRZ: 0.)
(NODE:
O

DRZ:
0.)

17.2 Characteristics of the grid

A number of nodes: 21
A number of meshs and types: 10 SEG3

17.3 Functionalities tested

Orders

Keys
“MECHANICAL” AFFE_MODELE “COQUE_AXIS”
ALL
[U4.22.01]
AFFE_CARA_ELEM HULL
A_CIS

[U4.24.01]
MODI_METRIQUE
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
ALL

CALC_CHAM_ELEM “DEGE_ELNO_DEPL”

[U4.61.01]
“EFGE_ELNO_DEPL”
“SIEF_ELGA_DEPL”
“SIGM_ELNO_DEPL”
POST_RELEVE ACTION
NODE
“EXTRACTION”
[U4.74.03]

---

18 Results of modeling J

18.1 Values tested

Not Reference
Aster %
difference
tolerance
REISSNER
O arrow (
W R)
-178.424 -178.368
0.03
rel 102
D arrow (
W R)
-101.827 -101.7769
0.05
rel 102
D rotation (R)
255.940 256.001
0.02
rel 102

Not
Réfé rence
Aster
%
diff érence

Krr
maill

K
K xx
K yy
K xx
K yy
D
170.625 511.875 IJK
167.892 512.050 -1.62 0.03

KLM
178.920
511.952
4.86
0.01

moy
173.406
512.001
1.60
0.02

Not
Réfé rence
Aster
%
diff érence

M rr
maill

M
M xx
M yy

M xx
M yy
O
0.08125 0.08125 STU
-0.08175 -0.08175 0.62
0.62
To +0.125
+0.0375
ABC
-0.12373
+0.03712
-1.02
-1.01
D 0.02969
-0.05156
IJK
-0.02944
-0.05150
-0.85
-0.11
KLM
-0.03045
-0.05179
2.49
0.46
moy
-0.02994
-0.05165
0.85
0.17

Note:

One notes the good results obtained, except on Krr and M rr, which utilize derivative of a higher nature less better calculated by the element.

18.2 Contents of the file results

Generalized displacements, deformations and efforts and constraints with the nodes.

18.3 Parameters of execution

Version: 3.02.11

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 MW
Time CPU To use:
4.99 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

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19 Modeling
K

19.1 Characteristics of modeling

Modeling: Element of hull COQUE_3D MEC3QU9H

C
B
E
O
D

With

Limiting conditions:

DDL_IMPO:
in all the nodes of the arc (Group_no: ABC DX: 0. , DY: 0. , DZ: 0.)
ABC
DRX: 0. , DRY: 0. , DRZ: 0.)
segment] OA]
(Group_no: OA DY: 0. , DRX: 0. , DRZ: 0.)
segment] OC]
(Group_no: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(Group_no: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Names of the nodes:

Point 0
meshs: M1
Not A
meshs: M21
Not B
meshs: M25
Not C
meshs: M5
Not D
meshs: M11
Not E
meshs: M3

19.2 Characteristics of the grid

A number of nodes: 96
A number of meshs and types: 25 QUAD9

19.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR

F3

GRAVITY

AFFE_MATERIAU ALL

[U4.23.02]
“MECHANICAL” AFFE_MODELE “COQUE_3D”
ALL
[U4.22.01]
CALC_CHAM_ELEM “EFFO_ELNO_DEPL”

[U4.61.01]
“SIGM_ELNO_DEPL”

DEFI_MATERIAU ELAS

[U4.23.01]
POST_RELEVE ACTION
OPERATION “EXTRACTION”
[U4.74.03]
VALE_TEST

EPSI_TEST

---

20 Results of modeling K

20.1 Values tested

Not Reference Aster %
difference
tolerance
REISSNER
O
-178.419 -178.39
0.016 rel 102
With
0. eps
- ABS 1010
B
0. eps
- ABS 1010
C W
(R)
0. eps
- ABS 1010
D
-101.82 -101.79
0.029 rel 102

E
-101.82 -101.79
0.029 rel 102

Not Reference
Aster

Mrr
M
Sm/2
M xx
M yy
Sm/2
O 0.08125

-0.08125
-0.08125
-0.08342
-0.08342
0.08342
To +0.125
+0.0375
+0.08125
0.03675
0.1234
0.08007
C +0.125
+0.0375
+0.08125
0.1243
0.03582
0.08006
D 0.02969
-0.05156
-0.04062
-0.05241
-0.02971
0.04106
E 0.02969
-0.05156
-0.04062
-0.02958
-0.05254
0.04106

Not
% difference
Relative tolerance

M xx
M yy
Sm/2
O 2.67
2.67
2.67 3.
To 2.
-1.28
-1.45 3.
C 0.56
-4.48
-1.46 5.
D 1.65
0.067
1.08 2.
E 0.37
1.9
0.95 2.

.
with eps 1014 and % difference on the absolute values

Note:

The test of the values is carried out automatically using the functionalities offered by procedure POST_RELEVE:

.
extraction on the nodes corresponding to the points observed of the average values of components Mxx and Myy; these values are extracted from field "EFGE_ELNO_DEPL", and the average is calculated for all the liquid assets on the meshs which contain it node observed,
.
calculation of the variation compared to the value of reference provided by observing the rules of correspondence between Mxx, Myy and Mrr, M given page 3.

Contents of the file results

Values at the points of observation of displacements and moments realised.

20.2 Parameters of execution

Version: 4.00.14

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 MW
Time CPU To use:
8.77 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

---

21 Modeling
L

21.1 Characteristics of modeling

Modeling: Element of COQUE_3D MEC3TR7H

C
B
E
O
D
With

Limiting conditions:

DDL_IMPO:
in all the nodes of the arc (Group_no: ABC DX: 0. , DY: 0. , DZ: 0.)
ABC
DRX: 0. , DRY: 0. , DRZ: 0.)
segment] OA]
(Group_no: OA DY: 0. , DRX: 0. , DRZ: 0.)
segment] OC]
(Group_no: OC DX: 0. , DRY: 0. , DRZ: 0.)
with the node O
(Group_no: O DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

Names of the nodes:

Point 0
meshs: M1 and m2
Not A
meshs: M41
Not B
meshs: M49 and M50
Not C
meshs: M10
Not D
meshs: M21
Not E
meshs: M6

21.2 Characteristics of the grid

A number of nodes: 121
A number of meshs and types: 50 TRIA7

21.3 Functionalities
tested

Orders

Keys
AFFE_CARA_ELEM HULL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
NEAR

F3

GRAVITY

AFFE_MATERIAU ALL

[U4.23.02]
"MECHANICAL" AFFE_MODELE "COQUE_3D"
ALL
[U4.22.01]
CALC_CHAM_ELEM "EFFO_ELNO_DEPL"

[U4.61.01]
"SIGM_ELNO_DEPL"

DEFI_MATERIAU ELAS

[U4.23.01]
POST_RELEVE ACTION
OPERATION "EXTRACTION"
[U4.74.03]
VALE_TEST

EPSI_TEST

---

22 Results of modeling L

22.1 Values tested

Not Reference Aster %
difference
tolerance
REISSNER
O
-178.419 -178.18
-0.13
rel 102
With
0. eps
- ABS 1010
B
0. eps
- ABS 1010
C W
(R)
0. eps
- ABS 1010
D
-101.82 -101.46
0.35 rel 102
E
-101.82 -101.46
0.35 rel 102

Not Reference
Aster

Mrr
M
Sm/2
M xx
M yy
Sm/2
O 0.08125

-0.08125
-0.08125
-0.08360

-0.08360
0.08360
To +0.125
+0.0375
+0.08125
0.03741
0.12294
0.08017
C +0.125
+0.0375
+0.08125
0.12325
0.03711
0.08018
D 0.02969
-0.05156
-0.04062
-0.05117
-0.02907
0.04012
E 0.02969
-0.05156
-0.04062
-0.02905
-0.05119
0.04012

Not
% difference
Relative tolerance

M xx
M yy
Sm/2
O 2.89
2.89
2.89 3.
To 0.24
-1.65
-1.33 3.
C 1.4
-1.04
-1.32 3.

D 0.76
-2.09
-1.23 3.
E 2.16
-0.72
-1.23 3.

.
with eps 1014 and % difference on the absolute values

Note:

The test of the values is carried out automatically using the functionalities offered by procedure POST_RELEVE:

.
extraction on the nodes corresponding to the points observed of the average values of components Mxx and Myy; these values are extracted from field "EFGE_ELNO_DEPL", and the average is calculated for all the liquid assets on the meshs which contain it node observed,
.
calculation of the variation compared to the value of reference provided by observing the rules of *correspondence between Mxx, Myy and Mrr, M given page 3.*

Contents of the file results

Values at the points of observation of displacements and moments realised.

22.2 Parameters of execution

Version: 4.00.14

Machine: CRAY C90

System:
UNICOS 8.0
Obstruction memory:
16 MW
Time CPU To use:
9.29 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates

23 Summary of the results

% of the differences compared to the reference solutions

DKT DKQ
DST
DSQ
Q4G
Modé. With
B
E
F
G
H
Coil Kirchhoff
Coil-Kirchhoff
Reissner
Reissner
Reissner
Point 50
nodes
170 nodes
169 nodes
170 nodes
169 nodes
169 nodes

76 TRIA3
296 TRIA3
147 QUAD4
296 TRIA3
147 QUAD4 147 QUAD4
O (
W R)
-0.76 +0.12 +0.22
+0.74 +0.19 -0.08
D (
W R)
-0.23 +0.18 +0.23
+0.77 +0.19 -0.28
E (
W R)
-0.25 +0.24 +0.23
+0.84 +0.19 -0.28
F (
W R)
-0.32 +0.22 +0.20
+0.75 +0.14 -0.34

COQU_AXIS MEC3QU9H
MEC3TR7H
Modé. I
J
K
L
Coil-Kirchhoff
Reissner

Point 21
nodes
96
nodes
121 nodes
10 SEG3
25 QUAD9
50 TRIA7
O (
W R)
+0.51 0.03
-0.16 -0.13

D (
W R)
+0.28 0.05
-0.029
-0.35
E (
W R)
- -
-0.029
-0.35
F (
W R)
***-** +0.22*
- -

DKT DKQ
DST
DSQ
Q4G
Modé. With
B
E
F
G
H
Coil Kirchhoff
Coil-Kirchhoff
Reissner
Reissner
Reissner
Point 50
nodes
170 nodes
169 nodes
170 nodes
169 nodes
169 nodes
76 TRIA3
296 TRIA3
147 QUAD4
296 TRIA3
147 QUAD4 147 QUAD4

O Sm/2 1.15
+0.19
+0.46
+1.04
-0.33
-0.07
To Sm/2 +0.81
+4.02
+0.49
+5.26
+3.79
-10.73
B Sm/2 +4.58
+2.64
+0.20
+2.02
+1.69
-10.95
C Sm/2 +0.75
+4.13
+0.45
+5.34
+3.64
-10.69
D Sm/2 +4.55
+1.99
+2.71
+2.07
+0.40
+0.74
E Sm/2 +4.55
+2.19
+2.71
+2.29
+0.40
+0.74
F Sm/2 +1.71
+2.05
-0.79
+1.19
+17.80
-0.94

COQU_AXIS MEC3QU9H
MEC3TR7H
Modé. I
J
K
L
Coil-Kirchhoff
Reissner

Point 21
nodes
96
nodes
121 nodes
10 SEG3
25 QUAD9
50 TRIA7
O Sm/2
+0.18 +0.62
2.67 2.89
To Sm/2
+14.2 -1.01
-1.45 -1.33
B Sm/2
- -
- -
C Sm/2
- -
-1.46
-1.32
D Sm/2
+0.84 -0.85
1.08 -1.23
E Sm/2
- -
0.95
-1.23
F Sm/2
- -
- -

Note:

Concerning the efforts, direct calculation with the nodes leads to variations in several nodes, in particular at the point F in DSQ and on the edge ABC in Q4.

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.101

SSLS101 - Plate circular posed subjected
with a uniform pressure

Summary:

One treats the case of a circular plate posed on the edge in linear elasticity under 3 loadings (weight clean, pressure, effort distributed constant) which gives the same deformation.

The first two modelings make it possible to evaluate the influence of the grid.

The test gathers 9 modelings (model Coils-Kirchhoff, Mindlin-Reissner and COQUE_3D and SHB8).

1
Problem of reference

1.1 Geometry

y
C
B
E
F
O
D

With
X
1/4 of plate
Ray
R = 1 m
Thickness
T = 0.1 m

Co-ordinates of the points:

O WITH B C D E F
X 0.
1.
2 / 2
0. 0.5
0. 0.4
y 0.
0.
2 / 2
1. 0. 0.5
0.4
Z
0. 0. 0. 0. 0. 0. 0.

1.2
Material properties

E = 1. Pa
= 0.3
= 1. kg/m3

1.3
Boundary conditions and loadings

Simple support on the edge of the plate:
in all the points P such as COp = R: U = v = W = 0

FORCE_COQUE
Uniform pressure
P = 1 N/m2
FORCE_COQUE

Charge distributed normal
F3 = 1 N/m2
GRAVITY
G = 10 m/s2 according to Z from where
FZ = WP = 1 N/m2

These three loadings lead to the same solution.

2
Reference solution

2.1
Method of calculation used for the reference solution

Two reference solutions are usable, for the calculation of the deformation, according to the theory of plate
used:

· the theory of Coils-Kirchhoff, usually used for the plates known as "thin", that one will retain for modelings A, B and E,
· the theory of Reissner, including the effects of shearing for the plates known as "thick", that one will retain for modelings F, G and H.

In any distant point of R of the center of the plate (R R), one has for the calculation of the arrow:
(

W R)
4
PR
2
R

2
R
(23+)
3
=-

And
1-

1+
-
- with D =

2

64
2
D
R
R
1+

12(1- 2)
16 T 2 1
and = 0 (Coil -
or

Kirchhoff)
=
(Reissner).
5 R 1

For the calculation of the moments the two theories lead to the same expressions:
P R2

R 2
P R2

1+ 3 R 2
Mrr (R) =
(3+)

1
M (R)

=
(3+) 1

16

-

R -
16

3 +
R

In the center of the plate:
(
4
4
PR
PR
W 0)
5 +
=-
(
5

Coil - Kirchhoff)
or

(
W 0)

+
=-
+ (

Reissner)
64D 1+
64D 1+

M rr (
2
PR
0) =M (0) =
(3+)
16
Note:

Code_Aster calculates the moments with the nodes of each finite element in the reference mark of reference defined by the external normal and the reference axes defined on the hull (see AFFE_CARA_ELEM in the documentation of use).
The value of moment Mxx (or M yy), extracted field "EFGE_ELNO_DEPL", in a node belonging to several finite elements can be regarded as being the average of computed values on the elements which have this joint node. This average can be obtained by procedure POST_RELEVE [U4.74.03].

For each node, one a: (M + M) = (M + M) = Sm
rr
xx
yy

for the point O
M
= M
= M
= M
xx
yy
rr

for the points A and D
M
= M
and

M
= M
xx
rr
yy

for the points C and E
M
= M
and
M

= M
xx
yy
rr
for the points B and F
M
= M
xx
yy
= (M + M
rr
)/2

2.2
Results of reference

Arrow and moments at the points: O, A, B C, D E, F.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
TIMOSHENKO and WOINOWSKY-KRIEGER, Plates and hulls, Béranger Edition - (1961).

3 Modeling
With

3.1
Characteristics of modeling

Element of hull DKT (modeling of a quarter of plate)

C
B
E
F
O
With
D

3.1.1 Conditions
limits

in all the nodes of the arc ABC
: DX: 0. , DY: 0. , DZ: 0.
in all the nodes of segment] OA [
: DY: 0. , DRX: 0. , DRZ: 0.
in all the nodes of segment] OC [: DX: 0. , DRY: 0. , DRZ: 0.
with the node O
: DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Point 0
meshs: M30 M33
Not A

meshs: M76
Not B
meshs: M39 M40 M51
Not C
meshs: M1
Not D
meshs: M55 M56 M65
Not E
meshs: M8 M17 M18
Not F
meshs: M34 M35 M37 M41 M46 M47 M48

3.2
Characteristics of the grid

A number of nodes: 50
A number of meshs and types: 76 TRIA3

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL
THICK

ANGL_REP
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR
AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE "DKT" ALL

CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

"SIGM_ELNO_DEPL"
DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION
"EXTRACTION"

VALE_TEST
EPSI_TEST
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4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
0 (
W R) 695.6256
-687.95
-1.10
D (

W R) 489.727
-484.76
-1.01
E (
W R) 489.727
-484.69
-1.03
F (
W R) 435.8974
-431.33
-1.05

Reference

Not
M
Sm/
rr
M
2
O 0.20625
-0.20625
-0.20625
To 0.
-0.0875
-0.04375
B 0.
-0.0875
-0.04375
C 0.
-0.0875
-0.04375
D 0.15469
-0.17656
-0.1656
E 0.15469
-0.17656
-0.1656
F 0.14025
-0.16825
-0.15425

Aster

Not
M
Sm/
xx
M yy
2
O 0.20377
-0.20382
-0.20379
To 0.00992
-0.08265
-0.04628
B 0.03827
-0.03771
-0.03799
C 0.08263
0.00990
-0.04626
D 0.15516
-0.17680
-0.16597
E 0.17677
-0.15509
-0.16593
F 0.15307
-0.15342
-0.15324

% difference (% difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-1.20 -1.18 -1.19
1.5
With
- -5.54
+5.79
-/6.
B

-12.5 -13.8 -13.1
13./14.
C
-5.56 - +5.73
6./-
D
0.30 0.14
+0.2
0.5
E
0.12 0.26
+0.19
0.3
F
+9.15 -8.81 -0.66
10.

---

5 Modeling
B

5.1
Characteristics of modeling

Element of hull DKT (modeling of a quarter of plate)

C
B
E
F
O
With
D
-

5.1.1 Conditions
limits

in all the nodes of the arc ABC
: DX: 0. , DY: 0. , DZ: 0.
in all the nodes of segment] OA [
: DY: 0. , DRX: 0. , DRZ: 0.
in all the nodes of segment] OC [
: DX: 0. , DRY: 0. , DRZ: 0.
with the node O
: DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Not O
meshs: M1 m2
Not A
meshs: M248 M255
Not B
meshs: M292 M293 M296
Not C
meshs: M74 M75
Not D
meshs: M76 M108 M109
Not E
meshs: M34 M40 M41
Not F
meshs: M122 M123 M124 M148 M152 M153

5.2
Characteristics of the grid

A number of nodes: 170
A number of meshs and types: 296 TRIA3

5.3 Functionalities

tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR
F3
GRAVITY

AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE "DKT" ALL

CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

"SIGM_ELNO_DEPL"
DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION
"EXTRACTION"

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6
Results of modeling B

6.1 Values
tested

Identification	*Reference*	*Aster*	*% difference*
O (W R)	*695.6256*	*-694.97*	*-0.09*
D (W R)	*489.727*	*-489.24*	*-0.1*
E (W R)	*489.727*	*-489.31*	*-0.09*
F (W R)	*435.8974*	*-435.48*	*-0.09*

Reference

Not
Mrr

M
Sm/2
O 0.20625
-0.20625
-0.20625
To 0.
-0.0875
-0.04375
B 0.
-0.0875
-0.04375
C 0.
-0.0875
-0.04375
D 0.15469
-0.17656
-0.1656
E 0.15469
-0.17656
-0.1656
F 0.14025
-0.16825
-0.15425

Aster

Not
Mxx
M yy
Sm/2
O 0.20631
-0.20609
-0.20620
To 0.00238
-0.08459
-0.04348
B 0.4132
-0.04134
-0.04133
C 0.08460
0.00238
-0.04349
D 0.15516

-0.17727
-0.16621
E 0.17739
-0.15523
-0.16631
F 0.15461
-0.15468
-0.15464

% difference (% difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
0.03 -0.7
0.02
0.1
With
- -3.32
-0.06
-/3.5
B
-5.56 -5.51 -5.53
6.
C
-3.31 - -0.06
3.5/-
D
+0.30 +0.40 +0.35
0.5
E
+0.47 +0.35 +0.42
0.5
F
+0.23 +0.28 +0.25
0.3

7 Modeling
C

7.1
Characteristics of modeling

Element of hull SHB8 (modeling of a quarter of plate)

C
1.0
B
0.5
E
0.0
O
D
With
0.0
0.5
1.0

7.1.1 Conditions
limits

in all the nodes of the arc ABC
: DX: 0. , DY: 0. , DZ: 0.
in all the nodes of face] OA [
: DY: 0. ,
in all the nodes of face] OC [

: DX: 0. ,
with the node O
: DX: 0. , DY: 0. ,

The grid is built starting from the surface grid of modeling E, by thickening, with assistance of CREA_MAILLAGE/COQU_VOLU. One builds 2 layers of meshs HEXA8.

7.2 Characteristics of the grid

A number of nodes: 338
A number of meshs and types: 147 HEXA8

7.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_FACE
F2
FORCE_INTERNE
F2
GRAVITY

AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE SHB8
ALL

CALC_CHAM_ELEM "EFGE_ELNO_DEPL"

"SIGM_ELNO_DEPL"
DEFI_MATERIAU ELAS

CREA_MAILLAGE COQU_VOLU

CALC_CHAM_ELEM OPTION
COOR_ELGA

8
Results of modeling C

8.1 Values
tested

Identification Reference
***Aster** %*
difference
O (
W R) 695.6256
-698.6
0.4
D (
W R) 489.727
491.4

0.3
E (
W R) 489.727
-491.4
0.3
F (
W R) 435.8974
-436.6
0.2

---

9 Modeling
E

9.1
Characteristics of modeling

Element of hull DKQ (modeling of a quarter of plate)

C
1.0
B
0.5
E
0.0
O

D
With
0.0
0.5
1.0

9.1.1 Conditions
limits

in all the nodes of the arc ABC
: DX: 0. , DY: 0. , DZ: 0.
in all the nodes of segment] OA [
: DY: 0. , DRX: 0. , DRZ: 0.
in all the nodes of segment] OC [
: DX: 0. , DRY: 0. , DRZ: 0.
with the node O
: DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Not O
meshs: M1
Not A
meshs: M147
Not B
meshs: M98 M111
Not C
meshs: M14
Not D
meshs: M85 M99
Not E
meshs: M7 M8
Not F
meshs: M91 M92 M105

9.2
Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 147 QUAD4

9.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR
F3
GRAVITY

AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE “DKT” ALL

CALC_CHAM_ELEM “EFGE_ELNO_DEPL”

“SIGM_ELNO_DEPL”
DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION
“EXTRACTION”

VALE_TEST
EPSI_TEST
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HT-66/03/008/A

Code_Aster ®
Version
7.2

10 Results of modeling E

10.1 Values tested

Identification Reference
Aster %
difference
O (
W R) 695.6256
-695.01
-0.09
D (
W R) 489.727
-489.20
-0.11
E (
W R) 489.727
-489.20
-0.12
F (
W R) 435.8974
-435.38
-0.09

Reference

Not
Mrr
M
Sm/2

O
-0.20625 -0.20625 -0.20625

To 0.
-0.0875
-0.04375

B 0.
-0.0875
-0.04375

C 0.
-0.0875
-0.04375

D
-0.15469 -0.17656 -0.1656

E
-0.15469 -0.17656 -0.1656

F
-0.14025 -0.16825 -0.15425

Aster

Not
Mxx
M yy
Sm/2

O
-0.20639 -0.20639 -0.20639

To +0.00036
-0.087104
-0.04353

B
-0.04330 -0.04332 -0.04331

C 0.087133
+0.00034
-0.04355

D
-0.15506 -0.17790 -0.16648

E
-0.17790 -0.15507 -0.16648

F
-0.15380 -0.15377 -0.15378

% difference (% difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
+0.07 +0.07 +0.07
0.1
With
- -0.45
-0.49
-/0.5
B
-1.02 +0.98 +1.0
1.1
C
-0.42 - -0.46
0.5/-
D
+0.24 +0.76 +0.5
1.
E
+0.76 +0.24 +0.5
1.
F
-0.29 -0.31 -0.3
0.5

11 Modeling
F

11.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate)

C
B
E
F
O
With
D

11.1.1 Limiting conditions

in all the nodes of the arc ABC
: DX: 0. , DY: 0. , DZ: 0.
in all the nodes of segment] OA [
: DY: 0. , DRX: 0. , DRZ: 0.
in all the nodes of segment] OC [
: DX: 0. , DRY: 0. , DRZ: 0.
with the node O
: DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Not O
meshs: M1 m2

Not A
meshs: M248 M255
Not B
meshs: M3292 M293 M296
Not C
meshs: M74 M75
Not D
meshs: M76 M108 M109
Not E
meshs: M34 M40 M41
Not F
meshs: M122 M123 M124 M148 M152 M153

11.2 Characteristics of the grid

A number of nodes: 170
A number of meshs and types: 296 TRIA3

11.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR
F3
GRAVITY

AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE "DST" ALL

CALC_CHAM_ELEM “EFGE_ELNO_DEPL”

“SIGM_ELNO_DEPL”
DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION
“EXTRACTION”

VALE_TEST
EPSI_TEST
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HT-66/03/008/A

Code_Aster ®
Version
7.2

Titrate:
SSLS101 Plates circular posed subjected to a uniform pressure
Date:
05/01/04
Author (S):
J.M. PROIX, P. MASSIN, D. BUI, A. LAULUSA Key
:
V3.03.101-D Page:
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12 Results of modeling F

12.1 Values
tested

Identification Reference
Reissner Aster %
difference
0 (
W R) 703.40

-704.25
+0.12
D (
W R) 495.56
-495.96
+0,08
E (
W R) 495.56
-496.04
+0.09
F (
W R) 441.18
-441.50
+0.07

Reference

Not
Mrr
M
Sm/2

O 0.20625
-0.20625
-0.20625

To 0.
-0.0875
-0.04375

B 0.
-0.0875
-0.04375

C 0.
-0.0875
-0.04375

D 0.15469
-0.17656
-0.1656

E 0.15469
-0.17656

-0.1656

F 0.14025
-0.16825
-0.15425

Aster

Not
Mxx
M yy
Sm/2

O
-0.20705 -0.20692 -0.20698

With
-0.01143 -0.07992 -0.04567

B
-0.03976 -0.03977 -0.03977

C
-0.07993 -0.01143 -0.4568

D
-0.15597 -0.17665 -0.16631

E
-0.17678 -0.15606 -0.16642

F
-0.15445 -0.15452 -0.15448

% difference (% difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-0.39 -0.32 +0.07

0.4
With
- -8.66
-4.40
-/9.
B
-9.12 -9.09 -9.10
9.5
C
-8.64 - -4.41
9./-
D
+0.83 +0.05 +0.43
0.9
E
+0.13 +0.89 +0.49
0.9
F
+0.13 +0.18 +0.15
0.2

---

13 Modeling
G

13.1 Characteristics of modeling

Element of hull DSQ (modeling of a quarter of plate)

C
1.0
B
0.5
E
0.0
O
D
With
0.0
0.5
1.0

13.1.1 Limiting conditions

in all the nodes of the arc ABC
:
DX: 0. , DY: 0. , DZ: 0.
in all the nodes of segment] OA [
:
DY: 0. , DRX: 0. , DRZ: 0.
in all the nodes of segment] OC [
:
DX: 0. , DRY: 0. , DRZ: 0.
with the node O
:
DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Not O
meshs: M1
Not A
meshs: M147
Not B
meshs: M98 M111
Not C
meshs: M14
Not D
meshs: M85 M99
Not E
meshs: M7 M8

Not F
meshs: M91 M92 M105

13.2 Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 147 QUAD4

13.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR
F3
GRAVITY

AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE “DST” ALL

CALC_CHAM_ELEM “EFGE_ELNO_DEPL”

“SIGM_ELNO_DEPL”
DEFI_MATERIAU ELAS

POST_RELEVE ACTION

---

14 Results of modeling G

14.1 Values tested

Identification	Reference Reissner	Aster	% difference
O (W R)	703.40	-702.61	-0.11
D (W R)	495.56	-494.90	-0.13
E (W R)	495.56	-494.90	-0.13

F (
W R) 441.18
-440.51
-0.15

Reference

Not
Mrr
M
Sm/2

O 0.20625
-0.20625
-0.20625

To 0.
-0.0875
-0.04375

B 0.
-0.0875
-0.04375

C 0.
-0.0875
-0.04375

D 0.15469
-0.17656
-0.1656

E 0.15469
-0.17656
-0.1656

F 0.14025
-0.16825
-0.15425

Aster

Not
Mxx

M yy
Sm/2

O 0.20469
-0.20469
-0.20469

To +0.00654
-0.08547
-0.39465

B 0.04063
-0.04063
-0.04063

C 0.08553
+0.00629
-0.39620

D 0.15560
-0.17723
-0.16641

E 0.17723
-0.15563
-0.16643

F 0.18352
-0.18349
-0.18350

% difference (% difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-0.76 -0.76 -0.76
1.
With
- -2.32
-9.80

-/2.5
B
-7.11 -7.12 -7.12
7.5
C
-2.24 - -9.44
2.5/-
D
+0.59 +0.37 +0.49
0.6
E
+0.38 +0.60 +0.50
0.7
F
+19.0 +18.9 +19.
19.

---

15 Modeling
H

15.1 Characteristics of modeling

Element of hull Q4 (modeling of a quarter of plate)

C

1.0
B
0.5
E
0.0
O
D
With
0.0
0.5
1.0

15.1.1 Limiting conditions

in all the nodes of the arc ABC
:
DX: 0. , DY: 0. , DZ: 0.
in all the nodes of segment] OA [
:
DY: 0. , DRX: 0. , DRZ: 0.
in all the nodes of segment] OC [
:
DX: 0. , DRY: 0. , DRZ: 0.
with the node O
:
DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Not O
meshs: M1
Not A
meshs: M147
Not B
meshs: M98 M111
Not C
meshs: M14
Not D
meshs: M85 M99
Not E
meshs: M7 M8
Not F
meshs: M91 M92 M105

15.2 Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 147 QUAD4

15.3 Functionalities tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR
F3
GRAVITY

AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE “DKT” ALL

CALC_CHAM_ELEM “EFGE_ELNO_DEPL”

“SIGM_ELNO_DEPL”
DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION
“EXTRACTION”

VALE_TEST

---

16 Results of modeling H

16.1 Values tested

Identification	Reference Reissner	Aster	% difference
O (W R)	-703.40	-702.18	-0.15
D (W R)	-495.56	-494.53	-0.20
E (W R)	-495.56	-494.53	-0.20
F (W R)	-441.18	-440.23	-0.21

Reference

Not

Mrr
M
Sm/2

O 0.20625
-0.20625
-0.20625

To 0.
-0.0875
-0.04375

B 0.
-0.0875
-0.04375

C 0.
-0.0875
-0.04375

D 0.15469
-0.17656
-0.1656

E 0.15469
-0.17656
-0.1656

F 0.14025
-0.16825
-0.15425

Aster

Not
Mxx
M yy
Sm/2

O 0.20595
-0.20595
-0.20595

To 0.01204

-0.09107
-0.05155

B 0.05233
-0.05236
-0.05234

C 0.09107
-0.01207
-0.05157

D 0.15438
-0.17699
-0.16568

E 0.17699
-0.15437
-0.16568

F 0.15374
-0.15374
-0.15374

% difference (% difference on the absolute values)

Not
Mxx
M yy
Sm/2
Relative tolerance
O
-0.14 -0.14 -0.14
0.2
With
- +4.08
+17.8
-/4.5
B
+19.6 +19.7 +19.7
20.
C
+4.08 - +17.9
4.5/-

D
-0.2 +0.24 +0.05
0.25
E
+0.24 -0.2 +0.05
0.25
F
-0.33 -0.33 -0.33
0.35

---

17 Modeling I

17.1 Characteristics of modeling

Modeling: Element of COQUE_3D MEC3QU9H

C
B
E
O
D
With

17.1.1 Limiting conditions

in all the nodes of arc DX: 0. , DY: 0. , DZ: 0.
ABC
DRX: 0. , DRY: 0. , DRZ: 0.
segment] OA]
DY: 0. , DRX: 0. , DRZ: 0.
segment] OC]
DX: 0. , DRY: 0. , DRZ: 0.
with the node O
DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Names of the nodes:

Point 0
meshs: M1

Not A
meshs: M21
Not B
meshs: M25
Not C
meshs: M5
Not D
meshs: M11
Not E
meshs: M3

17.2 Characteristics of the grid

A number of nodes: 96
A number of meshs and types: 25 QUAD9

17.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR

F3

GRAVITY

AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE "COQUE_3D"
ALL

CALC_CHAM_ELEM "EFFO_ELNO_DEPL"

"SIGM_ELNO_DEPL"

DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION "EXTRACTION"

VALE_TEST

EPSI_TEST

---

18 Results of modeling I

18.1 Values

tested

Not Reference Aster %
difference
REISSNER
O
-703.40 -703.41 1.42 10-3
With
0. eps -
B
0. eps -
C W
(R)
0. eps -
D
-495.56 -496.57 2. 10-3
E
-495.56 -496.57 2. 10-3

Not Reference
Aster

Mrr
M
Sm/2
M xx
M yy
Sm/2
O 0.20625
-0.20625
-0.20625
-0.20842
-0.20842
-0.20842
To 0.
-0.0875
-0.04375
-0.08846
-0.00159
-0.04502
C 0.
-0.0875
-0.04375

-0.00067
-0.08938
-0.04502
D 0.15469
-0.17656
-0.1656
-0.17743
-0.15472
-0.16607
E 0.15469
-0.17656
-0.1656
-0.15459
-0.17757
-0.16608

Not
% difference
Relative tolerance

M xx
M yy
Sm/2
O 1.05
1.05
1.05 3
At 1.09
-
2.9 3
C -
2.1
2.9 5
D 0.49
0.02
0.28 1
E 0.06
0.57
0.28 1

· with eps 1014 and % difference on the absolute values

Note:

The test of the values is carried out automatically using the functionalities offered by procedure POST_RELEVE:

· extraction on the nodes corresponding to the points observed of the average values of components Mxx and Myy; these values are extracted from field "EFGE_ELNO_DEPL", and average is calculated for all the liquid assets on the meshs which contain it node observed,
· calculation of the variation compared to the value of reference provided by observing the rules of correspondence between Mxx, Myy and Mrr, M given page 3.

19 Modeling
J

19.1 Characteristics of modeling

Modeling: Element of COQUE_3D MEC3TR7H

C
B
E
O
D
With

19.1.1 Limiting conditions

in all the nodes of arc DX: 0. , DY: 0. , DZ: 0.
ABC
DRX: 0. , DRY: 0. , DRZ: 0.
segment] OA]
DY: 0. , DRX: 0. , DRZ: 0.
segment] OC]
DX: 0. , DRY: 0. , DRZ: 0.
with the node O
DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.

Names of the nodes:

Point 0
meshs: M1 and m2
Not A
meshs: M41
Not B
meshs: M49 and M50
Not C
meshs: M10
Not D
meshs: M21
Not E
meshs: M6

19.2 Characteristics of the grid

A number of nodes: 121
A number of meshs and types: 50 TRIA7

19.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_COQUE
NEAR

F3

GRAVITY

AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE “COQUE_3D”
ALL

CALC_CHAM_ELEM “EFFO_ELNO_DEPL”

“SIGM_ELNO_DEPL”

DEFI_MATERIAU ELAS

POST_RELEVE ACTION
OPERATION “EXTRACTION”

VALE_TEST

EPSI_TEST

Titrate:
SSLS101 Plates circular posed subjected to a uniform pressure
Date:
05/01/04
Author (S):
J.M. PROIX, P. MASSIN, D. BUI, A. LAULUSA Key
:
V3.03.101-D Page:
21/22

20 Results of modeling J

20.1 Values
tested

Not Reference Aster %
difference
REISSNER
O
-703.40 -703.19 -0.03
With
0. eps -
B
0. eps -
C W
(R)
0. eps -
D
-495.56 -495.22 -0.07
E
-495.56 -495.22 -0.07

Not Reference
Aster

Mrr
M
Sm/2
M xx
M yy
Sm/2
O 0.20625

-0.20625
-0.20625
-0.20860
-0.20860
-0.20860
To 0.
-0.0875
-0.04375
-0.08619
-0.00154
-0.04386
C 0.
-0.0875
-0.04375
-0.00134
-0.08639
-0.04386
D 0.15469
-0.17656
-0.1656
-0.17617
-0.15409
-0.16513
E 0.15469
-0.17656
-0.1656
-0.15407
-0.17619
-0.16513

Not
% difference
Relative tolerance

M xx
M yy
Sm/2
O 1.14
1.14
1.14 2
At 1.49
-
0.25 2

C -
-1.27
0.25 2
D 0.22
-0.39
-0.28 1.
E 0.40
-0.21
-0.28 1.

· with eps 1014 and % difference on the absolute values

Note:

The test of the values is carried out automatically using the functionalities offered by procedure POST_RELEVE:

· extraction on the nodes corresponding to the points observed of the average values of components Mxx and Myy; these values are extracted from field "EFGE_ELNO_DEPL", and average is calculated for all the liquid assets on the meshs which contain it node observed,
· calculation of the variation compared to the value of reference provided by observing the rules of correspondence between Mxx, Myy and Mrr, M given page 3.

---

21 Summary of the results

% of the differences compared to the reference solutions

DKT
DKQ
DST
DSQ
Q4G
WITH B
E
F
G
H
Coil-Kirchhoff
Coil-Kirchhoff
Coil-Kirchhoff
Reissner
Reissner
Reissner
50
nodes
170 nodes
169 nodes
170 nodes
169 nodes
169 nodes
76 TRIA3
296 TRIA3
147 QUAD4
296 TRIA3
147 QUAD4 147 QUAD4
O (
W R)
-1.10 -0.09 -0.09
+0.12
-0.11
-0.15
D (
W R)
-1.01 -0.1 -0.11
+0.08
-0.13

-0.20
E (
W R)
-1.03 -0.09 -0.12
+0.09
-0.13
-0.20
F (
W R)
-1.05 -0.09 -0.09
+0.07
-0.15
-0.21

MEC3QU9H MEC3TR7H
SHB8

I J C

96
nodes
121 nodes
338 nodes

25 QUAD9
50 TRIA7
147 HEXA8
O (
W R) 1.42
10-3 -0.03 0.4
D (
W R) 2.
10-3 -0.07 0.3
E (
W R) 2.
10-3 -0.07 0.3
F (
W R) -
-

0.2

DKT
DKQ
DST
DSQ
Q4G
WITH B
E
F
G
H
Coil-Kirchhoff
Coil-Kirchhoff
Coil-Kirchhoff
Reissner
Reissner
Reissner
50
nodes
170 nodes
169 nodes
170 nodes
169 nodes
169 nodes
76 TRIA3
296 TRIA3
147 QUAD4
296 TRIA3
147 QUAD4 147 QUAD4
O Sm/2
-1.19
+0.02
+0.07
+0.07
-0.76
-0.14

In Sm/2
+5.79
-0.06
-0.49
-4.40
-9.80
+17.80
B Sm/2
-13.100
-5.53
+1.00
-9.10
-7.12
+19.70
C Sm/2
+5.73
-0.06
-0.46
-4.41
-9.44
+17.90
D Sm/2
+0.20
+0.35
+0.50
+0.43
+0.49
+0.05
E Sm/2
+0.19
+0.42
+0.50
+0.49
+0.50
+0.05
F Sm/2
-0.66
+0.25
-0.30
+0.15
+19.00
-0.33

MEC3QU9H MEC3TR7H

I J

96
nodes
121 nodes

25 QUAD9
50 TRIA7
O Sm/2
1.05
1.14

In Sm/2
2.9
0.25

B Sm/2
-
-

C Sm/2
2.9
0.25

D Sm/2

0.28
-0.28

E Sm/2
0.28
-0.28

F Sm/2
-
-

Concerning the efforts:

· the value on the supported edge is unacceptable for DSQ and Q4 and to a lesser extent for DST,
· for DSQ, one notes in more one important error at the point F.

V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.104
SSLS104 - Cylindrical hull pinch
with diaphragm
Summary:
One treats in linear elasticity the case of a cylinder formed by two circular funds at the two ends and gripped
with semi-length.
This makes it possible to treat the modes of deformation inextensionnels and a complex membrane behavior
had with the diaphragms.
The value tested is the arrow at the point of application of the force.
Three modelings: DKT, COQUE_3D QUAD9 and COQUE_3D TRIA7.

1
Problem of reference
1.1 Geometry
y
F
F
B
B
C
With
C
D
With
X

D
L
F
Z
R
L
eighth of cylinder
Length
L = 600
Ray
R = 300
Thickness
T = 3
Co-ordinates of the points:
With
B
C
D
X
300.
0.
0.
300.
y
0.
300.
300.
0.
Z
0.
0.
300.
300.
1.2
Material properties
E = 3. 106 Pa
= 0.3
A_CIS = 0.8333
1.3
Boundary conditions and loadings
Rigid diaphragm at each end:
U = v = 0, Z = 0
Specific force out of C:

F = 1. NR

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The parameters of the dealt with problem and the results of reference are explicitly given in publication quoted below.

2.2 Results of reference

Displacement of the point C following Y.

2.3 References bibliographical

[1]
Thomas J.R HUGHES, Ted BELYTSCHKO. Race notes for Recent advances in nonlinear finite element analysis. Volume III - p 238 and 239 (1990).

---

3 Modeling
With
3.1
Characteristics of modeling

Element of hull DKT
y
B
C
With
X
Z
D
Modeling of a eighth of plate
Cutting:
10 on AD and BC
16 on AB and cd. 364 meshs TRIA3
Limiting conditions:
in all the nodes of:
DDL_IMPO:
arc (AB)
(GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0.)
arc (CD)
(GROUP_NO: CD DZ: 0. , DRX: 0. , DRY: 0.)
segment) BC (
(GROUP_NO: BCsansBC DX: 0. , DRY: 0. , DRZ: 0.)
segment) AD (
(GROUP_NO: ADsansAD DY: 0. , DRX: 0. , DRZ: 0.)
out of C
(GROUP_NO: C DX: 0. , DRZ: 0.)
in D
(GROUP_NO: D DY: 0. , DRZ: 0.)
Loading:
with the node C:
(GROUP_NO: C FY: -0.25)
Names of the nodes:
Not A
N04
Not B
N02

Not C
N01
Not D
N03
3.2
Characteristics of the grid
A number of nodes: 209
A number of meshs and types: 364 TRIA3
3.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
AFFE_MODELE
"MECHANICAL"
"DKT"
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]

Key:
V3.03.104-C Page:
5/10
4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference
tolerance
Not C
1.8248 105
1.8776 105
2.89
3.102
displacement v
With 1.366 nodes: 1.8511 F out of C.
4.2 Parameters
of execution
Version: 4.00.02
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
5.5 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/98/040 - Ind A

---

5 Modeling
B

5.1
Characteristics of modeling

Element of hull 3D MEC3QU9H
y
B
C
With
X
Z
D
Modeling of a eighth of plate
Cutting:
4 on AD and BC
8 on AB and cd. 32 meshs QUAD9
Limiting conditions:
in all the nodes of:
DDL_IMPO:
arc (AB)
(GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0.)
arc (CD)
(GROUP_NO: CD DZ: 0. , DRX: 0. , DRY: 0.)
segment) BC (
(GROUP_NO: BCsansBC DX: 0. , DRY: 0. , DRZ: 0.)
segment) AD (
(GROUP_NO: ADsansAD DY: 0. , DRX: 0. , DRZ: 0.)
out of C
(GROUP_NO: C DX: 0. , DRZ: 0.)
in D
(GROUP_NO: D DY: 0. , DRZ: 0.)

Loading:
with the node C:
(GROUP_NO: C FY: -0.25)
Names of the nodes:
Not A
N01
Not B
N02
Not C
N03
Not D
N04

5.2
Characteristics of the grid

A number of nodes: 121
A number of meshs and types: 32 QUAD9

5.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“COQUE_3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates

---

6 Results of modeling B

6.1 Values tested

Identification	Reference	Aster	% difference	tolerance
Not C displacement v	1.8248 105	1.7806 105	2.42	3.102

6.2 Remarks

For a grid of 60 meshs QUAD9 and 213 nodes (corresponding to cutting 6 on AD and BC and 10 on AB and cd.), displacement v at the point C is worth 1.8011 105.

6.3 Parameters of execution

Version: 4.00.14
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use:
6.52 seconds

---

7 Modeling
C
7.1
Characteristics of modeling

Element of hull MEC3TR7H
y
B
C
With
X
Z
D
Modeling of a eighth of plate
Cutting:
10 on AD and BC
18 on AB and cd. 360 meshs TRIA7
Limiting conditions:
in all the nodes of:
DDL_IMPO:
arc (AB)
(GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0.)
arc (CD)
(GROUP_NO: CD DZ: 0. , DRX: 0. , DRY: 0.)
segment) BC (
(GROUP_NO: BCsansBC DX: 0. , DRY: 0. , DRZ: 0.)
segment) AD (
(GROUP_NO: ADsansAD DY: 0. , DRX: 0. , DRZ: 0.)
out of C

(GROUP_NO: C DX: 0. , DRZ: 0.)
in D
(GROUP_NO: D DY: 0. , DRZ: 0.)
Loading:
with the node C:
(GROUP_NO: C FY: -0.25)
Names of the nodes:
Not A
N01
Not B
N02
Not C
N03
Not D
N04

7.2
Characteristics of the grid

A number of nodes: 777
A number of meshs and types: 360 TRIA7

7.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_NODALE
GROUP_NO
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“COQUE_3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS

---

8 Results of modeling C

8.1 Values tested

Identification	Reference	Aster	% difference	tolerance
Not C displacement v	1.8248 105	1.7424 105	4.51	5. 102

8.2 Remarks

For a grid with 500 meshs TRIA7 and 1071 nodes (cutting 10 on AD and BC, 25 on AB and Cd.), one obtains a displacement v at the point C of 1.7723 105. The relative error on displacement v in C is then 2.88%. The results with this element for light grids is thus not very good and improves relatively little with an increase of the number of meshs.

8.3 Parameters of execution

Version: 4.00.14
Machine: CRAY C90
System:
UNICOS 8.0

Obstruction memory:
16 megawords
Time CPU To use:
89.25 seconds

9
Summary of the results

With regard to the elements:

DKT:

The result is better with a finer grid (1366 nodes) which leads to an error < 1.5%.

MEC3QU9H:

The result is acceptable with relatively few elements (compared with DKT). While increasing appreciably the number of elements (60 instead of 32), the error is < 1.3%.

MEC3TR7H:

Result little satisfying even with a fine grid leading to a great total number of nodes for MEC3TR7H (777 for MEC3TR7H to be compared with 209 for DKT and 121 for MEC3QU9H). To arrive at an error lower than 2.9%, that requires a very great number of nodes (1071). It seems recognized that this element is worse than MEC3QU9H.

Titrate:
SSLS105 - Doubly gripped hemisphere

Date:
03/11/03
Author (S):
***P. MASSIN**, J.M. PROIX, Key S. BAGUET*
:
V3.03.105-D Page:
1/8

Organization (S): EDF-R & D /AMA, INSA LYON

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.105

SSLS105 - Doubly gripped hemisphere

Summary:

One treats the case of the hemisphere doubly gripped in linear elasticity, which makes it possible to evaluate the quality of
plane facets for the representation of a deep hull.

The values tested are the arrows at the points of application of the forces.

One has 3 modelings:

.
A: elements DKT
.
B: elements of COQUE_3D in QUAD9
.
C: elements SHB8

---

1 *Problem of reference*

1.1 Geometry

Z
Z
C
C
y
B
B
y
2KN

With
With
2KN
X
X
Ray
R = 10. m
Thickness
T = 0.04 m

Co-ordinates of the points:

With
B
C
X 10.
0.
0.
y 0.
10.
0.
Z 0.
0.
10.

1.2
Material properties

E = 6.825 107 Pa, = 0.3

1.3
Boundary conditions and loadings

On a quarter of the hemisphere:

Not C
no displacement in Z
Side AC
symmetry compared to the xz plan
Side BC
symmetry compared to the yz plan

Side AB
free

Specific force in a: F = 2. KN
Specific force in b: F = +2. KN

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in the card "Test No LE3" of the tests of reference published by NAFEMS [bib1].

2.2
Results of reference

Displacement of point A following X.

2.3 References

bibliographical

[1]
A. Morris. Dynamics Working Group - College of Aeronautics, Cranfield, the U.K. Free vibrations benchmarks. NAFEMS - Test No LE3 - (1986).

---

3 Modeling With

3.1 Characteristics of modeling

Element of hull DKT

Modeling of a quarter of the hemisphere in TRIA3.

Names of the nodes:

Not A
N03
Not B
N02
Not C

N01

3.2
Characteristics of the grid

A number of nodes: 734
A number of meshs and types: 1373 TRIA3

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL
ALL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
“MECHANICAL” AFFE_MODELE “DKT”
ALL

DEFI_MATERIAU ELAS

4
Results of modeling A

4.1 Values
tested

Identification Reference Aster %
difference
Not A

-0.185 -0.1838 -0.66
displacement U
Not B
+0.185 +0.1839 -0.59
displacement v

---

5 Modeling B

5.1 Characteristics of modeling

Element of hull COQUE_3D MEC3QU9H

C
With
B
Modeling of a quarter of the hemisphere in QUAD9

Names of the nodes:

Not A
N01

Not B
N021
Not C
N041

5.2
Characteristics of the grid

A number of nodes: 256
A number of meshs and types: 75 QUAD9

5.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL
ALL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE "COQUE_3D"
ALL

DEFI_MATERIAU ELAS

6
Results of modeling B

6.1 Values

tested

Identification Reference Aster %
difference
Not A
-0.185 -0.1844
-0.32
displacement U
Not B
+0.185 +0.1844
-0.32
displacement v
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

---

7 Modeling C

7.1 Characteristics of modeling

Element of hull COQUE_MASSIF SHB8
C2
C1
A1
B1
A2
B2

Modeling of a quarter of the hemisphere in SHB8

7.2 Characteristics of the grid

Case 1:
A number of nodes: 662
A number of meshs and types: 300 SHB8
Names of the nodes:

Not A1

N40
Not A2
N42

Not B1
N01
Not B2
N02

Not C1
N662
Not C2
N658

Case 2:
A number of nodes: 2522
A number of meshs and types: 1200 SHB8
Names of the nodes:

Not A1
N1239
Not A2
N1241

Not B1
N301
Not B2
N303

Not C1
N602
Not C2
N604

Case 3:
A number of nodes: 5582
A number of meshs and types: 2700 SHB8
Names of the nodes:

Not A1
N329
Not A2
N331

Not B1
N3439
Not B2
N3441

Not C1
N4760
Not C2
N4762

7.3 Functionalities tested

Orders

MODI_MAILLAGE ORIE_SHB8
GROUP_MA ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MATERIAU ALL

"MECHANICAL" AFFE_MODELE SHB8
ALL
DEFI_MATERIAU ELAS

Titrate:
SSLS105 - Doubly gripped hemisphere

Date:
03/11/03
Author (S):
***P. MASSIN**, J.M. PROIX, Key S. BAGUET*
:
V3.03.105-D Page:
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8
Results of modeling C

8.1 Values tested

Identification Reference Aster % difference

Not A
-0.185 -0.1490
-19.44
Cas¨ 1
displacement U
Not
B
+0.185 +0.1490
-19.44
displacement v

Not A
-0.185 -0.1822
-1.49
Case 2
displacement U
Not
B
+0.185 +0.1822
-1.49
displacement v

Not A
-0.185 -0.1845
-0.24
Case 3
displacement U
Not
B
+0.185 +0.1845
-0.24
displacement v

8.2 Notice

For this modeling, convergence is relatively slower than for the MEC3QU9H, it is necessary in effect 1200 elements to obtain a relative error of about 1%. But time CPU is not crippling (12s). This is undoubtedly due to the choice of the law of behavior specific to the element SHB8: law of plane constraints, and nonnull rigidity in the direction of the normal to the element. If one chose a law of elasticity in plane constraints, without modification, one one would obtain then correct solution (0,2% of variation) as of the 1st case (300 elements). But this law would be then unsuited for other tests, such that of the sphere under pressure (SSLS123).

9
Summary of the results

Severe test which requires a fine grid, in particular for element DKT. Results with the element MEC3TR7H were not retained as test because it is necessary to have many elements (1801) and thus a time of convergence much longer to obtain correct values by report/ratio with other modelings (> 500 S for a relative error of about 4%).
For element SHB8, convergence is relatively slower than for the MEC3QU9H, it is necessary in effect 1200 elements to obtain a relative error of about 1%. But time CPU is not crippling (12s).

Results in conformity with the reference solution.

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.107

SSLS107 - Subjected cylindrical panel
with its own weight

Summary:

This test makes it possible to validate two finite elements of thick hull in linear elasticity. Modeling A tests it
quadrangle, modeling B tests the triangle associated with the formulation. This problem of cylindrical panel
under actual weight is a traditional test of hull.

The results of reference are analytical solutions.

One will note the good results obtained with the quadrangle and the results much worse obtained with triangle.

Author (S):
P. Key MASSIN, A. LAULUSA

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1
Problem of reference

1.1 Geometry

Z
D
With
C
Free
X
y
B
L

R
Length
L = 6. m
Ray
R = 3. m
Thickness
T = 0.03 m
Angular section = 40°

Co-ordinates of the points:

WITH B C D
X
3. cos 40°
3. cos 40°
3.
3.
y
3. sin 40°
3. sin 40°
0.
0.
Z 3.
0.
0.

3.

1.2
Material properties

E = 3. 1010 Pa
= 0.
= 2.0833 104 kg/m3

1.3
Boundary conditions and loadings

Rigid diaphragm at each end: U = v = 0, Z = 0.

Loading 1: Force due to gravity G = 10 m/s2

Loading 2: Force hull charges distributed vertical Fx = 6250.N

Two loadings leading to the same solution are tested.

2
Reference solution

2.1
Method of calculation used for the reference solution

The parameters of the problem and the results of reference (analytical solutions) are given by BATOZ and DHATT [bib1].

2.2
Results of reference

Displacement of the point B following X
Displacement of the point C following X.

2.3 References
bibliographical

[1]
BATOZ J.L., DHATT G.: Modeling of the structures by finite elements. Volume 3 hulls, p445-448 (1992).

---

3 Modeling
With

3.1 Characteristics of modeling

Element of COQUE_3D MEC3QU9H

Z
D
C
With
X
y
B

Modeling of a quarter of cylinder

Cutting:

6 on AB and cd.
6 on AD and BC 36 meshs QUAD9

Limiting conditions:

in all the nodes of:
DDL_IMPO:
arc (AD)
(GROUP_NO: AD DX: 0. , DY: 0. , DRZ: 0.)
segment] CD [
(GROUP_NO: CDsansCD DY: 0. , DRY: 0. , DRZ: 0.)
arc (BC)
(GROUP_NO: BC DX: 0. , DRX: 0. , DRY: 0.)
out of C
(GROUP_NO: C DY: 0. , DRZ: 0.)

Loading:

FORCE_COQUE:
(FX: -6250.)
GRAVITY:
(10. -1. 0. 0.)

Names of the nodes:

Not A
N03
Not B
N02
Not C
N01
Not D
N04

3.2
Characteristics of the grid

A number of nodes: 169
A number of meshs and types: 36 QUAD9

3.3 Functionalities
tested

Orders

Keys
AFFE_MODELE AFFE
MODELING
:
"COQUE_3D"
[U4.22.01]
AFFE_CARA_ELEM HULL
ALL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
FX
GRAVITY
DEFI_MATERIAU
ELAS
E, NAKED, RHO

[U4.23.01]
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

Code_Aster ®
Version
4.0

Titrate:
Cylindrical SSLS107 Panel subjected to its own weight

Date:
05/10/98
Author (S):
P. Key MASSIN, A. LAULUSA
:
V3.03.107-A Page:
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4
Results of modeling A

4.1 Values
tested

Identification Reference Aster %
difference
Not B
-3.61 10-2 -3.619
10-2
-0.25
displacement DX
Not C
5.44 10-3 5.427
10-3
-0.31
displacement DX

4.2 Parameters of execution

Version: 4.00.14

Machine: CRAY

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use: 7.34 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

---

5 Modeling B

5.1 Characteristics of modeling

Element of hull 3D MEC3TR7H

Z
D

C
With
X
y
B

Modeling of a quarter of cylinder

Cutting:

12 on AB and cd.
12 on AD and BC 288 meshs TRIA7

Limiting conditions:

in all the nodes of:
DDL_IMPO:
arc (AD)
(GROUP_NO: AD DX: 0. , DY: 0. , DRZ: 0.)
segment) CD (
(GROUP_NO: CDsansCD DY: 0. , DRY: 0. , DRZ: 0.)
arc (BC)
(GROUP_NO: BC DX: 0. , DRX: 0. , DRY: 0.)
out of C
(GROUP_NO: C DY: 0. , DRZ: 0.)
The grid is of directed type:

Loading:

FORCE_COQUE:
(FX: -6250.)
GRAVITY:
(10. -1. 0. 0.)

Names of the nodes:

Not A
N03
Not B
N02
Not C
N01

Not D
N04

5.2
Characteristics of the grid

A number of nodes: 913
A number of meshs and types: 288 TRIA7

5.3 Functionalities
tested

Orders

Keys
AFFE_MODELE AFFE
MODELING
:
"COQUE_3D"
[U4.22.01]
AFFE_CARA_ELEM HULL
ALL

[U4.24.01]
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

[U4.25.01]
FORCE_COQUE
FX
GRAVITY
DEFI_MATERIAU
ELAS
E, NAKED, RHO

[U4.23.01]

6
Results of modeling B

6.1 Values
tested

Identification Reference
Aster %
difference
Not B
-3.61 10-2 -3.603
10-2
-0.19
displacement DX
Not C
5.41 10-3 5.396
10-3
-0.26
displacement DX

6.2 Parameters
of execution

Version: 4.00.14

Machine: CRAY

System:
UNICOS 8.0
Obstruction memory:
16 megawords
Time CPU To use: 54.54 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

7
Summary of the results

Element MEC3QU9H makes it possible to obtain a good solution with a coarse grid, while element MEC3TR7H requires a very fine grid to reach a satisfactory precision.

It is noted that the reference solution is the analytical solution obtained starting from the theory of "deep" hulls. The 2 elements of hull converge towards this solution and not towards the theory "not very deep" hulls.

Organization (S): EDF-R & D /AMA, SAMTECH, INSA-LYON

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.108

SSLS108 - Helicoid hull under load
concentrated

Summary:

This test in linear elasticity is very severe from its geometry (left hull). Two first modelings correspond one to the element of QUAD of modeling COQUE_3D (MEC3QU9H) and the other with element TRI7 of modeling COQUE_3D (MEC3TR7H). The two following ones relate to modeling SHB8.

The values of reference are computation results provided in the literature and the comparison calculation/reference relates to displacement in a point of the structure. One notes variations compared to reference lower than 0.15% for element MEC3QU9H and lower than 0.4% for element MEC3TR7H. For modelings SHB8, the stupid maximum changes of 1.4% with 24 elements SHB8 (modeling C) and 0.3% with 96 SHB8 (modeling D).
Handbook of Validation

1
Problem of reference

1.1 Geometry

Y
FY
L
C
H
O
B
With
X
Z
B
FZ

The hull is thickness 0.32 m, length 12 m and of width 1.1 Mr.

1.2
Material properties

E = 29. 106 Pa
= 0.22

1.3 Boundary conditions and loadings

Embedded on side OBC: U = v = W = 0, X = y = Z = 0

Two loading cases which corresponds to loadings concentrated at point a:

- *Force parallel with axis Z; Fz = 1 NR*
- *Force parallel with the axis Y; Fy = 1 NR*

---

2 Reference solution

2.1 Method of calculation used for the reference solution

Parameters of the problem and results of reference (solutions obtained by finite elements of beam type) are given in the reference below [bib1].

2.2
Results of reference

Displacement of point A following Y
Displacement of point A following Z.

2.3 References
bibliographical

[1]
BATOZ J.L., DHATT G.: Modeling of the structures by finite elements. Volume 3 hulls, p456-459 (1992).

---

3 Modeling
With

3.1
Characteristics of modeling

Element of hull 3D MEC3QU9H

B
O
C
With

Cutting:

2 according to the width, 12 according to the length
24 meshs QUAD9, thickness: H = 0.32

Names of the nodes:

Not O
N06
Not B
N01
Not C
N02
Not A
N032

3.2
Characteristics of the grid

A number of nodes: 125
A number of meshs and types: 24 QUAD9

3.3 Functionalities
tested

Orders

AFFE_CARA_ELEM HULL
ALL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MODELE AFFE
MODELING
:
“COQUE_3D”

DEFI_MATERIAU ELAS

4
Results of modeling A

4.1 Values
tested

Case of
Not
Size in unit
Reference
Aster %
difference

loads
Fz = 1 NR
With
displacement V (m)
-1.72 10-3 -1.717
10-3
-0.15

displacement W (m)
5.42 10-3 5.411
10-3
-0.16
Fy = 1 NR
With
displacement V (m)
1.75 10-3 1.750
10-3
0.0

displacement W (m)
-1.72 10-3 -1.717
10-3
-0.15

6/12

5 Modeling B

5.1 Characteristics of modeling

Element of hull MEC3TR7H

Cutting:

2 according to the width, 12 according to the length
48 meshs TRIA7, thickness: H = 0.32

Names of the nodes:

Not O
N06
Not B
N01
Not C
N02
Not A
N032

5.2 Characteristics of the grid

A number of nodes: 173
A number of meshs and types: 48 TRIA7

5.3 Functionalities tested

Orders

AFFE_CARA_ELEM HULL

ALL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MATERIAU ALL

“MECHANICAL” AFFE_MODELE “COQUE_3D”
ALL

DEFI_MATERIAU ELAS

6
Results of modeling B

6.1 Values
tested

Case of
Not
Size in unit
Reference
Aster %
difference
loads
Fz = 1 NR
With
displacement V (m)
-1.72 10-3 -1.714
10-3
-0.34

displacement W (m)
5.42 10-3 5.399
10-3
-0.38
Fy = 1 NR
With
displacement V (m)
1.75 10-3 1.746
10-3
-0.23

displacement W (m)
-1.72 10-3 -1.714
10-3
-0.34

---

7 Modeling
C

7.1
Characteristics of modeling

MASSIVE element of hull SHB8

B1
O1
C1
C2
A1
A2

Cutting:

2 according to the width, 12 according to the length
24 meshs SHB8, thickness: H = 0.32

Names of the nodes:

Not O1
N03
Not O2
N05
Not B1
N04
Not B2
N06
Not C1
N01
Not C2
N02
Not A1

N78
Not A2
N75

7.2
Characteristics of the grid

A number of nodes: 78
A number of meshs and types: 24 SHB8

7.3 Functionalities
tested

Orders

MODI_MAILLAGE ORIE_SHB8
GROUP_MA
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MODELE AFFE
MODELING
:
SHB8
DEFI_MATERIAU ELAS

8
Results of modeling C

8.1 Values
tested

Case of
Not
Size in unit
Reference
Aster
% difference
loads
Fz = 1 NR
A1 and A2
displacement V (m)
-1.72 10-3
-1.717 10-3
0.16

displacement W (m)
5.42 10-3
5.408 10-3
-0.21
Fy = 1 NR
A1 and A2
displacement V (m)
1.75 10-3
1.726 10-3
-1.36

displacement W (m)
-1.72 10-3

-1.717 10-3
0.16

8.2 Remarks

A modeling 3D on the same grid (meshs HEXA8) revealed a blocking: results are very far away from the reference. For example, in the case of load 1, one obtains:

Not
Size in unit
Reference
Aster
A1 and A2
displacement V (m)
-1.72 10-3
-7.5 10-4
displacement W (m)
5.42 10-3
5.408 10-3

This blocking does not appear any more with quadratic meshs HEXA20, since one obtains then:

Not
Size in unit
Reference
Aster
A1 and A2
displacement V (m)
-1.72 10-3
-1.729 10-3
displacement W (m)
5.42 10-3
5.43 10-3

Modeling SHB8 makes it possible to avoid any numerical blocking, at a cost (in time CPU) similar to that of a grid HEXA8.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

---

9 Modeling
D

9.1
Characteristics of modeling

MASSIVE element of hull SHB8
B1D1O1E1
C1
C2
A1
A2

Cutting:

4 according to the width, 24 according to the length
96 meshs SHB8, thickness: H = 0.32

Names of the nodes:

Not O1
N245
Not O2
N249
Not B1
N224
Not B2
N226

Not C1
N239
Not C2
N241
Not D1
N236
Not D2
N238
Not E1
N250
Not E2
N246
Not A1
N05
Not A2
N06

9.2
Characteristics of the grid

A number of nodes: 250
A number of meshs and types: 96 SHB8

9.3 Functionalities tested

Orders

MODI_MAILLAGE ORIE_SHB8
GROUP_MA
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MODELE AFFE
MODELING
:
SHB8
DEFI_MATERIAU ELAS

---

10 Results of modeling D

10.1 Values tested

Case of
Not
Size in unit
Reference
Aster
% difference
loads
Fz = 1 NR
A1 and A2
displacement V (m)
-1.72 10-3
-1.718 10-3
0.09

displacement W (m)

5.42 10-3
5.41 10-3
-0.18
Fy = 1 NR
A1 and A2
displacement V (m)
1.75 10-3
1.744 10-3
-0.33

displacement W (m)
-1.72 10-3
-1.718 10-3
0.09

10.2 Remarks

A modeling 3D on the same grid (meshs HEXA8) revealed a blocking: even with a grid with 96 elements. The results remain very far away from the reference. For example, for loading case 1, one obtains:

Not
Size in unit
Reference
Aster
A1 and A2
displacement V (m)
-1.72 10-3
-2.49 10-4
displacement W (m)
5.42 10-3
1.12 10-3

This blocking does not appear any more with quadratic meshs HEXA20, since one obtains then:

Not
Size in unit
Reference
Aster
A1 and A2
displacement V (m)

-1.72 10-3
-1.735 10-3
displacement W (m)
5.42 10-3
5.438 10-3

With HEXA20, convergence is much better. Modeling SHB8 makes it possible to avoid all numerical blocking, at a cost (in time CPU) similar to that of a grid HEXA8.

---

11 Summary of the results

This test is very severe because of geometry of the hull which is left.

Good solutions are obtained for four modelings.

Titrate:
SSLS109 Plates in traction made up of three tablecloths of Date reinforcements
:

21/03/02
Author (S):
C. CHAVANT, O. MERABET, Key Mr. DJERROUD
:
V3.03.109-A Page:
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Organization (S): EDF/AMA, INSA-Lyon

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
V3.03.109 document

SSLS109 - Plate in traction made up of three
tablecloths of reinforcements (Model ROASTS)

Summary

This test quasi-static 2D forced plane enters within the framework of the validation of the finite elements in elasticity
linear. A plate made up of three tablecloths of reinforcements offset compared to the average layer is subjected to a uniaxial traction. The orientations of the reinforcements and the mechanical

characteristics are
different for the three tablecloths.

The principal interest of this test is to validate in linear elasticity the model "ROASTS" which is in fact an element
of thin section (DKT) with a offsetting compared to the average layer.

The results provided by the model "ROASTS" (modeling B) are identical to those obtained by modeling "DEFI_COQU_MULT" of Code_Aster (modeling A).

1
Problem of reference

1.1 Geometry

Y
NO4
NO3
Xref
30°
X
NO1
NO2

Xref
Z
Y
Xref
-75°
-20°
Xref
1
E
E
2
X
E
3

1.2
Properties of materials

Solid 1
E
1
1 = ;
7

1
G
10-
=
;
0
1 =
;
=
=1
1
L
T1
; offsetting = +0,01; épaisseur=0,01
Solid 2
E
2
2 =
;
7
G2 10
=
;
0
2 =
;
=
=1
L2
T 2
; offsetting = 0,00; épaisseur= 0,01
Solid 3
E
3
3 =
;
7
3
G
10-
=
;
0

3 =
;
=
= 1
L3
T3
; offsetting = -0,01; épaisseur= 0,01

1.3
Boundary conditions and loadings

Embedded side NO1-NO4.
One imposes a tractive effort on side NO2-NO3: FX = 2

2
Reference solution

2.1 Solution
formal

Model DEFI_COQU_MULT of Code_Aster (modeling A) makes it possible to validate the model "GRID" proposed (modeling B).

2.2
Numerical values of reference

Values of:

U, v, W, X and y with node NO2,
membrane deformation: xx, yy, xy in solid 1 calculated with node NO2,
variation of curve: xx, yy, xy in solid 1 calculated with node NO2,
constraints 3D: xx, yy, zz, xy in solid 1 calculated with node NO2.

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V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:

3 Modeling
With

3.1
Characteristics of modeling

The test-tube is with a grid with four elements "DKT"

Y
NO4
NO3
1
1
NO5
X
1
1
NO1
NO2

Grid:

A number of nodes: 5
A number of meshs and type: 4 meshs TRIA3

The grid is symmetrical in order to avoid the parasitic modes of deformations.

3.2
Stages of calculation and functionalities tested

The principal stages of calculation correspond to the functionalities which one wishes to validate:

Orders

AFFE_MODELE AFFE MODELING
"DKT"

AFFE_CARA_ELEM HULL

DEFI_MATERIAU ELAS_ORTH

DEFI_COQU_MULT SLEEP

MECA_STATIQUE

CALC_ELEM

CALC_NO

RECU_CHAMP

4
Results of modeling A

Variables
DEFI_COQU_MULT

(modeling A)
Displacements node NO2

U 81.9373
v 18.6398
W 2098.66
X
-1239.88
y
-3820.42
Deformations node NO2

(Solid 1)
xx
32.9433
yy
2.33011
xy
-34.3522
zz
0
Constraints node NO2

(Solid 1)
xx
42.7252
yy
63.0951
xy
-5.88029

zz
0
Curves node NO2

(Solids 1, 2 and 3)
xx
-531.043
yy
-2035.19
xy
2058.44

4.1 Remarks

R
R
The results presented are given in the reference mark of reference (X
, Y
)
ref.
ref. forming an angle of 30°
R R
compared to (X, Y), concerning the deformations, constraints and curves.

5
Modeling B (GRID)

5.1
Characteristics of modeling

The test-tube is with a grid with 12 elements "ROASTS" (4 elements by tablecloth of reinforcements) to three
nodes (thin section: formulation DKT with offsetting compared to the datum-line).
nodes are common to each tablecloth.

Y
NO4
NO3
1
1
NO5
X
1
1
NO1
NO2

Grid:

A number of nodes: 5
A number of meshs and type: 3x4 meshs TRIA3

The grid is symmetrical in order to avoid the parasitic modes of deformations.

5.2
Stages of calculation and functionalities tested

The principal stages of calculation correspond to the functionalities which one wishes to validate:

Orders

AFFE_MODELE AFFE
MODELING "ROASTS"

PHENOMENON
"MECHANICAL"

DEFI_MATERIAU ELAS

AFFE_CARA_ELEM ROASTS

MECA_STATIQUE

CALC_ELEM OPTION
EPSI_ELNO_DEPL

SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

EFGE_ELNO_DEPL

SIEF_ELGA_DEPL

CALC_NO OPTION
FORC_NODA

RECU_CHAMP

6
Results of modeling B

Variables
Modeling A
Modeling B
% difference

Displacements node NO2

U 81.9373
81.9373
0
v 18.6398
-18.6398
0
W 2098.66
2098.66
0
X
-1239.88 -1239.88 0
y
-3820.42 -3820.42 0
Deformations node NO2

(Solid 1)
xx

32.9433 32.9433 0
yy
2.33011 2.33011 0
xy
-34.3522 -34.3522 0
zz
0 0
0
Constraints node NO2

(Solid 1) xx
42.7252 42.7252 0
yy
63.0951 63.0951 0
xy
-5.88029 -5.88029 0
zz
0 0
0
Curves node NO2

(Solids 1, 2 and 3)
xx
-531.043 -531.043 0
yy
-2035.19 -2035.19 0
xy
2058.44 2058.44 0

6.1 Remarks

R
R
The results presented are given in the reference mark of reference (X
, Y
)
ref.
ref. forming an angle of 30°
R R
compared to (X, Y), concerning the deformations, constraints and curves.

7
Summary of the results and remarks general

The results of modeling A are identical to those of modeling B.

Code_Aster ®
Version
5.0

Titrate:
SSLS110 Stability of a compressed square plate

Date:
03/01/00
Author (S):
***P. MASSIN,** Key Mr. Al MIKDAD*
:
V3.03.110-A Page:
1/8

Organization (S): EDF/IMA/MMN, SAMTECH

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.110

SSLS110 - Stability of a compressed square plate

Summary:

A homogeneous isotropic linear plate square elastic simply pressed on its four sides is subjected with a linear compressive force acting on two on its sides.

One calculates the critical loads leading to the elastic buckling of the plate. The matrix of rigidity geometrical used in the resolution of the problem to the eigenvalues is that which is due to the constraints initial.

· mechanical linear rubber band,
· buckling of a hull,
· interest of the test: calculation of the geometrical matrix of rigidity of elements COQUE_3D,
· 2 modelings.
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLS110 Stability of a compressed square plate

Date:
03/01/00
Author (S):
P. MASSIN, Key Mr. Al MIKDAD
:
V3.03.110-A Page:
2/8

1
Problem of reference

1.1 Geometry

Because of the geometrical and physical symmetry of the problem, only the quarter of the plate is modelled. By taking account the conditions of symmetry, one can collect only the only modes of buckling symmetrical.

L
L = 250 mm
2
2
P3
Q
P4
P2
H = 5 mm
1
P
Z
y
X

1.2
Material properties

E = 2.1 10+5 Mpa.

= 0.3
The transverse coefficient of shearing for the plate is worth A_CIS = 5/6.
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

1.3
Boundary conditions and loadings

C.L. :
P2P3:

DZ = 0.

P3P4:

DZ = 0.

Symmetry
P1P2:
DY = 0.
DRX=0.
DRZ=0.

P4P1:
DX=0.

DRY=0. DRZ=0.

Loading:

Linear compressive force Q on P2P3

1.4 Remarks

It is not possible to solve the problem of deformation of compression without introducing them conditions of symmetry. Indeed, to impose boundary conditions of symmetry for a quarter of plate amounts eliminating the modes from rigid body for the complete plate.

2
Reference solution

2.1
Reference solution

The analytical solution obtained with a thin theory of section in homogeneous linear elasticity *isotropic [bib1] without taking into account of the transverse energy of shearing I ème load determines critical:*

2
D
1 2
Q
= (I +)
Cr I
2
L
I

with:

3
=
Eh
D
: the coefficient of rigidity of inflection of the hull
12 1
(
2
-)

H: the thickness
L: the length on the side of the square plate.

2.2
Results of reference

Certain modes corresponding to the critical loads of the analytical solution are not symmetrical and cannot be collected with the conditions of symmetry for a quarter of plate. The Values of the critical loads obtained thus correspond to the first 3 symmetrical modes of buckling:

· Mode 1 of the quarter of the plate = Mode 1 of all the plate
· Mode 2 of the quarter of the plate = Mode 3 of all the plate
· Mode 3 of the quarter of the plate = Mode 5 of all the plate

2.3
Uncertainty on the solution

Exact solution for a theory of plate without transverse shearing.

2.4 References
bibliographical

[1]
J.G. EISLEY "Mechanics of Elastic Structures: Classical years Finite Methods Element". Prentice Hall, Englewood Cliffs N.J. 07632 (19XX).
[2]
"Stability of Square Punt Biaxial Under Loading". The the SAMCEF software User' S Manuals V7.1. (1998).
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLS110 Stability of a compressed square plate

Date:
03/01/00
Author (S):

3 Modeling With

3.1 Characteristics of modeling

MEC3QU9H (hull 3D)

4
3
1
2

modeling COQUE_3D

3.2 Characteristics of the grid

A number of nodes: 121

A number of meshs and types: 25 QUAD9

3.3 Functionalities tested

Orders

Keys
AFFE_MODELE
"MECHANICAL"
"COQUE_3D"
ALL
[U4.22.01]
AFFE_CARA_ELEM
HULL

A_CIS
[U4.24.01]
THICK

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_ARETE
GROUP_MA

CALC_MATR_ELEM
“RIGI_GEOM”
[U4.41.01]
MODE_ITER_SIMULT
“PLUS_PETITE”
[U4.52.02]

4
Results of modeling A

4.1 Values tested

Identification Reference Aster %
difference

mode 1
3.79600E+02 3.78520E+02 0.987
mode 2
1.05444E+03 1.04904E+03 0.512
mode 3
2.56609E+03 2.57466E+03 +0.334

4.2 Remarks

Energy due to transverse shearing is not neglected.

4.3 Parameters of execution

Version: 5.02.20

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 13.30 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLS110 Stability of a compressed square plate

Date:

5 Modeling B

5.1 Characteristics of modeling

MEC3TR7H (COQUE_3D)

4
3
1
2

modeling COQUE_3D

5.2 Characteristics of the grid

A number of nodes: 641

A number of meshs and types: 200 TRIA7

5.3 Functionalities tested

Orders

Keys
AFFE_MODELE
“MECHANICAL”
“COQUE_3D”
ALL
[U4.22.01]
AFFE_CARA_ELEM

HULL
A_CIS
[U4.24.01]
THICK

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_ARETE
GROUP_MA

CALC_MATR_ELEM
“RIGI_GEOM”
[U4.41.01]
MODE_ITER_SIMULT
“PLUS_PETITE”
[U4.52.02]

6
Results of modeling B

6.1 Values
tested

Identification Reference Aster %
difference

Mode 1
3.79600E+02 3.77689E+02 0.503
Mode 2
1.05444E+03 1.05744E+03 +0.284
mode 3
2.56609E+03 2.58295E+03 +0.657

6.2 Remarks

Energy due to transverse shearing is not neglected.

6.3 Parameters
of execution

Version: 5.02.20

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 48.06 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLS110 Stability of a compressed square plate

Date:

7
Summary of the results

The results obtained are very satisfactory for the two types of elements, QUAD9 and TRIA7, even if it is necessary to employ a greater number of elements triangles.

Organization (S): EDF/AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.111

SSLS111 - Simple Excentremement of plate

Summary:

This test makes it possible to validate the offsetting of the simple plates (i.e it acts neither of multi-layer, nor of one homogenized behavior).

The reference is given by a first resolution where one models double-layered made up of 2 materials.

The validation is done in the second calculation where one models the 2 layers of the preceding model by 2 plates offset compared to the average plan of the first calculation.

Three modelings are used: DKT, DST (meshs QUAD4) DST (meshs TRIA3).

1
Problem of reference

1.1 Geometry

A3

5 subdivisions

Z y
GRN011
0.2
m

A2
0.2
m
A1
10
subdivisions
X

The co-ordinates of the points are:

A1 (0,0,0)
A3 (10,5,0)
A2 (10,0,0)
A4 (0,5,0)

1.2
Material properties

The material is double-layered.

The material constituting the first layer is orthotropic and is characterized by the data following:

EL = 20000.MPa
AND = 20000.MPa
VLT = 0.3
GLT = 2000.MPa.

The material constituting the second layer is also orthotropic and is characterized by the data following:

EL = 15000.MPa
AND = 15000.MPa
VLT = 0.3
GLT = 1500.MPa

1.3
Boundary conditions and loadings

The A1 node is embedded:

dx = 0.
Dy = 0.
dz = 0.

dRx = 0.
DRy = 0.
DRz=0.

The A2 node is blocked according to following ddls:

dx = 0.
Dy = 0.

One applies a nodal force Fz = 1000 to the A3 node.

In addition, one applies to the meshs M1, m2 and m3 (see drawing) the loading distributed (key word Force_coque) according to:

Fx = 200 N/m2, Fy = 500 N/m2, Fz = 500 N/m2, MX = 100 N/m, My = 40 N/m

in the plan of the grid.

2
Reference solution

2.1
Method of calculation used for the reference solution

Calculation with double-layered material is used as reference. Nonregression of the results obtained for it *the first calculation is checked.*

2.2
Results of reference

They are consisted of the values of the field of displacement DX, DY, DZ, DRX, DRY at the point A3 (node
N1 for ASTER) and at the point of co-ordinates (9,2,0).

One compares also the efforts with the A1 point.

In addition, the 4 smaller frequencies of the structure are calculated.

2.3
Uncertainty on the solution

Null since it is about the same calculation carried out by two different ways.

---

3 Modeling
With

3.1

Characteristics of modeling

The model consists of 2 plates corresponding to the average plan of the 2 layers of the model of reference.

***To represent these 2 plates, one leaves the grid of the average plan of double-layered which one offsets
distances 0.1 and 0.1.***

***PLAQ1
The elements used are elements of***

plate DKQ.

PLAQ 2

***+ 0.1
-
0.1***

***3.2
Characteristics of the grid***

***Z
y
5***

***10
X***

***The grid is regular. There are 10 subdivisions according to X and 5 subdivisions according to y; that is to say on the whole 50 meshs
DKQ (quad4) and 66 nodes.***

***3.3 Functionalities
tested***

Order

Key word factor key Word

AFFE_CARA_ELEM
Offsetting
AFFE_CHAR_MECA
Force_coque
PLAN

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
Difference
DX (N1)
-7.9818
-7.9818
0
DY (N1)

-1.1477
-1.1477
0
DZ (N1)
-6330
-6330
0
DRX (N1)
-454.433
-454.433
0
DRY (N1)
566.451
566.451
0
DX (N10)
-4.5814
-4.5814
0
DY (N10)
-1.8758
-1.8758
0
DZ (N10)
-4466
-4466
0
DRX (N10)
-430.09
-430.09
0
DRY (N10)
512.163
512.163
0
Frequency 1st mode
9.5393.10-4 9.5393.10-4 0
Frequency 2nd mode
3.7115.10-3 3.7115.10-3 0
Frequency 3rd mode
8.2208.10-3 8.2208.10-3 0
Frequency 4th mode
1.6837.10-2

1.6837.10-2
0
NXX
2.2024.104 2.2024.104
0
NYY
-2.4402.103 -2.4402.103
0
NXY
1.0581.103 1.0581.103
0
MXX
4.1733.104 4.1733.104
0
MYY
1.8444.104 1.8444.104
0
MXY
6.3333.103 6.3333.103
0
QX
-3.193.104 -3.193.104
0
QY
-1.4346.104 -1.4346.104
0

---

5 Modeling B

5.1 Characteristic of modeling

The model is the same one as that of modeling A, with this close that instead of having elements of plate DKQ, one has elements DSQ.

5.2 Characteristic of the grid

Z
y
5

10
X

The grid is regular. There are 10 subdivisions according to X and 5 subdivisions according to y; that is to say on the whole 50 meshs DSQ and 66 nodes.

5.3 Functionalities tested

Order
Key word factor key Word

AFFE_CARA_ELEM
Offsetting
AFFE_CHAR_MECA
Force_coque

PLAN
AFFE_MODELE
AFFE
MODELING = DST

6
Result of modeling B

6.1 Values
tested

Identification Reference
Aster %
Difference
DEPL DX N1
7.98940E06
8.01344E06
0.301
DEPL DY N1
1.17388E06
1.19166E06
1.514

DEPL DZ N1
6.35573E03
6.37537E03
0.309
DEPL DRX N1
4.42621E04
4.39613E04
-0.679
DEPL DRY N1
5.72702E04
5.75565E04
0.500
DEPL DX N10
4.62813E06
4.65034E06
0.480
DEPL DY N10
1.88945E06
1.90341E06
0.739
DEPL DZ N10
4.52107E03
4.54691E03
0.572
DEPL DRX N10
4.17874E04
4.14602E04
-0.783
DEPL DRY N10
5.19527E04
5.22722E04
0.615
EFGE NXX N60
1.62953E+04
1.53979E+04
-5.507
EFGE NYY N60
4.50035E+03
5.11922E+03
13.752
EFGE NXY N60
9.91495E+02
9.30980E+02

-6.103
EFGE MXX N60
3.63645E+04
3.56107E+04
-2.073
EFGE MYY N60
1.59599E+04
1.56220E+04
-2.118
EFGE MXY N60
6.31716E+03
6.32614E+03
0.142
EFGE QX N60
2.07352E+04
1.90500E+04
-8.127
EFGE QY N60
1.04743E+04
1.01187E+04
-3.395
MODE 1
9.50214E-01
9.48127E-01
-0.220
MODE 2
3.61805E+00
3.58389E+00
-0.944
MODE 3
8.16228E+00
8.13462E+00
-0.339
MODE 4
1.65440E+01
1.64359E+01
-0.653

6.2 Remarks

There is a difference (not explained) on this modeling between the value of reference (double-layered) and
two offset plates.

---

7 Modeling C

7.1 Characteristics of modeling

The model is the same one as that of modeling A, with this close that instead of having elements of plate DKQ, one has DST elements. (DST Modeling with meshs TRIA3).

7.2 Characteristics of the grid

Z
y
5

10
X

The grid is regular. There are 10 subdivisions according to X and 5 subdivisions according to y; that is to say on the whole 100
DST meshs and 66 nodes.

7.3 Functionalities
tested

Order
Key word factor key Word

AFFE_CARA_ELEM
Offsetting
AFFE_CHAR_MECA
Force_coque
PLAN
AFFE_MODELE
AFFE
MODELING = DST

8

Result of modeling C

8.1 Values tested

Identification Reference Aster % Difference

DEPL DX N66
6.49678E06
6.50205E06
0.081
DEPL DY N66
6.08932E07
6.10332E07
0.230
DEPL DZ N66
5.33844E03
5.36043E03
0.412
DEPL DRX N66
4.29182E04
4.29587E04
0.095
DEPL DRY N66
4.75601E04
4.77482E04
0.395
DEPL DX N53
3.58293E06
3.58709E06
0.116
DEPL DY N53
1.18788E06
1.19013E06
0.190
DEPL DZ N53
3.63885E03
3.65793E03
0.524
DEPL DRX N53
4.05175E04

4.05324E04
0.037
DEPL DRY N53
4.23116E04
4.25311E04
0.519
EFGE NXX N6
1.70005E+04
1.68443E+04
-0.918
EFGE NYY N6
1.14438E+04
1.12660E+04
-1.554
EFGE NXY N6
3.53598E+03
3.57111E+03
0.993
EFGE MXX N6
2.14585E+04
2.13070E+04
-0.706
EFGE MYY N6
1.53094E+04
1.51378E+04
-1.121
EFGE MXY N6
5.71331E+03
5.76258E+03
0.862
EFGE QX N6
3.03380E+03
2.81593E+03
-7.181
EFGE QY N6
1.76436E+03
1.78725E+03
1.297
MODE 1
1.01181E+00
1.00910E+00
-0.268
MODE 2

4.27003E+00
4.26070E+00
-0.218
MODE 3
8.39151E+00
8.36517E+00
-0.314
MODE 4
1.72305E+01
1.71358E+01
-0.549

8.2 Remarks

As for modeling B, one notes a difference between the solution obtained for a hull double-layered and that resulting from two offset full-course hulls, without it being possible at the time drafting of the test to determine from which the variation comes.

9
Summary of the results

With regard to modeling A (DKT) results obtained with two full-course hulls offset coincide perfectly with those obtained by a double-layered hull, as well in terms displacements, that generalized efforts or Eigen frequencies. This thus validates offsetting by hulls DKT.

On the other hand, modelings B and C, both with DST hulls, reveal one difference between the two ways of carrying out calculation. This one is lower than 1,5% with regard to displacements and frequencies, which remains reasonable.

On the other hand, there are variations on the efforts going up to 7% for modeling C (DST triangles) and 14% for modeling B (DST quadrangles).

This variation is not explained and one cannot know a priori if it is due to offsetting for DST modelings or with the multi-layer hulls DST.

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.112

SSLS112 - Offsetting of composite plates

Summary:

This test makes it possible to validate the offsetting of composite plates.

The reference is given by a first resolution where one models a quadricouche presenting one material not-symmetry compared to the average plan.

The validation is done in the second calculation where one models the quadricouche preceding model by
2 double-layered offset compared to the average plan of the first calculation.

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

---

1 Problem of reference

1.1 Geometry

A4
A3
5 subdivisions

Z
A1
A2
y

0,4

10 subdivisions

X

co-ordinates of the points (in m): A1 (0,0,0)
A2 (10,0,0) A3 (10,5,0) A4 (0,5,0)

1.2
Material properties

The material consists of 4 orthotropic layers thickness 0.1.

The first layers is characterized by:
EL = 20000.106 Pa
AND = 20000.106 Pa
VLT = 0.3
GLT = 2000.106 Pa

the second layer by:
EL = 15000.106 Pa
AND = 15000.106 Pa
VLT = 0.3
GLT = 1500.106 Pa

the third layer by:
EL = 20000.106 Pa
AND = 20000.106 Pa
VLT = 0.3
GLT = 2000.106 Pa

and the fourth layer by:
EL = 15000.106 Pa
AND = 15000.106 Pa
VLT = 0.3
GLT = 1500.106 Pa

1.3
Boundary conditions and loadings

The A1 node is embedded:

dx = 0.
Dy = 0.
dz = 0.

dRx = 0.
dRy = 0.

dRz = 0.

The A2 node is blocked according to following ddls:

dx = 0.
Dy = 0.

One applies a modal force Fz = -1000.N to the A3 node.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution results from the first calculation with ASTER with the quadricouche describes in
the problem of reference.

2.2
Results of reference

They are consisted of the values of the field of displacement DX, DY, DZ, DRX, DRY at the A3 point
(N1 node for ASTER) and with the N10 node of co-ordinates (9,2,0).

2.3
Uncertainty on the solution

Null, since it is about the same calculation carried out by two different ways.

3 Modeling
With

3.1
Characteristics of modeling

The model consists of 2 double-layered plates corresponding to the average plan of the quadricouche of
model of reference.

To represent these 2 plates, one leaves the grid of the average plan of the quadricouche which one offsets
distances -0.1 and 0.1.

PLAQ1
The elements used are elements of

plate DKT.

PLAQ
2

+
0.1
-
0.1

3.2
Characteristics of the grid

Z

y

5

5
X

The grid is regular.
There are 10 subdivisions according to X and 5 subdivisions according to y; that is to say on the whole 50 meshs DKQ (quad4) and 66 nodes.

3.3 Functionalities tested

Order Mot
key

AFFE_CARA_ELEM
Offsetting

4
Result of modeling A

4.1 Values tested

Identification	*Reference (*10-6m)*	*ASTER (*10-6m)*	*% Difference*
DX (N1)	*-3.680419*	*-3.680419*	*0*
DY (N1)	*-0.493941*	*-0.493941*	*0*
DZ (N1)	*-5697.7635*	*-5697.7635*	*0*
DRX (N1)	*-436.1676*	*-436.1676*	*0*
DRY (N1)	*508.6670*	*508.6670*	*0*
DX (N10)	*-2.172360*	*-2.172360*	*0*
DY (N10)	*-0.783905*	*-0.783905*	*0*
DZ (N10)	*-3946.2632*	*-3946.2632*	*0*

DRX (N10)
-412.1209
-412.1209
0
DRY (N10)
455.0638
455.0638
0

5 Synthesis

The results obtained with offset multi-layer plates agree with the reference.

This test thus validates offsetting for the multi-layer plates.

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.113

SSLS113 - Offsetting of plates
homogenized

Summary:

This test makes it possible to validate the offsetting of the plates having a behavior "ELAS_COQUE".

The reference is given by a first resolution where one models double-layered orthotropic not having one
material symmetry compared to the average plan.

The validation is done in the second calculation where one models the behavior of the preceding plate by 2
offset full-course plates having a behavior "ELAS_COQUE".

1
Problem of reference

1.1 Geometry

N60 GRNO13
N87

0,7071m

Z

N1
GRNO11
N28
0,1m
y

0,1m

0,7071m
X

Co-ordinates of the points:

N1 (0,0,0)
N87 (0,7071,0.7071, 0)

N28 (0,7071,0,0)
N60 (0,0.7071, 0)

1.2

Material properties

The material is double-layered.

The material constituting the first layer is orthotropic and is characterized by the data following:

EL = 6800. Pa
AND = 6800.Pa
VLT = 0.35
GLT = 2530.Pa.

The material constituting the second layer is also orthotropic and is characterized by following data:

EL = 14000.Pa
AND = 14000.Pa
VLT = 0.144
GLT = 2070.Pa.

1.3
Boundary conditions and loadings

Side N1N28 (GRN011) is embedded:

dx = 0.
Dy = 0.
dz = 0.

dRx = 0.
dRy = 0.
dRz = 0.

One imposes the ddls dx and Dy of the nodes on the side N80N60 (GROUPNO GRN013) on the values following:

dx = 0.07071 m,
Dy = 0.07071 m

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution results from the first calculation with ASTER with the double-layered one describes in
problem of reference.

2.2
Results of reference

They are consisted of the values of the field of displacement to the N1 node of co-ordinates (0, .0. , 0.) (ddl
DZ) and with the N10 node of co-ordinates (0.216760, 0.0764431, 0.).

2.3
Uncertainty on the solution

Null, since it is about the same calculation carried out by two different ways.

3 Modeling

3.1
Characteristics of modeling

The model consists of 2 plates corresponding to the average plan of the 2 layers of the model of *reference.*

To represent these 2 plates, one leaves the grid of the average plan of double-layered which one offsets distances -0.05 m and 0.05 Mr.

PLAQ1
The elements used are elements of

plate DKT.

PLAQ
2

+
0.05
-
0.05

One assigns behavior "ELAS_COQUE" to each one of these plates corresponding to homogenized orthotropic behavior of the corresponding layer.

The values of the coefficients material introduced under "ELAS_COQUE" were calculated directly [U4.43.01], page 27.

3.2
Characteristics of the grid

The model has 87 triangular nodes and 140 elements DKT.

3.3 Functionalities
tested

Order Mot
key

AFFE_CARA_ELEM
Offsetting

DEFI_MATERIAU
ELAS_COQUE

4 Result of modeling A

4.1 Values tested

Identification	***Reference***	***ASTER***	***% Difference***
DZ (N1)	*-0.169388*	*-0.169388*	*0*
DX (N10)	*0.008962*	*0.008962*	*0*
DY (N10)	*0.008170*	*0.008170*	*0*
DZ (N10)	*0.163598*	*0.163598*	*0*
DRX (N10)	*4.196430*	*4.196428*	*0*
DRY (N10)	*-0.050793*	*-0.050793*	*0*

4.2 Remarks

No the error compared to double-layered orthotropic.

5 Synthesis

The results show the good taking into account of offsetting for ELAS_COQUE.

V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.114

SSLS114 - Not regression on quarter of ring
cylindrical

Summary:

It is about a test of mechanics in linear statics.

The goal is to test the setting under pressure of a cylindrical quarter of binding ring with the elements of hull and of
plate.

1
Problem of reference

1.1
Properties of materials

E = 200.000 MPa

= 0.3
3
=
.
1234 kg/m for modelings I, J and K.

1.2 Characteristics
geometrical

One notes:

.
R = 0 975
.

m the interior ray of the cylinder;
1
.
R = 1025
.

m the ray external of the cylinder;
2
· R = 1 m the average radius of the cylinder equal to the half the sum of the two preceding rays;
· E = 0 0
. 5 m the radial thickness of the cylinder;
· H = 0 5
. m the height of the cylinder.

1.3
Boundary conditions and loadings mechanical

Conditions of Dirichlet

DDL_IMPO, the nodes blocked depend on modeling.

pressure on the elements of hull and plate: P = 10 MPa on the cylinder

PRES_REP
FORCE_COQUE (real or given by a function)
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

2
Reference solution

Analytical solution.

2.1
Results of reference

Displacement of the average layer

Constraints of the average layer, layers superior and inferior.

In modelings I, J and K, one calculates the mass, the co-ordinates of the centre of gravity and them terms of the matrix of inertia. The analytical expressions are given in documentation [R3.07.02].

2.1.1 Method of calculation used for the reference solution in displacements and constraints

Into incompressible:

B
U
=
(1+)
a2 b2

R

R
with B =
P

2
2
U = U
E
= 0
(B - has)

Z

B
rr = - r2

B

= +

R

2
R = zz = 0

a2

b2
J
= P
1

rr
-

b2 - a2
r2

a2

b2
J = P
1+

b2 - a2
r2

R = 0

a2

= 2 P
zz

b2 - a2

Passage in the Cartesian system:

2
2
xx
= rr cos + sin - 2 R sin cos

2
2
yy
= rr sin + cos + 2 R sin cos

2
2
xy
= rr sin cos - sin cos - 2 R (cos sin)

2.1.2 Determination of the masses, centre of gravity and tensor of inertia

For modeling I of hull type of revolution around an axis OZ

· the mass is worth: M = H (R2 - R2) 2
;
2
1
= H
er

X 0
G

· the co-ordinates of the centre of gravity are: y
=
0
;
G

Z H/
2
G

· the tensor of inertia compared to O is worth:

MR2
1 E
M

1
[+
2
( )] +
H2
0
0

I
I
I
2
4 R

3

xx
xy
xz

MR2
1 E
M

2
2

I
I
I =
0
1
[+ ( )] +
H
0

xy

yy
yz

2
4 R

3
I
I
I

1

xz
yz
zz
E

0
0
MR2 1
[+
2
( )
]

4 R

· *the tensor of inertia compared to G is worth:*

MR2
1 E
M

1
[+
2
( )] +
H2
0
0

I
I
I
2
4 R

12

xx
xy
xz

MR2
1 E
M

2
2

I
I
I =
0
1
[+ ( )] +
H
0
xy
yy
yz

2
4 R

12
I
I
I

1

xz
yz
zz
E

0
0
MR2 1
[+
2
( )
]

4 R

For modelings J and K where the trace of a quarter of cylinder of cross-section around an axis OZ on one
plan perpendicular to this axis is represented

(R
)
1 + R2

· the mass per unit height is worth: M =
E = Re;
2
2
2

2
1 E 2
X
R

1
[+
( )
]
·
G

12 R
the co-ordinates of the centre of gravity are:
=

y
2
1 E
G
R 1
[+
2

( )]
12 R

· the tensor of inertia compared to O is worth:

M
1
2
2
2
E
M
1
2

E

R 1
[+
]
R 1
[
]
0

2
4
+

4
I
I
I

R
R

xx
xy
xz

M
1
2
2
2
E
M
1
2
E

I
I
I =
R 1
[+

]
R 1
[
]
0

xy
yy
yz

4 R
+
2
4 R

I
I
I

xz
yz
zz

1
2
2
E

0
0
MR. 1
[+
]

4 R

· the tensor of inertia compared to G is worth:

M
1

2
2

2
E
M
1
2
2
E

R 1
[+
] My
R 1
[
] MX y
0

G
G G

2
4 -
+

4 -
I
I
I
R
R

xx
xy
xz

M
1
2
2

2
E

M
1
2
E
I
I
I =
R 1
[+
] MX y
R 1
[
] Mx2
0

xy
yy
yz

4 R
G G

-
+
2
4 R
G

-
I
I
I

xz
yz
zz

1
2

2
E

0
0
MR. 1
[+
] M (x2
y2)

4 R
G

-
+ G

Note:

E
In practice, one neglects the terms in () 2 in these expressions.
R

---

3 Modeling
With

3.1

Characteristics of the grid
Pa
PB
PC
PD

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
Pa
-1.
0.
5.0E-01
PB
-1.
0.
0.
PC
0.
-1.
5.0E-01
PD
0.
-1.
0.

Characteristics of the elements:

Types of meshs:
24 COQUE_3D
24
TRIA7

Boundary conditions:

Group meshs AB:
- displacement following the axis Y: DY = 0
- rotation around axis X: DRX = 0
- rotation around axis Z: DRZ = 0
Group meshs CD:
- displacement following axis X: DX = 0
- rotation around the axis Y: DRY = 0

- rotation around axis Z: DRZ = 0
Group nodes PB:
- displacement following axis Z: DZ = 0

with AB the group of meshs connecting Pa and PB
and CD that connecting PC and PD

3.2
Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

4
Results of modeling A

4.1 Values
tested

In a systematic way, one takes the values of displacements and the constraints on node Pa

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

Average layer
9.81907 1010
-9.49753 10-10
-3.275%

Constraints (SIXX)

Average layer
194.93754
196.22121
0.659%
Higher layer
200.125
248.5679
24.206%
Lower layer
190.125
143.8745
-24.326%
FORCE_COQUE
Displacements

(REALITY)
Average layer
-9.81907 10-10
-9.49753 10-10
-3.275%

Constraints (SIXX)

Average layer
194.93754
196.22121
0.659%
Higher layer
200.125
248.5679
24.206%
Lower layer
190.125
143.8745
-24.326%
FORCE_COQUE
Displacements

(FUNCTION)
Average layer
-9.81907 10-10
-9.49753 10-10
-3.275%

Constraints
(SIXX)

Average layer
194.93754
196.22121
0.659%
Higher layer
200.125
248.5679
24.206%
Lower layer
190.125
143.8745
-24.326%

Handbook of Validation

---

5 Modeling
B

5.1
Characteristics of the grid

Pa
PB
PC
PD

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
Pa
-1.
0.
5.0E-01
PB
-1.
0.
0.
PC
0.

-1.
5.0E-01
PD
0.
-1.
0.

Characteristics of the elements:

Types of meshs:
12 COQUE_3D
12
QUAD9

Boundary conditions:

Group meshs AB:
- displacement following the axis Y: DY = 0
- rotation around axis X: DRX = 0
- rotation around axis Z: DRZ = 0
Group meshs CD:
- displacement following axis X: DX = 0
- rotation around the axis Y: DRY = 0
- rotation around axis Z: DRZ = 0
Group nodes PB:
- displacement following axis Z: DZ = 0

with AB the group of meshs connecting Pa and PB
and CD that connecting PC and PD

5.2
Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

6
Results of modeling B

6.1 Values tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

Average layer
9.81907 1010
-9.9465 10-10
1.298%

Constraints (SIXX)

Average layer
194.93754
199.36962
2.274%

Higher layer
200.125
204.3322
2.102%
Lower layer
190.125
194.406
2.252%
FORCE_COQUE
Displacements

(REALITY)
Average layer
-9.81907 10-10
-9.9465 10-10
1.298%

Constraints (SIXX)

Average layer
194.93754
199.36962
2.274%
Higher layer
200.125
204.3322
2.102%
Lower layer
190.125
194.406
2.252%
FORCE_COQUE
Displacements

(FUNCTION)
Average layer
-9.81907 10-10
-9.9465 10-10

1.298%

Constraints
(SIXX)

Average layer
194.93754
199.36962
2.274%
Higher layer
200.125
204.3322
2.102%
Lower layer
190.125
194.406
2.252%

---

7 Modeling
C

7.1
Characteristics of the grid

Pa
PB
PC
PD

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
Pa
-1.
0.
5.0E-01
PB
-1.
0.
0.
PC
0.
-1.
5.0E-01
PD
0.
-1.
0.

Characteristics of the elements:

Types of meshs:
12 DKT
12
DST

Boundary conditions:

Group meshs AB:
- displacement following the axis Y: DY = 0
- rotation around axis X: DRX = 0
- rotation around axis Z: DRZ = 0
Group meshs CD:
- displacement following axis X: DX = 0
- rotation around the axis Y: DRY = 0

- rotation around axis Z: DRZ = 0
Group nodes PB:
- displacement following axis Z: DZ = 0

with AB the group of meshs connecting Pa and PB
and CD that connecting PC and PD

7.2
Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

8
Results of the modélistaion C

8.1 Values
tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

Average layer
9.81907 1010
-9.91444 10-10
0.971%

Constraints (SIXX)

Average layer
194.93754
198.28897
1.719%
Higher layer
200.125
198.28897
-0.917%
Lower layer
190.125
198.28897
4.294%
FORCE_COQUE
Displacements

(REALITY)
Average layer
-9.81907 10-10
-9.91444 10-10
0.971%

Constraints (SIXX)

Average layer
194.93754
198.28897
1.719%
Higher layer
200.125
198.28897
-0.917%
Lower layer
190.125
198.28897
4.294%
FORCE_COQUE
Displacements

(FUNCTION)
Average layer
-9.81907 10-10
-9.91444 10-10
0.971%

Constraints
(SIXX)

Average layer
194.93754
198.28897
1.719%
Higher layer
200.125
198.28897
-0.917%
Lower layer
190.125
198.28897
4.294%

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9 Modeling D

9.1 Characteristics of the grid

Pa
PB
PC
PD

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
Pa
-1.
0.
5.0E-01
PB
-1.
0.
0.
PC
0.
-1.

5.0E-01
PD
0.
-1.
0.

Characteristics of the elements:

Types of meshs:
6 DKQ
6
DSQ

Boundary conditions:

Group meshs AB:
- displacement following the axis Y: DY = 0
- rotation around axis X: DRX = 0
- rotation around axis Z: DRZ = 0
Group meshs CD:
- displacement following axis X: DX = 0
- rotation around the axis Y: DRY = 0
- rotation around axis Z: DRZ = 0
Group nodes PB:
- displacement following axis Z: DZ = 0

with AB the group of meshs connecting Pa and PB
and CD that connecting PC and PD

9.2
Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

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V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

Code_Aster ®

10 Results of modeling D

10.1 Values
tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

Average layer
9.81907 1010
-9.91444 10-10
0.971%

Constraints (SIXX)

Average layer
194.93754
198.28897
1.719%
Higher layer
200.125

198.28897
-0.917%
Lower layer
190.125
198.28897
4.294%
FORCE_COQUE
Displacements

(REALITY)
Average layer
-9.81907 10-10
-9.91444 10-10
0.971%

Constraints (SIXX)

Average layer
194.93754
198.28897
1.719%
Higher layer
200.125
198.28897
-0.917%
Lower layer
190.125
198.28897
4.294%
FORCE_COQUE
Displacements

(FUNCTION)
Average layer
-9.81907 10-10
-9.91444 10-10
0.971%

Constraints
(SIXX)

Average layer
194.93754
198.28897
1.719%
Higher layer
200.125
198.28897
-0.917%
Lower layer
190.125
198.28897
4.294%

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---

11 Modeling E

11.1 Characteristics of the grid

PA_sup
PA_inf
PB_inf
PC_inf
PC_sup
PD_inf
PD_sup

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
PA_inf
-9.75E-01
0.
5.0E-01
Pa
-1.
0.
5.0E-01
PA_sup
-1.025E+00

0.
5.0E-01
PB_inf
-9.75E-01 0.
0.
PB
-1.
0.
0.
PB_sup
-1.025E+00
0.
0.
PC_inf
0.
-9.75E-01
5.0E-01
PC
0.
-1.
5.0E-01
PC_sup
0.
-1.025E+00
5.0E-01
PD_inf
0.
-9.75E-01
0.
PD
0.
-1.
0.
PD_sup
0. -1.025E+00
0.

Characteristics of the elements:

Types of meshs:
24 meshs linear Hexa_8 3D

Boundary conditions:

Group meshs S_AB:
- displacement following the axis Y: DY = 0
- displacement following axis Z: DZ = 0
Group meshs S_CD:
- displacement following axis X: DX = 0
- displacement following axis Z: DZ = 0

11.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

AFFE_CHAR_MECA_F PRES_REP

---

12 Results of modeling E

12.1 Values
tested

Key word
Identification
Reference
Aster Difference

PRES_REP
Displacements

(REALITY)
Average layer
-9.81907 10-10 -9.67127098 10-10
-1.505%
Lower layer
-9.90234 10-10 -9.78335202 10-10
-1.202%
Higher layer
-9.81907 10-10 -9.567175895 10-10
-2.565%

Constraints (SIYY)

Average layer
194.93754
211.10227
8.292%
Lower layer
200.125
217.9814
8.923%
Higher layer
190.125
204.62504
7.627%
PRES_REP
Displacements

(FUNCTION)
Average layer
-9.81907 10-10 -9.671270 10-10
-1.505%
Lower layer
-9.90234 10-10 -9.78335202 10-10
-1.202%
Higher layer

-9.81907 10-10 -9.5671758 10-10
-2.565%

Constraints (SIYY)

Average layer
194.93754
211.10227
8.292%
Lower layer
200.125
217.98146
8.923%
Higher layer
190.125
204.62504
7.627%

13 Modeling
F

13.1 Characteristics of the grid

PA_sup
PA_inf
PB_inf
PC_inf
PC_sup
PD_inf
PD_sup

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
PA_inf
-9.75E-01
0.
5.0E-01
Pa
-1.
0.
5.0E-01
PA_sup
-1.025E+00
0.
5.0E-01
PB_inf
-9.75E-01 0.
0.
PB
-1.
0.
0.
PB_sup
-1.025E+00
0.
0.
PC_inf
0.
-9.75E-01
5.0E-01
PC
0.
-1.

5.0E-01
PC_sup
0.
-1.025E+00
5.0E-01
PD_inf
0.
-9.75E-01
0.
PD
0.
-1.
0.
PD_sup
0. -1.025E+00
0.

Characteristics of the elements:

Types of meshs:
48 linear meshs PENTA6 3D

Boundary conditions:

Group meshs S_AB:
- displacement following the axis Y: DY = 0
- displacement following axis Z: DZ = 0
Group meshs S_CD:
- displacement following axis X: DX = 0
- displacement following axis Z: DZ = 0

13.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

AFFE_CHAR_MECA_F PRES_REP

14 Results of modeling F

14.1 Values tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

(REALITY)
Average layer
9.81907 1010
-9.454821 10-10
-3.710%
Lower layer
9.90234 1010
-9.5731464 10-10
-3.324%
Higher layer
9.81907 1010
-9.34578869 10-10
-4.820%

Constraints (SIYY)

Average layer
194.93754
193.619011
-0.676%
Lower layer
200.125
200.724933
0.300%
Higher layer
190.125
186.858348
-1.718%
PRES_REP
Displacements

(FUNCTION)
Average layer
9.81907 1010
-9.454821 10-10
-3.710%
Lower layer
9.90234 1010
-9.5731464 10-10
-3.324%
Higher layer
9.81907 1010
-9.34578869 10-10
-4.820%

Constraints (SIYY)

Average layer
194.93754
193.619011
-0.676%
Lower layer
200.125
200.724933

0.300%
Higher layer
190.125
186.858348
-1.718%

15 Modeling G

15.1 Characteristics of the grid

PA_sup
PA_inf
PB_inf
PC_inf
PC_sup
PD_inf
PD_sup

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y

Coor_z
PA_inf
-9.75E-01
0.
5.0E-01
Pa
-1.
0.
5.0E-01
PA_sup
-1.025E+00
0.
5.0E-01
PB_inf
-9.75E-01 0.
0.
PB
-1.
0.
0.
PB_sup
-1.025E+00
0.
0.
PC_inf
0.
-9.75E-01
5.0E-01
PC
0.
-1.
5.0E-01
PC_sup
0.
-1.025E+00
5.0E-01
PD_inf
0.
-9.75E-01
0.
PD
0.
-1.

0.
PD_sup
0. -1.025E+00
0.

Characteristics of the elements:

Types of meshs:
24 quadratic meshs HEXA_20 3D

Boundary conditions:

Group meshs S_AB:
- displacement following the axis Y: DY = 0
- displacement following axis Z: DZ = 0
Group meshs S_CD:
- displacement following axis X: DX = 0
- displacement following axis Z: DZ = 0

15.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

AFFE_CHAR_MECA_F PRES_REP

19/28

16 Result of modeling G

16.1 Values tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

(REALITY)
Average layer
9.81907 1010
-9.6611705 10-10
-1.608%
Lower layer
9.90234 1010
-9.7808343 10-10
-1.227%
Higher layer
9.81907 1010
-9.5508891 10-10
-2.731%

Constraints (SIYY)

Average layer
194.93754
219.59661
12.650%
Lower layer
200.125
226.83032
13.344%
Higher layer

190.125
211.09036
11.027%
PRES_REP
Displacements

(FUNCTION)
Average layer
9.81907 1010
-9.6611705 10-10
-1.608%
Lower layer
9.90234 1010
-9.7808343 10-10
-1.227%
Higher layer
9.81907 1010
-9.5508891 10-10
-2.731%

Constraints (SIYY)

Average layer
194.93754
219.59661
12.650%
Lower layer
200.125
226.83032
13.344%
Higher layer
190.125
211.09036
11.027%

17 Modeling
H

17.1 Characteristics of the grid

PA_sup
PA_inf
PB_inf
PC_inf
PC_sup
PD_inf
PD_sup

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Coor_z
PA_inf
-9.75E-01
0.
5.0E-01
Pa
-1.
0.
5.0E-01
PA_sup
-1.025E+00

0.
5.0E-01
PB_inf
-9.75E-01 0.
0.
PB
-1.
0.
0.
PB_sup
-1.025E+00
0.
0.
PC_inf
0.
-9.75E-01
5.0E-01
PC
0.
-1.
5.0E-01
PC_sup
0.
-1.025E+00
5.0E-01
PD_inf
0.
-9.75E-01
0.
PD
0.
-1.
0.
PD_sup
0. -1.025E+00
0.

Characteristics of the elements:

Types of meshs:
48 quadratic meshs PENTA15 3D

Boundary conditions:

Group meshs S_AB:
- displacement following the axis Y: DY = 0
- displacement following axis Z: DZ = 0
Group meshs S_CD:
- displacement following axis X: DX = 0
- displacement following axis Z: DZ = 0

17.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

AFFE_CHAR_MECA_F PRES_REP

---

18 Results of modeling H

18.1 Values
tested

Key word
Identification
Reference
Aster Difference

PRES_REP
Displacements

(REALITY)
Average layer
9.81907 1010
-9.6609841 10-10
-1.610%
Lower layer
9.90234 1010
-9.787884 10-10
-1.156%
Higher layer
9.81907 1010
-9.5539546 10-10
-2.700%

Constraints (SIYY)

Average layer
194.93754
214.780477
10.179%
Lower layer
200.125
242.54015
21.194%
Higher layer
190.125
186.1681
-2.081%
PRES_REP
Displacements

(FUNCTION)
Average layer
9.81907 1010
-9.6609841 10-10
-1.610%

Lower layer
9.90234 1010
-9.787884 10-10
-1.156%
Higher layer
9.81907 1010
-9.5539546 10-10
-2.700%

Constraints (SIYY)

Average layer
194.93754
214.780477
10.179%
Lower layer
200.125
242.54015
21.194%
Higher layer
190.125
186.1681
-2.081%

---

19 Modeling
I

19.1 Characteristics of the grid

Pa

PB

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Pa
1.0
0.5

PB
1.0 0.

Characteristics of the elements:

Types of meshs:
2 COQUE_AXI

Thus R1=1.025 m and R2=0.975 Mr.
h=0.5m
For this modeling and the following ones, one specifies the density = 1234.kg/m3

Boundary conditions:

Group nodes PB: displacement following the axis Y: DY = 0

19.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

20 Results of modeling I

20.1 Values
tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

Average layer
-9.81907 10-10

-1.000 10-9
1.843%

Constraints (SIYY)

Average layer
194.93754
200.000
2.597%

FORCE_COQUE
Displacements

(REALITY) with
Average layer
-9.81907 10-10
-1.000 10-9
1.843%
MODI_METRIQUE

Constraints (SIYY)

Average layer
194.93754
199.954
2.573%
Higher layer
200.125
205.588
2.730%
Lower layer
190.125
194.595
2.351%
FORCE_COQUE

Displacements

(FUNCTION) with
Average layer
-9.81907 10-10
-1.000 10-9
1.843%
MODI_METRIQUE

Constraints (SIYY)

Average layer
194.93754
199.954
2.573%
Higher layer
200.125
205.588
2.730%
Lower layer
190.125
194.595
2.351%
FORCE_COQUE
Displacements

(FUNCTION) without
Average layer
-9.81907 10-10
-1.000 10-9
1.843%
MODI_METRIQUE

Constraints (SIYY)

Average layer
194.93754

200.000
2.597%
Higher layer
200.125
200.000
-0.062%
Lower layer
190.125
200.000
5.194%

MASS
1.93836 E+02
1.93836 E+02
CDG_X
0.0
0.0
CDG_Y
0.0
0.0
CDG_Z
2.5 E-01
2.5 E-01
IX_G
1.00956 E+02
1.00956 E+02
IY_G
1.00956 E+02
1.00956 E+02
IZ_G
1.93836 E+02
1.93836 E+02
IXY_G
0.0
0.0
IXZ_G
0.0
0.0
IYZ_G
0.0
0.0

Handbook of Validation

V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

---

21 Modeling J

21.1 Characteristics of the grid

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Pa
1.0
0.

PC
0. 1.

Characteristics of the elements:

Types of meshs:
10 COQUE_C_PLAN

R = 1 Mr.
= 1234. Kg/m3

Boundary conditions:

Group nodes Pa:
- displacement following the axis Y = 0

- rotation around axis Z: DRZ = 0

Group nodes PC:
- displacement following axis X: DX = 0
- rotation around axis Z: DZ = 0

21.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

Code_Aster ®
Version
6.5

Titrate:
SSLS114 - Not regression on cylindrical quarter of binding ring

Date:
03/11/03
Author (S):
P. Key MASSIN, J.R. LEVESQUE
:
V3.03.114-A Page:
25/28

22 Results of modeling J

22.1 Values
tested

Key word
Identification
Reference

Aster Difference
PRES_REP
Displacements

Average layer
-9.81907 10-10
-9.999974 10-10
1.842%

Constraints (SIXX)

Average layer
194.93754
200.000
2.597%

FORCE_COQUE
Displacements

(REALITY) with
Average layer
-9.81907 10-10
-9.999974 10-10
1.842%
MODI_METRIQUE

Constraints (SIXX)

Average layer
194.93754
199.959
2.576%
Higher layer

200.125
205.046
2.459%
Lower layer
190.125
195.118
2.626%
FORCE_COQUE
Displacements

(FUNCTION) with
Average layer
-9.81907 10-10
-9.999974 10-10
1.842%
MODI_METRIQUE

Constraints (SIXX)

Average layer
194.93754
199.959
2.576%
Higher layer
200.125
205.046
2.459%
Lower layer
190.125
195.118
2.626%
FORCE_COQUE
Displacements

(FUNCTION) without
Average layer
-9.81907 10-10
-9.999974 10-10

1.842%
MODI_METRIQUE

Constraints (SIXX)

Average layer
194.93754
200.000
2.597%
Higher layer
200.125
200.000
-0.062%
Lower layer
190.125
200.000
5.194%

MASS
9.69181 E+01
9.69181 E+01
CDG_X
6.36619 E-01
6.36619 E-01
CDG_Y
6.36619 E-01
6.36619 E-01
CDG_Z
0.0
0.0
IX_G
9.17961
9.17961
IY_G
9.17961
9.17961
IZ_G
1.83592 E+01
1.83592 E+01
IXY_G
-8.42942

-8.42942
IXZ_G
0.0
0.0
IYZ_G
0.0
0.0

23 Modeling
K

23.1 Characteristics of the grid

Co-ordinates of the points:

GROUP_NO
Coor_x Coor_y
Pa
1.0
0.

PC
0. 1.

Characteristics of the elements:

Types of meshs:
10 COQUE_D_PLAN

R = 1 Mr.
= 1234. Kg/m3

Boundary conditions:

Group nodes Pa:
- displacement following the axis Y = 0
- rotation around axis Z: DRZ = 0

Group nodes PC:
- displacement following axis X: DX = 0
- rotation around axis Z: DZ = 0

23.2 Functionalities tested

Orders Word
key
AFFE_CHAR_MECA PRES_REP

FORCE_COQUE
AFFE_CHAR_MECA_F FORCE_COQUE

---

24 Results of modeling K

24.1 Values tested

Key word
Identification
Reference
Aster Difference
PRES_REP
Displacements

Average layer
-9.81907 10-10
-9.099974 10-10
-7.323%

Constraints (SIXX)

Average layer
194.93754
200.000
2.597%

FORCE_COQUE
Displacements

(REALITY) with
Average layer
-9.81907 10-10
-9.099974 10-10

-7.323%
MODI_METRIQUE

Constraints (SIXX)

Average layer
194.93754
199.959
2.576%
Higher layer
200.125
205.046
2.459%
Lower layer
190.125
195.118
2.627%
FORCE_COQUE
Displacements

(FUNCTION) with
Average layer
-9.81907 10-10
-9.099974 10-10
-7.323%
MODI_METRIQUE

Constraints (SIXX)

Average layer
194.93754
199.959
2.576%
Higher layer
200.125
205.046
2.459%

Lower layer
190.125
195.118
2.627%
FORCE_COQUE
Displacements

(FUNCTION) without
Average layer
-9.81907 10-10
-9.099974 10-10
-7.323%
MODI_METRIQUE

Constraints (SIXX)

Average layer
194.93754
200.000
2.597%
Higher layer
200.125
200.000
-0.062%
Lower layer
190.125
200.000
5.194%

MASS
9.69181 E+01
9.69181 E+01
CDG_X
6.36619 E-01
6.36619 E-01
CDG_Y
6.36619 E-01
6.36619 E-01
CDG_Z
0.0

0.0
IX_G
9.17961
9.17961
IY_G
9.17961
9.17961
IZ_G
1.83592 E+01
1.83592 E+01
IXY_G
-8.42942
-8.42942
IXZ_G
0.0
0.0
IYZ_G
0.0
0.0

25 Summary of the results

The key words PRES_REP (real or function) and FORCE_COQUE (real or function) can be indifferently used for the elements of hull and plate, the results obtained coincide.

Code_Aster ®
Version
6.0

Titrate:
SSLS115 - Composite square plate under uniform pressure
Date:
23/10/02
Author (S):
J.M. PROIX, NR. RAHNI Key
:
V3.03.115-A Page:
1/24

Organization (S): EDF-R & D /AMA, CS IF

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.115

SSLS115 - Composite square plate under pressure uniform

Summary:

One treats the case of a square plate tri-layers, simply supported and subjected to a uniform pressure. The skins consist of an orthotropic homogeneous material, as well as the heart (same axes of orthotropism).
The modules E and G of the heart are ten times weaker than those of the skins.

One calculates displacement in the center as well as the constraints with the lower and higher interfaces of
skins.

The test gathers eight modelings: with regard to the four first, the results obtained are compared for triangular surface meshs then quadrangular, in two reference marks user different. Four last modelings make it possible to measure the sensitivity of the results the orientation triangular meshs in the two reference marks user.

1
Problem of reference

1.1 Geometry

Because of the geometrical and physical symmetry of the problem, only the quarter of the plate is

modelled.

L
L
With
= 500 mm
2
2
B
D
Z
y
X
H = 100 mm
C
10 mm
Material 1
Material 2
80 mm
Material 1
10 mm

L
Twinge:
= 10: the plate is relatively thick.
H

1.2
Material properties

Material 1
Material 2
E_L (1011 N/m ²)
3.4156
0.34156
E_T (1011 N/m ²)
1.793
0.1793
G_LN (1011 N/m ²)
0.608
0.0608
G_TN (1011 N/m ²)
1.015

0.1015
G_LT (1011 N/m ²)
1.0
0.1
NU_T
0.44
0.44

1.3
Boundary conditions and loadings

Simple bearing plate
C.L. :
AB:
DZ = 0.
DRY=0.

AD:
DZ = 0.
DRX=0.

Symmetry
BC:
DX = 0.
DRY=0.

DRZ=0.

CD:
DY = 0.
DRX=0. DRZ=0.

Loading:

FORCE_COQUE
Uniform pressure
P = 1N/m ²

2 Reference solution

2.1 Reference solution

The numerical solution obtained with a theory of plate multi-layer in linear elasticity orthotropic is given in the reference [bib1] page 341.

2.2 Results of reference

At the point C, one calculates displacement according to Z of the point as well as the constraints with the interfaces
X
lower and higher of the skins.

2.3 Uncertainty on the solution

Numerical solution.

2.4 References bibliographical

[1]
BATOZ and DHATT. Modeling of the structures by finite elements. Beams and plates. Hermès, 1990.

---

3 Modeling
With

3.1
Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The reference mark user is confused with the reference mark of orthotropism.

D
C
With
B

Limiting conditions:
DDL_IMPO
(GROUP_NO=' AB', DZ=0., DRY=0.)
(GROUP_NO=' BC', DX=0., DRY=0.)
(GROUP_NO=' CD', DY=0., DRX=0.)
(GROUP_NO=' DA', DZ=0., DRX=0.)
Not C
net: 72

3.2
Characteristics of the grid

A number of nodes: 56

A number of meshs and types: 72 TRIA3

3.3 Functionalities
tested

Orders

AFFE_MODELE
"MECHANICAL"
"DST"

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

DDL_IMPO
GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

4
Results of modeling A

4.1 Values
tested

Not C
Identification
Reference
Aster %
Difference

on lower layer 3
4.7100E+01 4.7662E+01
1.194
X

on higher layer 3
5.8800E+01 5.9577E+01
1.323

X
Constraints
on lower layer 2
4.7100E+01 4.7662E+01
1.194
X

on higher layer 2
4.7100E+01 4.7662E+01
1.194
X

on lower layer 1
5.8800E+01 5.9577E+01
1.323
X

on higher layer 1 4.7100E+01 4.7662E+01
1.194
X
DX
0.0 0.0 0.0
Displacement DY
0.0 0.0 0.0
DZ
4.1920E+01 4.1851E+01
-0.163

4.2
Contents of the file results

Values at the point of observation of displacements and constraints.
X

4.3 Parameters
of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 5.74 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HT-66/02/001/A

---

5 Modeling B

5.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The reference mark user is confused with the reference mark of orthotropism.

D
C
With
B

Limiting conditions:
DDL_IMPO
(GROUP_NO=' AB', DZ=0., DRY=0.)
(GROUP_NO=' BC', DX=0., DRY=0.)
(GROUP_NO=' CD', DY=0., DRX=0.)
(GROUP_NO=' DA', DZ=0., DRX=0.)
Not C
net: 36

5.2 Characteristics of the grid

A number of nodes: 57

A number of meshs and types: 36 QUAD4

5.3 Functionalities tested

Orders

AFFE_MODELE
"MECHANICAL"
"DST"

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP

THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

DDL_IMPO
GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

6
Results of modeling B

6.1 Values
tested

Not C
Identification
Reference
***Aster** %*
Difference

on lower layer 3
4.7100E+01 5.0881E+01
8.028
X

on higher layer 3
5.8800E+01 6.3601E+01
8.166
X
Constraints
on lower layer 2
4.7100E+01 5.0881E+01
8.028

X

on higher layer 2
4.7100E+01 5.0881E+01
8.028
X

on lower layer 1
5.8800E+01 6.3601E+01
8.166
X

on higher layer 1 4.7100E+01 5.0881E+01
8.028
X
DX
0.0 0.0 0.0
Displacement DY
0.0 0.0 0.0
DZ
4.1920E+01 4.2040E+01
0.29

6.2
Contents of the file results

Values at the point of observation of displacements and constraints.
X

6.3 Parameters of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 4.25 seconds

Handbook of Validation

7 Modeling C

7.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The model of plate associated with modeling A is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta.
C
D
B
With

Limiting conditions:
LIAISON_OBLIQUE
(GROUP_NO=' AB', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRY=0.)
(GROUP_NO=' BC', ANGL_NAUT= (20. , 30. , 0.), DX=0., DRY=0.)
(GROUP_NO=' CD', ANGL_NAUT= (20. , 30. , 0.), DY=0., DRX=0.)
(GROUP_NO=' DA', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRX=0.)
Not C
net: 72

7.2 Characteristics of the grid

A number of nodes: 56

A number of meshs and types: 72 TRIA3

7.3 Functionalities tested

Orders

AFFE_MODELE
"MECHANICAL"
"DST"

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU

ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

8
Results of modeling C

8.1 Values
tested

Not C
Identification
Reference
***Aster** %*
Difference

on lower layer 3
4.7100E+01 4.7662E+01
1.194
X

on higher layer 3
5.8800E+01 5.9577E+01
1.323

X
Constraints
on lower layer 2
4.7100E+01 4.7662E+01
1.194
X

on higher layer 2
4.7100E+01 4.7662E+01
1.194
X

on lower layer 1
5.8800E+01 5.9577E+01
1.323
X

on higher layer 1
4.7100E+01 4.7662E+01
1.194
X
DX
1.9696E+01 1.9663E+01
-0.163
Displacement DY
7.1687E+00 7.1570E+00
-0.162
DZ
3.6304E+01 3.6244E+01
-0.163

8.2 Remarks

The values of reference of displacement to the point C are obtained by projecting displacement theoretical bench for a plate not turned in the new reference mark user (displacement for a not turned plate being vertical, new displacement is a function of the projection of the axis Z). In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =
.
30

cos

8.3
Contents of the file results

Values at the point of observation of displacements and constraints.
X

8.4 Parameters
of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 4.52 seconds

9 Modeling
D

9.1
Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The model of plate associated with modeling B is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta.

C
D
B
With

Limiting conditions:
LIAISON_OBLIQUE
(GROUP_NO=' AB', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRY=0.)
(GROUP_NO=' BC', ANGL_NAUT= (20. , 30. , 0.), DX=0., DRY=0.)
(GROUP_NO=' CD', ANGL_NAUT= (20. , 30. , 0.), DY=0., DRX=0.)
(GROUP_NO=' DA', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRX=0.)
Not C
net: 36

9.2

Characteristics of the grid

A number of nodes: 57

A number of meshs and types: 36 QUAD4

9.3 Functionalities
tested

Orders

AFFE_MODELE
"MECHANICAL"
"DST"

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

10 Results of modeling D

10.1 Values tested

Not C
Identification
Reference
Aster %
Difference

on lower layer 3
4.7100E+01 5.0881E+01
8.028
X

on higher layer 3 5.8800E+01 6.3601E+01
8.166
X

Constraints
on lower layer 2
4.7100E+01 5.0881E+01
8.028
X

on higher layer 2 4.7100E+01 5.0881E+01
8.028
X

on lower layer 1
5.8800E+01 6.3601E+01
8.166
X

on higher layer 1 4.7100E+01 5.0881E+01
8.028
X
DX
1.9696E+01 1.9750E+01
0.290
Displacement DY
7.1687E+00 7.1895E+00
0.291
DZ
3.6304E+01 3.6409E+01
0.289

10.2 Remarks

The values of reference of displacement to the point C are obtained by projecting displacement theoretical bench for a plate not turned in the new reference mark user (displacement for a not turned plate being vertical, new displacement is a function of the projection of the axis Z). In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =
.
30

cos

10.3 Contents of the file results

Values at the point of observation of displacements and constraints.
X

10.4 Parameters of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 6.11 seconds

11 Modeling E

11.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The reference mark user is confused with the reference mark of orthotropism. Compared to modeling A,
the model is characterized here by an orientation different from the surface meshs.

D
C
With
B

Limiting conditions:
DDL_IMPO
(GROUP_NO=' AB', DZ=0., DRY=0.)
(GROUP_NO=' BC', DX=0., DRY=0.)
(GROUP_NO=' CD', DY=0., DRX=0.)
(GROUP_NO=' DA', DZ=0., DRX=0.)
Not C
net: 72

11.2 Characteristics of the grid

A number of nodes: 56

A number of meshs and types: 72 TRIA3

11.3 Functionalities

tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

DDL_IMPO
GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

12 Results of modeling E

12.1 Values tested

Not C
Identification
Reference
Aster %
Difference

on lower layer 3
4.7100E+01 5.2430E+01
11.317
X

on higher layer 3 5.8800E+01 6.5537E+01 11.459
X
Constraints
on lower layer 2
4.7100E+01 5.2430E+01
11.317
X

on higher layer 2 4.7100E+01 5.2430E+01 11.317
X

on lower layer 1
5.8800E+01 6.5537E+01
11.459
X

on higher layer 1 4.7100E+01 5.2430E+01
11.317
X
DX
0.0 0.0 0.0
Displacement DY
0.0 0.0 0.0
DZ
4.1920E+01 4.2024E+01
0.248

12.2 Contents of the file results

Values at the point of observation of displacements and constraints.
X

12.3 Parameters
of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 4.14 seconds

---

13 Modeling
F

13.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The model of plate associated with modeling E is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta. Compared to modeling C, the model is here characterized by an orientation different from the meshs.

C
D
B
With

Limiting conditions:
LIAISON_OBLIQUE
(GROUP_NO=' AB', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRY=0.)
(GROUP_NO=' BC', ANGL_NAUT= (20. , 30. , 0.), DX=0., DRY=0.)
(GROUP_NO=' CD', ANGL_NAUT= (20. , 30. , 0.), DY=0., DRX=0.)
(GROUP_NO=' DA', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRX=0.)
Not C
net: 72

13.2 Characteristics of the grid

A number of nodes: 56

A number of meshs and types: 72 TRIA3

13.3 Functionalities tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

14 Results of modeling F

14.1 Values tested

Not C
Identification
Reference
Aster %
Difference

on lower layer 3
4.7100E+01 5.2430E+01
11.317
X

on higher layer 3
5.8800E+01 6.5537E+01
11.459
X
Constraints
on lower layer 2
4.7100E+01 5.2430E+01
11.317
X

on higher layer 2

4.7100E+01 5.2430E+01
11.317
X

on lower layer 1
5.8800E+01 6.5537E+01
11.459
X

on higher layer 1
4.7100E+01 5.2430E+01
11.317
X
DX
1.9696E+01 1.9744E+01
0.248
Displacement DY
7.1687E+00 7.1865E+00
0.249
DZ
3.6304E+01 3.6393E+01
0.248

14.2 Remarks

The values of reference of displacement to the point C are obtained by projecting displacement theoretical bench for a plate not turned in the new reference mark user (displacement for a not turned plate being vertical, new displacement is a function of the projection of the axis Z). In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =
.
30

cos

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HT-66/02/001/A

14.3 Contents of the file results

Values at the point of observation of displacements and constraints.
X

14.4 Parameters of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 4.22 seconds

15 Modeling G

15.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The model of plate is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta, without reference to a model not turned.
The orientation of the meshs is here identical to that of the reference [bib1].
C

D
B
With

Limiting conditions:
LIAISON_OBLIQUE
(GROUP_NO=' AB', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRY=0.)
(GROUP_NO=' BC', ANGL_NAUT= (20. , 30. , 0.), DX=0., DRY=0.)
(GROUP_NO=' CD', ANGL_NAUT= (20. , 30. , 0.), DY=0., DRX=0.)
(GROUP_NO=' DA', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRX=0.)
Not C
net: 72

15.2 Characteristics of the grid

A number of nodes: 56

A number of meshs and types: 72 TRIA3

15.3 Functionalities
tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA
FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

16 Results of modeling G

16.1 Values tested

Not C
Identification
Reference
Aster %
Difference

on lower layer 3
4.7100E+01 4.7920E+01
1.742
X

on higher layer 3
5.8800E+01 5.9900E+01
1.872
X
Constraints
on lower layer 2
4.7100E+01 4.7920E+01
1.742
X

on higher layer 2
4.7100E+01 4.7920E+01
1.742
X

on lower layer 1
5.8800E+01 5.9900E+01
1.872
X

on higher layer 1
4.7100E+01 4.7920E+01
1.742
X
DX
1.9696E+01 1.9882E+01
0.946
Displacement DY
7.1687E+00 7.2365E+00
0.947
DZ
3.6304E+01 3.6647E+01

0.946

16.2 Remarks

The values of reference of displacement to the point C are obtained by projecting displacement theoretical bench for a plate not turned in the new reference mark user (displacement for a not turned plate being vertical, new displacement is a function of the projection of the axis Z). In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =
.
30

cos

16.3 Contents of the file results

Values at the point of observation of displacements and constraints.
X

16.4 Parameters
of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 4.22 seconds

17 Modeling
H

17.1 Characteristics of modeling

Element of hull DST (modeling of a quarter of plate).
The model of plate is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to
beta, without reference to a model not turned.
C
D
B
With

Limiting conditions:
LIAISON_OBLIQUE
(GROUP_NO=' AB', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRY=0.)
(GROUP_NO=' BC', ANGL_NAUT= (20. , 30. , 0.), DX=0., DRY=0.)
(GROUP_NO=' CD', ANGL_NAUT= (20. , 30. , 0.), DY=0., DRX=0.)
(GROUP_NO=' DA', ANGL_NAUT= (20. , 30. , 0.), DZ=0., DRX=0.)
Not C
net: 142
Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HT-66/02/001/A

Code_Aster ®
Version
6.0

Titrate:
SSLS115 - Composite square plate under uniform pressure
Date:

17.2 Characteristics of the grid

A number of nodes: 101

A number of meshs and types: 144 TRIA3

17.3 Functionalities tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE
ORIE_NORME_COQUE

AFFE_CARA_ELEM
HULL
THICK

ANGLE_REP

DEFI_MATERIAU
ELAS_ORTH

DEFI_COQU_MULT
SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA

FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM
SIGM_ELNO_DEPL

18 Results of modeling H

18.1 Values tested

Not C
Identification
Reference
Aster %
Difference

on lower layer 3
4.7100E+01 5.0957E+01
8.19
X

on higher layer 3
5.8800E+01 6.3691E+01
8.32
X
Constraints
on lower layer 2
4.7100E+01 5.0957E+01
8.19
X

on higher layer 2
4.7100E+01 5.0957+01
8.19

X

on lower layer 1
5.8800E+01 6.3696E+01
8.32
X

on higher layer 1
4.7100E+01 5.0957E+01
8.19
X
DX
1.9696E+01 1.9735E+01
0.199
Displacement DY
7.1687E+00 7.1830E+00
0.200
DZ
3.6304E+01 3.6376E+01
0.200

18.2 Remarks

The values of reference of displacement to the point C are obtained by projecting displacement theoretical bench for a plate not turned in the new reference mark user (displacement for a not turned plate being vertical, new displacement is a function of the projection of the axis Z). In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =
.
30

cos

18.3 Contents of the file results

Values at the point of observation of displacements and constraints.
X

18.4 Parameters
of execution

Version: 6.0.29

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 4.22 seconds

Titrate:
SSLS115 - Composite square plate under uniform pressure
Date:
23/10/02
Author (S):
J.M. PROIX, NR. RAHNI Key

19 Synthesis
graph

Modeling C
Modeling D

Modeling F
Modeling G

Modeling H
% Forced
% Displacement
C

1.2
-0.17
D
8.1
0.23
F
11.4
0.25
G
1.8
0.95
H
8.2
0.20

---

20 Summary of the results

The results obtained show that:

Identical · A grid (standard of surface meshs and orientation of the meshs), change of reference mark user does not influence the constraints;

· Because of orthotropism of the problem, there exists a considerable sensitivity to the orientation triangular surface meshs (the precision of calculations passes from 1 to 11% for constraints and from 0.17 to 0.95% for displacements). This sensitivity does not disappear in refining the grid. This point is thus to take into account at the time of the comparison of

performances triangle/quadrangle.

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Code_Aster ®
Version
6.0

Titrate:
Membrane SSLS116 Loading of an offset plate
Date:
19/08/02
Author (S):
Key ***P.MASSIN****, D. NUNEZ GUAJARDO*
:
V3.03.116-A Page:
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Organization (S): EDF/AMA, CS IF

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.116

SSLS116 - Membrane loading of a plate
offset

Summary:

This test relates to the offsetting of a plate compared to the plan of the grid or plan of diagram. The

loading
is purely membranous.

The reference is given by a first resolution where a not offset plate is modelled. It validates it the second calculation where one models a plate offset compared to the plan of the grid.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

0.2

A4
Plate

A3
offset

L14
Plan purifies

L12

Z

y
A1
A2

Plate reference

not offset

X

One represented here the plate offset compared to the plan of diagram (which is confused here with the plan inferior of the offset plate).
To avoid overloading the diagram, one does not trace the plate of not offset reference, for which the plan of diagram is also the average plan.

1.2
Properties of materials

The material constituting plate is characterized by the following data:

EL=20000.Pa ET=20000.Pa EN=20000.Pa
LN = 0. LT = 0 TN = 0. GLT=2000.Pa GLN=0. GTN=0.
RHO= 1000.kg/m3

1.3
Boundary conditions and loadings

The L14 mesh is embedded DX=DY=DZ=0.
DRX=DRY=DRZ=0.

One applies the forces to the L12 mesh

FX=1000.N MY=100.N.m
on the offset plate
FX=1000.N
on the not offset plate

These loadings are applied by means of FORCE_ARETE of AFFE_CHAR_MECA in the plan of diagram.

Note:

The fact of applying a force FX to the plate offset to the level of the plan of diagram generates one moment MY which should be compensated for to find itself under conditions purely membrane on the level of the offset plate.

2
Reference solution

2.1
Method of calculation used for the reference solution

The calculation of the membrane type with the not offset plate is used as reference. Nonregression by report/ratio with the results obtained by this first calculation is checked.

2.2
Results of reference

They are consisted of the values of the field of displacement DX, DY, DZ, DRX, DRY with nodes 66 and 52
(for the DKT and DST) and with the nodes N1 and N16 (for the DKQ and the DSQ) and of the calculation of the frequencies
of the first 4 modes.

2.3
Uncertainty on the solution

Uncertainty is null since it is about the same calculation carried out by two different ways.

2.4 Bibliography

[1]
[R3.07.03]: Elements of plate DKT, DST, DKQ, DSQ and Q4.

[2]
[R3.07.06]: Treatment of offsetting for the elements of plate DKT, DST, DKQ, DSQ and Q4G.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
6.0

Titrate:
Membrane SSLS116 Loading of an offset plate
Date:
19/08/02
Author (S):
*Key **P.MASSIN**, D. NUNEZ GUAJARDO*
:
V3.03.116-A Page:
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3 Modeling
With

3.1
Characteristics of modeling

Average plan Plates
d=0.1

offset
With
With
3
4

Plan purifies

A1
A2

The elements used are elements of plate DKT.

3.2
Characteristics of the grid

Co-ordinates of the nodes:

Node	Coor_X (m)	Coor_Y (m)	Coor_Z (m)
A1	0.	0.	0.
A2	10.	0.	0.
A3	10.	5.	0.
A4	0.	5.	0.
N66	10.	5.	0.
N52	8.	2.	0.

66 Nodes
100 meshs DKT (TRIA3)

3.3 Functionalities
tested

Orders	Key word factor
AFFE_CARA_ELEM	OFFSETTING
AFFE_CHAR_MECA	FORCE_ARETE

4
Results of modeling A

4.1 Values
tested

Identification Reference
(m) Aster (m) %
difference

DX (N66)
2.5m 2.5 1.78
E15
DY (N66)
0.m
4.615 E14
4.615 E14
DZ (N66)
0.m
1.158 E12
1.158 E12
DRX (N66)
0.rad
2.76 E13
2.76 E13
DRY (N66)
0.rad
7.86 E14
7.86 E14

DX (N52)
2. 2. 1.49
E08
DY (N52)
0.
3.90 E14
3.90 E14
DZ (N52)
0.
2.72 E13
2.72 E13
DRX (N52)
0.
2.34 E13
2.34 E13
DRY (N52)
0.
1.84 E14
1.84 E14

Frequency 1st mode
1.4439E03Hz
1.4465 E03
0.182

Frequency 2nd mode
3.71554 E03
3.7984 E03
2.231

Frequency 3rd mode
9.01537 E03
9.1305 E03
1.277

Frequency 4th mode
1.34708 E02
1.4077 E02
4.501

4.2 Parameters
of execution

Version: 6.0.21

Machine: SGI Origin 2000

Obstruction memory:
16 MW
Time CPU To use:
6 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

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5 Modeling
B

5.1
Characteristics of modeling

Average plan Plates
d=0.1

offset

Plan purifies

The elements used are elements of plate DKQ.

5.2
Characteristics of the grid

Co-ordinates of the nodes:

Node
Coor_X (m)
Coor_Y (m)
Coor_Z (m)
A1 0. 0. 0.
A2 10. 0. 0.
A3 10. 5. 0.
A4 0. 5. 0.
N1 1. 5. 0.
N16 8. 2. 0.

66 Nodes
50 meshs DKQ (QUAD4)

5.3 Functionalities

tested

Orders Key word
factor
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_ARETE
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

6
Results of modeling B

6.1 Values
tested

Identification Reference
(m) Aster (m) %
difference

DX (N1)
2.5m 2.5 3.42
E14
DY (N1)
0.m
2.52 E14
2.52 E14

DZ (N1)
0.m
1.521 E12
1.521 E12
DRX (N1)
0.rad
1.54 E14
1.54 E14
DRY (N1)
0.rad
2.63 E13
2.63 E13

DX (N16)
2. 2. 1.49
E08
DY (N16)
0.
2.03 E14
2.03 E14
DZ (N16)
0.
1.12 E12
1.12 E12
DRX (N16)
0.
4.29 E14
4.29 E14
DRY (N16)
0.
2.19 E13
2.19 E13

Frequency 1st mode
1.44474E03 Hz
1.446841 E03
0.145

Frequency 2nd mode
3.69339 E03
3.703038 E03
0.261

Frequency 3rd mode
9.04773 E03
9.14141 E03
1.023

Frequency 4th mode
1.33393 E02
1.34463 E02
0.802

6.2 Parameters of execution

Version: 6.0.21

Machine: SGI Origin 2000

Obstruction memory:
16 MW
Time CPU To use:
6 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version

7 Modeling
C

7.1
Characteristics of modeling

Average plan Plates
d=0.1

offset

Plan purifies

The elements used are elements of DST plate.

7.2
Characteristics of the grid

Co-ordinates of the nodes:

Coor_X node
Coor_Y
Coor_Z
A1 0. 0. 0.

A2 10. 0. 0.
A3 10. 5. 0.
A4 0. 5. 0.
N66 10. 5. 0.
N52 8. 2. 0.

66 Nodes
100 meshs DKT (TRIA3)

7.3 Functionalities tested

Orders Key word
factor
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_ARETE

---

8 Results of modeling C

8.1 Values tested

Identification Reference Aster % difference

DX (N66)
2.5 2.5
5.73
E14
DY (N66)
0.
6.62 E15
6.62 E15
DZ (N66)
0.
4.48 E12
4.48 E12
DRX (N66)
0.
2.19 E13
2.19 E13
DRY (N66)
0.
6.69 E13
6.69 E13

DX (N52)
2. 2.
1.49
E08
DY (N52)
0.
4.08 E15
4.08 E15
DZ (N52)
0.
3.62 E12
3.62 E12
DRX (N52)
0.
1.60 E13
1.60 E13

DRY (N52)
0.
7.34 E13
7.34 E13

Frequency 1st mode
1.4439E03
1.4465 E03
0.182

Frequency 2nd mode
3.71554 E03
3.7984 E03
2.231

Frequency 3rd mode
9.01537 E03
9.1305 E03
1.277

Frequency 4th mode
1.34708 E02
1.4077 E02
4.501

8.2 Parameters of execution

Version: 6.0.21

Machine: SGI Origin 2000

Obstruction memory:
16 MW
Time CPU To use:
6 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
6.0

Titrate:
Membrane SSLS116 Loading of an offset plate
Date:
19/08/02
Author (S):
Key ***P.MASSIN****, D. NUNEZ GUAJARDO*
:
V3.03.116-A Page:
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9 Modeling D

9.1 Characteristics of modeling

Average plan Plates
d=0.1

offset

Plan purifies

The elements used are elements of plate DSQ.

9.2
Characteristics of the grid

Co-ordinates of the nodes:

Coor_X node
Coor_Y
Coor_Z
A1 0. 0. 0.
A2 10. 0. 0.
A3 10. 5. 0.
A4 0. 5. 0.
N1 1. 5. 0.
N16 8. 2. 0.

66 Nodes
50 meshs DSQ (QUAD4)

9.3 Functionalities
tested

Orders Key word
factor
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_ARETE
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
6.0

Titrate:
Membrane SSLS116 Loading of an offset plate
Date:

10 Results of modeling D

10.1 Values tested

Identification Reference Aster % difference

DX (N1)
2.5 2.5
-1.33
E14
DY (N1)
0.
2.61 E14
2.61 E14
DZ (N1)
0.
6.26 E13
6.26 E13
DRX (N1)
0.
8.18 E15
8.18 E15
DRY (N1)
0.
9.57 E14
9.57 E14

DX (N16)
2. 2.
1.49
E08

DY (N16)
0.
1.79 E14
1.79 E14
DZ (N16)
0.
3.97 E13
3.97 E13
DRX (N16)
0.
1.71 E14
1.71 E14
DRY (N16)
0.
9.03 E14
9.03 E14

Frequency 1st mode
1.44474E03
1.446841 E03
0.145

Frequency 2nd mode
3.69339 E03
3.703038 E03
0.261

Frequency 3rd mode
9.04773 E03
9.14141 E03
1.023

Frequency 4th mode
1.33393 E02

1.34463 E02
0.802

10.2 Parameters of execution

Version: 6.0.21

Machine: SGI Origin 2000

Obstruction memory:
16 MW
Time CPU To use:
6 seconds
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---

11 Summary of the results

For each modeling, DKT, DKQ, DST and DSQ, results found for the offset plate coincide with the reference solution.

Titrate:
SSLS117 - Offsetting of nonsymmetrical plates

Date:
19/08/02

Author (S):
P. Key MASSIN, D. NUNEZ-GUAJARDO

:
V3.03.117-A Page:
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Organization (S): EDF/AMA, CS IF

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.117

SSLS117 - Offsetting of plates
nonsymmetrical

Summary:

This test validates the offsetting of nonsymmetrical simple plates compared to the plan of the grid or plan
of diagram (key word OFFSETTING of order AFFE_CARA_ELEM).

The reference is given by a first resolution where one models double-layered made up of two layers various thicknesses and of two materials.

It is used to validate the second calculation where one models two layers offset compared to the plan of the grid.

It differs from test SSLS111 only by the fact that the 2 layers are different thicknesses.

Four modelings implement elements DKT, DKQ, DST, DSQ.

SSLS117 - Offsetting of nonsymmetrical plates

Date:
19/08/02
Author (S):
P. Key MASSIN, D. NUNEZ-GUAJARDO
:
V3.03.117-A Page:
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1
Problem of reference

1.1 Geometry

10 m

0.4 m
5 m

A4
A3

0.2 m

A1
A2

m1 m2 m3

Z
y

X

1.2

Properties of materials

The material constituting the first layer is orthotropic and is characterized by the data following:
EL=20000. 106 Pa
ET=20000. 106 Pa
LT = 0.3
GLT=2000. 106 Pa

The material constituting the second layer is also orthotropic and has the following characteristics:
EL=15000. 106 Pa
ET=15000. 106 Pa
LT = 0.3
GLT=1500. 106 Pa

1.3
Boundary conditions and loadings

The A1 node is embedded
DX=DY=DZ=0.
DRX=DRY=DRZ=0.
The A2 node is blocked according to following ddls: DX=DY=0.

One applies nodal forces FZ=1000 NR to the A3 node, and one applies the loading distributed (key word FORCE_COQUE) on the meshs m1, m2 and m3:

FX=200 NR
FX=500. N/m2 FZ=500.
N/m2
MX=100. N/m
MY=40. N/m

The selected loading utilizes requests out of membrane and inflection.

2
Reference solution

2.1
Method of calculation used for the reference solution

Calculation with double-layered material (order DEFI_COQU_MULT) is used as reference. Not regression compared to the results obtained by this first calculation is checked. Two plates of the second modeling are offset compared to the average plan of the double-layered one.

2.2
Results of reference

They are consisted of the values of the field of displacement DX, DY, DZ, DRX, DRY at the A3 point and A4,
efforts at the A1 point and of the first 4 Eigen frequencies.

2.3
Uncertainty on the solution

Uncertainty is null since it is about the same calculation carried out by two different ways.

2.4 Bibliography

[1]
[R3.07.03]: Elements of plate DKT, DST, DKQ, DSQ and Q4.
[2]
[R3.07.06]: Treatment of offsetting for the elements of plate DKT, DST, DKQ, DSQ and Q4G.

3 Modeling With

3.1 Characteristics of modeling

The model consists of two plates corresponding to the average plan of each of both layers of the model of reference. To represent these two plates, one leaves the grid of the plan of diagram which one offsets distances 0.1 and 0.2.

Plan average Plaq2
d=0.1 m

d= -0.2 m

Plan of diagram

Plan average Plaq1

The elements used are elements of plate DKT.

3.2
Characteristics of the grid

Co-ordinates of the nodes:

Node Coor_X Coor_Y Coor_Z
A1 0. 0. 0.
A2 10.
0.
0.
A3 10.
5.
0.
A4 0. 5. 0.

94 Nodes
100 meshs DKT (TRIA3)

3.3 Functionalities
tested

Orders Key word
factor Key word
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_COQUE
PLAN
DEFI_COQU_MULT

4
Results of modeling A

4.1 Values tested

Identification Reference
Aster %
difference
Displacement

DX (A4)
-1.9426 10-6 -1.93937
10-6 -0.166
DY (A4)
-1.1438 10-6 -1.138746
10-6 -0.442
DZ (A4)
-2.1832 10-4 -2.169149 10-4 -0.644
DRX (A4)
-6.0633 10-5 -6.03126
10-5 -0.528
DRY (A4) 1.2815
10-4 1.28078
10-4 -0.056

DX (A3)
-2.4225 10-6 -2.419616
10-6 -0.119
DY (A3)
-2.3106 10-7 -2.3104

10-7 -0.04
DZ (A3)
-1.5584 10-3 -1.5563
10-3 -0.133
DRX (A3)
-1.2578 10-4 -1.2543
10-4 -0.276
DRY (A3) 1.3909 104 1.3903 104 0.038

Eigen frequencies

Frequency 1st mode
1.5303
1.53038
0.006

Frequency 2nd mode
6.41979
6.41979
1.07 E-04

Frequency 3rd mode
1.269898 101 1.269898
101 2.81
E-05

Frequency 4th mode
2.61597 101 2.61597
101 1.23
E-04

Efforts

NXX
N6
1.12134 E+04
1.11996 E+04
-0.124
NYY
N6
7.52699 E+03
7.48953 E+03
-0.498
NXY
N6
1.89850 E+03
1.89286 E+03
-0.297
MXX
N6
2.33596 E+04
2.33480 E+04
-0.050
MYY
N6
1.67905 E+04
1.66988 E+04
-0.546
MXY
N6
5.43976 E+03
5.42402 E+03
-0.289
QX
N6
4.60472 E+03
4.63427 E+03
0.642
QY
N6
1.58798 E+03
1.61207 E+03
1.517

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Version
6.0

Titrate:
SSLS117 - Offsetting of nonsymmetrical plates

Date:
19/08/02
Author (S):
P. Key MASSIN, D. NUNEZ-GUAJARDO
:
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5 Modeling B

5.1 Characteristics of modeling

The model consists of two plates corresponding to the average plan of each of both layers of the model of reference. To represent these two plates, one leaves the grid of the plan of diagram which one offsets distances 0.1 and 0.2

Plan average Plaq2
d=0.1 m

d= -0.2 m

Plan of diagram

Plan average Plaq1

The elements used are elements of plate DKQ.

5.2
Characteristics of the grid

Co-ordinates of the nodes:

Node Coor_X Coor_Y Coor_Z
A1 0. 0. 0.
A2 10.
0.
0.
A3 10.
5.
0.
A4 0. 5. 0.

67 Nodes
50 meshs DKQ (QUAD4)

5.3 Functionalities
tested

Orders Key word
factor Key word
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_COQUE
PLAN

6
Results of modeling B

6.1 Values tested

Identification Reference
Aster %
difference
Displacement

DX (A4)
-2.354 10-6 -2.341
10-6 -0.520
DY (A4)
-2.059 10-6 -2.039
10-6 -0.940
DZ (A4)
-2.50 10-4 -2.45
10-4 -1.924
DRX (A4)
-6.93 10-5 -6.823
10-5 -1.538
DRY (A4) 1.541
10-4 1.541
10-4 -0.005

DX (A3)
-2.9951 10-6 -2.9835
10-6 -0.384
DY (A3)
-4.4646 10-7 -4.4648
10-7 0.006
DZ (A3)
-1.8604 10-3 -1.8550
10-3 -0.287
DRX (A3)
-1.3346 10-4 -1.3217
10-4 -0.963
DRY (A3) 1.6649
10-4 1.6649
10-4 0.002

Eigen frequencies

Frequency 1st mode
1.4362
1.4362
0.

Frequency 2nd mode
5.57419
5.57419
0.

Frequency 3rd mode
1.23524 101 1.23524
101 0.

Frequency 4th mode
2.52573 101 2.52573
101 0.

Efforts

NXX
N60
1.30762 E+04
1.31749 E+04
0.755
NYY
N60
2.68634 E+03
2.82116 E+03
5.019
NXY
N60
4.33581 E+02
4.32313 E+02
-0.292
MXX
N60
4.17329 E+04
4.19250 E+04
0.460
MYY
N60
1.84443 E+04
1.79620 E+04
-2.615
MXY
N60
6.33337 E+03
6.29774 E+03
-0.563
QX
N60

3.19128 E+04
3.20627 E+04
0.470
QY
N60
1.43089 E+04
1.39373 E+04
-2.597

7 Modeling
C

7.1
Characteristics of modeling

The model consists of two plates corresponding to the average plan of each of both layers of the model of reference. To represent these two plates, one leaves the grid of the plan of diagram which one offsets distances 0.1 and 0.2

Plan average Plaq2
d=0.1 m

d= -0.2 m

Plan of diagram

Plan average Plaq1

The elements used are elements of DST plate.

7.2
Characteristics of the grid

Co-ordinates of the nodes:

Node Coor_X Coor_Y Coor_Z
A1 0. 0. 0.
A2 10.
0.
0.
A3 10.
5.
0.
A4 0. 5. 0.

66 Nodes
100 meshs DST (TRIA3)

7.3 Functionalities
tested

Orders Key word
factor Key word
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_COQUE
PLAN

8
Results of modeling C

8.1 Values
tested

Identification Reference
Aster %
difference
Displacement

DX (A4)
-1.939 10-6 -1.93217
10-6 -0.352
DY (A4)
-1.149 10-6 -1.1358
10-6 -1.145
DZ (A4)
-2.2091 10-4 -2.199799
10-4 -0.421
DRX (A4)
-6.09302 10-5 -6.06238

10-5 -0.503
DRY (A4) 1.297279
10-4 1.30383
10-4 0.505

DX (A3)
-2.4385 10-6 -2.4305
10-6 -0.328
DY (A3)
-2.3382 10-7 -2.4272
10-7 -3.806
DZ (A3)
-1.5864 10-3 -1.5952
10-3 0.558
DRX (A3)
-1.2639 10-4 -1.2621
10-4 -0.138
DRY (A3) 1.4127
10-4 1.4215
10-4 0.627

Eigen frequencies

Frequency 1st mode
1.512356
1.50555
-0.450

Frequency 2nd mode
6.373398
6.343485
-0.469

Frequency 3rd mode
1.25011 101 1.24249
101 -0.610

Frequency 4th mode
2.546726 101 2.518863
101 -1.094

Efforts

NXX
N1
9.85902 E+03
1.09606 E+04
11.173
NYY
N1
6.36055 E+03
7.04694 E+03
10.791
NXY
N1
2.07601 E+03
2.07850 E+03
0.120
MXX
N1
2.11639 E+04
2.10507 E+04
-0.535
MYY
N1
1.49410 E+04
1.46867 E+04
-1.701
MXY

N1
5.82623 E+03
5.86877 E+03
0.730
QX
N1
2.56538 E+03
2.35368 E+03
-8.252
QY
N1
1.79286 E+03
1.81901 E+03
1.458

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9 Modeling D

9.1 Characteristics of modeling

The model consists of two plates corresponding to the average plan of each of both layers of the model of reference. To represent these two plates, one leaves the grid of the plan of diagram which one offsets distances 0.1 and 0.2

Plan average Plaq2
d=0.1 m

d= -0.2 m

Plan of diagram

Plan average Plaq1

The elements used are elements of plate DSQ.

9.2
Characteristics of the grid

Co-ordinates of the nodes:

Node Coor_X Coor_Y Coor_Z
A1 0. 0. 0.
A2 10.
0.
0.
A3 10.
5.
0.
A4 0. 5. 0.

67 Nodes
50 meshs DSQ (QUAD4)

9.3 Functionalities
tested

Orders Key word
factor Key word
AFFE_CARA_ELEM
OFFSETTING
AFFE_CHAR_MECA
FORCE_COQUE
PLAN

---

10 Results of modeling D

10.1 Values tested

Identification Reference
Aster %
difference
Displacement

DX (A4)
-2.34539 10-6 -2.3241
10-6 -0.904
DY (A4)
-1.9694 10-6 -1.9363
10-6 -1.680
DZ (A4)
-2.2428 10-4 -2.1154
10-4 -5.680
DRX (A4)
-6.2983 10-5 -5.9831
10-5 -5.003
DRY (A4) 1.5823
10-4 1.5991
10-4 -1.062

DX (A3)
-3.0023 10-6 -2.9771
10-6 -0.839
DY (A3)
-4.6612 10-7 -4.6487
10-7 -0.267

DZ (A3)
-1.8842 10-3 -1.8923
10-3 0.430
DRX (A3)
-1.2768 10-4 -1.2478
10-4 -2.264
DRY (A3) 1.7064
10-4 1.724
10-4 1.054

Eigen frequencies

Frequency 1st mode
1.4219
1.4155
-0.445

Frequency 2nd mode
5.2995
5.21015
-1.686

Frequency 3rd mode
1.215 101 1.206
101 -0.723

Frequency 4th mode
2.4385 101 2.407
101 -1.252

Efforts

NXX
N1
8.68372 E+03
1.64692 E+04
89.657
NYY
N1
4.10693 E+03
2.34359 E+03
-42.936
NXY
N1
3.90190 E+02
4.54002 E+02
16.354
MXX
N1
3.47663 E+04
3.43655 E+04
-1.153
MYY
N1
1.52451 E+04
1.45102 E+04
-4.821
MXY
N1
6.34489 E+03
6.33555 E+03
-0.147
QX
N1
1.70439 E+04
1.56565 E+04
-8.140
QY
N1
9.82819 E+03
9.49952 E+03
-3.344

---

11 Summary of the results

With regard to displacements for the modelings DKT and DKQ, the results obtained with 2 offset hulls differ from to the more 2% compared to the reference solution. For the others modelings, one obtains to the maximum of the errors of 4% for DST and 6% for the DSQ. For these two last modelings, the error is more important because the calculation of transverse shearing is not not are equivalent between the double-layered one and the two offset plates.

Indeed, transverse shearing is supposed to be constant in the thickness of each DST element or DSQ; this transverse shearing is an average shearing. An average value is thus obtained for each plate offset, overall different from average transverse shearing on the double-layered plate.

This is marked even more for the efforts, where the differences remain lower than 5% for modelings DKT (A and B) but reach 11% for modeling C and 89% for modeling D. Being given the nature of the test, one cannot know a priori if the problem comes from the hulls and plates multi-layer or of offsetting. An anomaly is in the course of treatment on this problem.

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V3.03 booklet: Linear statics of the plates and hulls
V3.03.118 document

SSLS118 - Square plate posed subjected
with a sinusoidal pressure

Summary:

One treats the case of a multi-layer full-course square plate then, simply supported and subjected to one

sinusoidal pressure.
One calculates displacement in the center, the constraints, with the lower interfaces
xx
yy
xy
xz
yz
averages and higher, efforts of membrane NR, NR, NR, efforts sharp T, T and them
xx
yy
xy
X
y
moments M, M and Mr.
xx
yy
xy

The test gathers 14 modelings: with regard to modelings A with F, the results obtained are compared for modelings DKQ, DSQ, DKT, DST, COQUE_3D with triangular meshs and COQUE_3D with rectangular meshs.
Modelings G and H make it possible to test the results in a reference mark user different from the total reference mark.
Modelings I and J measure the sensitivity of the results to the smoothness of the grid, for the configuration
DSQ.
Modelings K with NR relate to the multi-layer plate, for modelings DST and DSQ, in reference mark total and user. They make it possible to estimate the distribution of the plane constraints and transverse shearing
inside the plate.

---

1 Problem of reference

1.1 Geometry

1.2 Properties of materials

E = 25 Pa
= 0.25
= 1 kg/m3

1.3 Boundary conditions and loadings

Simple bearing plate

C.L. :
AB
DX = 0.
DZ = 0.
DRY=0.
MY = 0.

BC
DY = 0.
DZ = 0.
DRX=0.
MX = 0.

CD
DX = 0.
DZ = 0.
DRY=0.
MY = 0.

DA
DY = 0.
DZ = 0.
DRX=0.
MX = 0.

Not O
DX = 0.
DY = 0.
DRX=0.
DRY=0.
DRZ=0.

Loading:

FORCE_COQUE
Sinusoidal pressure
P

X
y
With P = F sin
, where F = 1 and has = 1
0
sin
has
has
0

1.4 Conditions
initial

Without object for the static analysis.
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Code_Aster ®
Version
6.0

Titrate:
SSLS118 - Square plate subjected to a sinusoidal pressure

2
Reference solution

2.1
Method of calculation used for the reference solution

The analytical solution of reference is based on the theory of Coils-Kirchhoff, usually used for the plates known as "thin" [bib1].

Taking into account the problem and in any point of the plate, one has for the calculation of the arrow:
F a4
0
X
y
W =
sin sin

4 4 D
has
has
with:
3
=
Eh
D
, F = 1, has = 1 and = 0.25
12(
2
1 -) 0

For the calculation of the moments, the theory leads to the following expressions:
M = 1+ sin sin
xx
(

)
X
y
has
has
M
= M

yy
xx
M
= - 1 - cos cos
xy
(
)
X
y
has
has
2
F
with
0

has
=

2
4

For the sharp efforts, one obtains:
F has
0
X
y
T =
cos sin
X

2
has
has
F has
X

y
T
0
=
sin cos
y

2
has
has

For a homogeneous plate, the plane constraints are given by:

M
xx
xx
Z A M

yy
= [ ]

yy

M
xy
xy
12
with []
With =
and Z the position in the thickness of the plate
3 [I]
H

and stresses shear transverse by:

T

xz = [D
,
1 (Z)] X

T
yz
y
6 H2

with [D

1 (Z)]

=
- z2
3
[I]
H

2

2.2 Results of reference

For each modeling, one calculates:

· in the center of the plate, displacement,

· in the center of the plate and in the middle of side AB, the constraints, on

xx

yy

xy

xz

yz

plans:

-

inferior, means and superior of the plate in the full-course case,

-

inferior, means and superior of each section in the multi-layer case (5 layers),

· in the center, the corners and in the middle of sides AB and AD, the efforts of membrane NR, NR, NR,

xx

yy

xy

sharp efforts T, T and the moments M, M and Mr.

X

y

xx

yy

xy

The expression of these quantities to the points O, A, B, C, D gives:

W M

M

M

T

T

xx

yy

xy

X

y

O

(2

3 1-)

(1+)
(1+)
0 0 0

4
3
Eh
With -
0
0 -(1-)
0 0
B -
0
0 (1-)
0 0
B1 -
0
0
0
0
1/
2
C -
0
0 -(1-)
0 0
D -
0
0 (1-)
0 0

Numerical application:
(31 2
-) =1.1549 ,
4
3
Eh
(1+) = 0.031662 ,
(1-) = 0.018997
1/ 2 = 0.1591
The distribution of the plane constraints and shearing at the points O and B1 inside the plate is the following one:

O

xx
yy
xy
xz
yz
H/2
18.9972 18.9972
0
0
0
3h /10
11.3983 11.3983
0
0
0
H /10
3.7994 3.7994 0 0
0
0 0
0
0 0
0
H /10
-3.7994 -3.7994
0
0
0
3h /10
-11.3983 -11.3983
0
0 0
H/2
-18.9972 -18.9972
0
0 0

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h/2
5 sleep
3h/10
4 sleep
h/10
3 sleep
H
0
2 sleep
Lay down 1

B1

xx
yy
xy
xz
yz
H/2
0 0 0
0
0
3h /10
0 0 0

0
1.5278
H /10
0 0 0
0
2.3777
0 0
0
0 0
2.3873
H /10
0 0 0
0
2.3777
3h /10
0 0 0
0
1.5278
H/2
0 0 0
0
0

2.3 Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
BATOZ and DHATT. Modeling of the structures by finite elements. Beams and Plates. Volume 2 HERMES, 1990.

3 Modeling With

3.1 Characteristics of modeling

Quadrangular element of hull DKQ.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M66, M67, M78, M79
Not A
Net: M1
Not B
Net: M12
Not C
Net: M144
Not D
Net: M133
Not B1
Meshs: M6, M7
Not D1
Meshs: M73, M61

3.2 Characteristics

grid

A number of nodes: 171
A number of meshs and type: 144 QUAD4

3.3 Functionalities
tested

Orders

AFFE_MODELE
"MECHANICAL"
"DKT"

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS_ORTH

DEFI_COQU_MULT SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM SIGM_ELNO_DEPL

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

4
Results of modeling A
4.1 Values tested

Identification
Reference
Aster *Difference*
Tolerance
Not O

M78

on lower layer
18.990 18.871
-0.626%
1.0%
xx

on lower layer
18.990 18.871
-0.626%
1.0%
yy

on lower layer
0.000 2.03E08 2.03E08

0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
Constraints
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -0.251
-0.251 0.26
xz

on layer medium
0.000 0.251 0.251
0.26
yz

on higher layer
-18.990 -18.871 -0.626% 1.0%
xx

on higher layer
-18.990 -18.871 -0.626% 1.0%

yy

on higher layer
0.000 2.03E08
2.03E08
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.1406
-1.232%
1.25%
Not B1

M6

on lower layer
0.000 1.052E03
-0.001 0.01
xx

on lower layer
0.000 4.208E03
-0.004 0.01
yy

on lower layer
0.000 7.326E01
-0.733 0.74
xy

on lower layer

0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz

on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy
Constraints
on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 2.690E05
2.
690E05 0.26
xz

on layer medium
-2.39732 -1.90731 -20.44% 21.0%
yz

on higher layer
0.000 1.052E03 0.001 0.26
xx

on higher layer
0.000 4.208E03 0.004 0.26
yy

on higher layer
0.000 7.326E01 0.733 0.74
xy

on higher layer
0.000 0.000 0.000 0.01
xz

on higher layer
0.000 0.000 0.000 0.01
yz

Reference
Not
NR
NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000 3.1662E02
3.1662E02
0.000 0.000

0.000
O M79
- - -
-
-
-
0.000
0.000
O M66
- - -
-
-
-
0.000
0.000
O M67
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02
0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02
0.000

0.000
B1 M6
0.000 0.000 0.000
0.000
0.000 0.000 0.000 1.5915E01
B1 M7
0.000 0.000 0.000
0.000
0.000 0.000 0.000 1.5915E01
D1 M61
- - -
-
-
1.5915E01 0.000
D1 M73 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000

Aster
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000 3.1451E02
3.1451E02
3.3849E11
1.6740E02 1.6740E02

O M79
- - -
-
-
-
1.6740E02 1.6740E02
O M66
- - -
-
-
1.6740E02
1.6740E02
O M67
- - -
-
-
-
1.6740E02 1.6740E02
With
0.000 0.000 0.000 1.07E17 3.53E18
1.8548E02 1.3609E05
1.3617E05
B
0.000 0.000 0.000 2.00E17 9.39E17
1.8548E02
1.3617E05 1.3612E05
C
0.000 0.000 0.000 8.61E18 4.15E18 1.8548E02 1.3612E05 1.3619E05
D
0.000 0.000 0.000 1.35E17 1.16E18
1.8548E02
1.3619E05 1.3609E05
B1 M6
0.000 0.000 0.000 1.7534E06 7.0138E06 1.221E03 1.7933E06 1.2715E01
B1 M7
0.000 0.000 0.000 1.7534E06 7.0138E06 1.221E03 1.7921E06 1.2715E01
D1 M61
- - -
-
-
1.2715E01 1.7933E06
D1 M73 0.000 0.000 0.000 7.0138E06 1.7534E06 1.221E03 1.2715E01 1.7933E06

Difference
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000 -0.666%
0.666% 3.38E11 0.017
0.017
O M79
- - -
-
-
-
0.017
0.017
O M66
- - -
-
-
-
-0.017
-0.017
O M67
- - -
-
-
-
0.017
-0.017

With
0.000 0.000 0.000 1.07E17 3.53E18 2.363% 1.36E05 1.36E05
B
0.000 0.000 0.000 2.00E17 9.39E17 2.363% 1.36E05 1.36E05
C
0.000 0.000 0.000 8.61E18 4.15E18 2.363% 1.36E05 1.36E05
D
0.000 0.000 0.000 1.35E17 1.16E18 2.363% 1.36E05 1.36E05
B1 M6
0.000 0.000 0.000 1.75E06
7.01E06 0.001 1.79E06 20.106%
B1 M7
0.000 0.000 0.000 1.75E06
7.01E06 0.001 1.79E06 20.106%
D1 M61
- - -
-
-
-
20.106% 1.79E06
D1 M73 0.000 0.000 0.000 7.01E06 1.75E06 0.001 20.106% 1.79E06

4.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use: 5.74 seconds

5 Modeling B

5.1 Characteristics of modeling

Quadrangular element of hull DSQ.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M66, M67, M78, M79
Not A
Net: M1
Not B
Net: M12
Not C
Net: M144
Not D
Net: M133
Not B1
Meshs: M6, M7
Not D1
Meshs: M73, M61

5.2 Characteristics

grid

A number of nodes: 171
A number of meshs and type: 144 QUAD4

5.3 Functionalities tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS_ORTH

DEFI_COQU_MULT SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM SIGM_ELNO_DEPL

6
Results of modeling B
6.1 Values
tested
Identification
Reference
Aster *Difference*
Tolerance
Not O

M78

on lower layer
18.990 18.959
-0.158%
1.0%
xx

on lower layer
18.990 18.959

-0.158%
1.0%
yy

on lower layer
0.000 4.73E08 4.73E08
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
Constraints
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -0.306
-0.306 0.31
xz

on layer medium
0.000 0.306 0.306
0.31
yz

on higher layer
-18.990 -18.959 -0.158% 1.0%
xx

on higher layer
-18.990 -18.959 -0.158% 1.0%
yy

on higher layer
0.000 4.73E08
4.73E08
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.2012 4.017%
4.1%
Not B1

M6

on lower layer
0.000 1.695E01 0.17 0.7
xx

on lower layer
0.000 6.933E01
-0.693 0.7
yy

on lower layer
0.000 7.316E01

-0.732 0.74
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz

on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy
Constraints
on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 5.256E04
5.26E04 0.26
xz

on layer medium
-2.39732 -2.32183 -3.149% 3.2%
yz

on higher layer
0.000 1.695E01 0.17
0.7
xx

on higher layer
0.000 6.933E01 0.693
0.7
yy

on higher layer
0.000 7.316E01 0.732 0.74
xy

on higher layer
0.000 0.000 0.000 0.01
xz

on higher layer
0.000 0.000 0.000 0.01
yz

Reference
Not
NR
NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y

O M78
0.000 0.000 0.000 3.1662E02
3.1662E02 0.000
0.000
0.000
O M79
- - -
-
-
-
0.000
0.000
O M66
- - -
-
-
-
0.000
0.000
O M67
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02
0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D

0.000 0.000 0.000
0.000
0.000 1.8997E02
0.000
0.000
B1 M6
0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M7
0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
D1 M61
- - -
-
-
1.5915E01 0.000
D1 M73 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000

Aster
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X

y
O M78
0.000 0.000 0.000 3.1599E02
3.1599E02 7.878E11 2.0378E02 2.0378E02
O M79
- - -
-
-
-
2.0378E02 2.0378E02
O M66
- - -
-
-
2.0378E02
2.0378E02
O M67
- - -
-
-
-
2.0378E02
2.0378E02
With
0.000 0.000 0.000 6.3887E05 6.3887E05 1.8524E02 2.6619E04 2.6619E04
B
0.000 0.000 0.000 6.3887E05 6.3887E05 1.8524E02
2.6619E04 2.6619E04
C
0.000 0.000 0.000 6.388E05 6.388E05 1.8528E02 2.6619E04 2.6619E04
D
0.000 0.000 0.000 6.388E05 6.388E05 1.8548E02
2.6619E04 2.6619E04
B1 M6
0.000 0.000 0.000 2.8258E04 1.1555E03 1.2194E03 3.5045E05 1.5478E01
B1 M7
0.000 0.000 0.000 2.8258E04 1.1555E03 1.2194E03
3.5045E05 1.5478E01
D1 M61
- - -
-
-
1.5478E01

3.5045E05
D1 M73 0.000 0.000 0.000 1.1555E03 2.8258E04 1.2194E03
1.5478E01 3.5045E05

Difference
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000 -0.199%
0.199% 7.88E11 0.02
0.02
O M79
- - -
-
-
-
0.02
0.02
O M66
- - -
-
-
-
-0.02
-0.02
O M67
- - -
-

-
-
0.02
-0.02
With
0.000 0.000 0.000 6.39E05 6.39E05 2.491% 2.66E04 2.66E04
B
0.000 0.000 0.000 6.39E05 6.39E05 2.491% 2.66E04 2.66E04
C
0.000 0.000 0.000 6.39E05 6.39E05 2.491% 2.66E04 2.66E04
D
0.000 0.000 0.000 6.39E05 6.39E05 2.491% 2.66E04 2.66E04
B1 M6
0.000 0.000 0.000 2.83E04
0.001 0.001
3.50E05
-2.743%
B1 M7
0.000 0.000 0.000 2.83E04
0.001 -0.001
3.50E05
-2.743%
D1 M61
- - -
-
-
-
2.743% 3.50E05
D1 M73 0.000 0.000 0.000
0.001 2.83E04 0.001 2.743% 3.50E05
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

Code_Aster ®
Version
6.0

Titrate:
SSLS118 - Square plate subjected to a sinusoidal pressure
Date:
16/11/01
Author (S):

6.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
5.74 seconds

7 Modeling C

7.1 Characteristics of modeling

Triangular element of hull DKT.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1
Not B
Net: M266
Not C
Net: M288
Not D
Net: M23
Not B1
Meshs: M122, M146
Not D1
Meshs: M14, M11

7.2 Characteristics

grid

A number of nodes: 170
A number of meshs and type: 288 TRIA3

7.3 Functionalities tested

Orders

AFFE_MODELE
“MECHANICAL”
“DKT”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

DDL_IMPO
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

8
Results of modeling C
8.1 Values
tested
Identification

Reference
Aster *Difference*
Tolerance
Not O

M134

on lower layer
18.990 19.003 0.073%
1.0%
xx

on lower layer
18.990 18.899
-0.475%
1.0%
yy

on lower layer
0.000 4.428E02
-0.044 0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
Constraints
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01

yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 3.8507E01
-0.385 0.4
xz

on layer medium
0.000 3.2121E01 0.321 0.4
yz

on higher layer
-18.990 -19.003 0.073% 1.0%
xx

on higher layer
-18.990 -18.899 -0.475% 1.0%
yy

on higher layer
0.000 4.4282E02 0.044 0.05
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.1362
-1.62%
2.0%
Not B1

M122

on lower layer
0.000 1.7562E01
-0.176 0.2
xx

on lower layer
0.000 7.0248E01
-0.702 0.8
yy

on lower layer
0.000 7.4243E01
-0.742
0.8
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz

on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy
Constraints
on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 2.9390E01
-0.294
0.3
xz

on layer medium
-2.39732 -2.3762 -0.878% 2.0%
yz

on higher layer
0.000 1.7562E01 0.176
0.26
xx

on higher layer
0.000 7.0248
E01 0.702
0.8
yy

on higher layer
0.000 7.4243
E01 0.742
0.8
xy

on higher layer
0.000 0.000 0.000 0.01
xz

on higher layer
0.000 0.000 0.000 0.01
yz

Titrate:
SSLS118 - Square plate subjected to a sinusoidal pressure
Date:
16/11/01
Author (S):
***P. MASSIN**, NR. RAHNI Key*
:

V3.03.118-A Page:
17/62

Reference
Not
NR NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1662E02 3.1662E02
0.000 0.000 0.000
O M158
- - -
-
-
-
0.000
0.000
O M132
- - -
-
-
-
0.000
0.000
O M156
- - -
-
-
-
0.000
0.000

With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B1 M122 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M146 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
D1 M11
- - -
-
-
-
1.5915E01 0.000
D1 M14 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000
Aster
Not
NR NR
NR

M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1673E02 3.1499E02
7.38E05
2.567E02 2.1414E02
O M158
-
-
-
-
-
-
2.0275 E02
7.084 E03
O M132
-
-
-
-
-
-
2.567 E02
2.1414 E02
O M156
-
-
-
-
-
-
2.0275 E02
7.084 E03

With
0.000 0.000 0.000 8.33
E04
2.08 E04
1.8758 E02
3.4239 E02
6.153 E03
B
0.000 0.000 0.000 3.07
E18
3.26 E18
1.8431 E02
1.17 E04
1.17 E04
C
0.000 0.000 0.000 -1.18
E16
1.13 E16
1.8431 E02
1.17 E04
1.17 E04
D
0.000 0.000 0.000 8.33
E04
2.08 E04
1.8758 E02
3.423 E02
6.153 E03
B1 M122 0.000 0.000 0.000 2.93
E04
1.170 E03
1.237 E03
1.9593 E02
1.5841 E01
B1 M146 0.000 0.000 0.000 9.19
E04
3.677 E03
1.0159 E03
1.8524 E02 1.5581 E01
D1 M11
-
-
-

-
-
-
1.2826 E01
2.3404 E02
D1 M14 0.000 0.000 0.000 2.289
E03
6.58 E04
8.50 E04
1.9585 E01
5.3227 E02
Difference
Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 0.033%
-0.515% 7.38
E05 0.026
0.021
O M158
- - -
-
-
-
0.02
0.007
O M132
- - -
-
-

-
-0.026
-0.021
O M156
- - -
-
-
-
0.02
-0.007
With
0.000 0.000 0.000 8.33
E04
2.08 E04
-1.26%
-0.034
-0.006
B
0.000 0.000 0.000 3.07
E18 3.26
E18 2.98%
1.17 E04
1.17 E04
C
0.000 0.000 0.000 -1.18
E16 1.13
E16
-2.98%
1.17 E04
1.17 E04
D
0.000 0.000 0.000 8.33
E04
2.08 E04
-1.26%
-0.034
0.006
B1 M122 0.000 0.000 0.000 2.93
E04
0.001 0.001 -0.02 -0.463%
B1 M146 0.000 0.000 0.000 9.19
E04
0.004 -0.001 -0.019 -2.101%

D1 M11
- - -
-
-
-
-19.41%
0.023
D1 M14 0.000 0.000 0.000

23.059%
0.053
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

8.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
7.38 seconds

9 Modeling D

9.1 Characteristics of modeling

Triangular element of hull DST.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1
Not B

Net: M266
Not C
Net: M288
Not D
Net: M23
Not B1
Meshs: M122, M146
Not D1
Meshs: M14, M11

9.2 Characteristics

grid

A number of nodes: 170
A number of meshs and type: 288 TRIA3

9.3 Functionalities tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

DDL_IMPO
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

---

10 Results of modeling D

10.1 Values

tested
Identification
Reference
Aster Difference
Tolerance
Not O

M134

on lower layer
18.990 18.872
-0.62% 1.0%
xx

on lower layer
18.990 18.896
-0.49% 1.0%
yy

on lower layer
0.000
2.61 E04
2.61 E04
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer

0.000 0.000 0.000
0.01
yz
Constraints
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -2.8134
E01
-0.281
0.3
xz

on layer medium
0.000 3.0148
E01 0.301 0.4
yz

on higher layer
-18.990 -18.872 -0.62% 1%
xx

on higher layer
-18.990 -18.896 -0.49% 1%
yy

on higher layer
0.000
2.61 E04
2.61 E04
0.01

xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.1951 3.487%
4.1%
Not B1

M122

on lower layer
0.000 -5.2518
E01
-0.525 0.8
xx

on lower layer
0.000 -6.8948
E01
-0.689 0.8
yy

on lower layer
0.000 -7.305
E01
-0.731
0.8
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz

on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy
Constraints
on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 -4.900
E02
-0.049
0.05
xz

on layer medium
-2.39732 -2.3421 -2.3%
3%
yz

on higher layer
0.000 5.2518
E01 0.525
0.8
xx

on higher layer
0.000 6.8948
E01 0.689
0.8
yy

on higher layer
0.000 7.3051
E01 0.731
0.8

xy

on higher layer
0.000 0.000 0.000 0.01
xz

---

on higher layer
0.000 0.000 0.000 0.01
yz
Reference
Not
NR NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y

O M134 0.000 0.000 0.000 3.1662E02 3.1662E02
0.000 0.000 0.000
O M158
- - -
-
-
-
0.000
0.000
O M132
- - -
-
-
-
0.000
0.000
O M156
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000

B1 M122 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M146 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
D1 M11
- - -
-
-
-
1.5915E01 0.000
D1 M14 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000
Aster
Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1453
E02 3.1494 E02
4.36 E07
1.8756 E02
2.009 E02
O M158
-

-
-
-
-
-
2.2389 E02
1.7581 E02
O M132
-
-
-
-
-
-
1.8756 E02
2.009 E02
O M156
-
-
-
-
-
-
2.2389 E02
1.7581 E02
With
0.000 0.000 0.000 7.61
E04
1.6 E05
1.8869 E02
3.8490 E02
9.68 E04
B
0.000 0.000 0.000 -2.69
E05
2.69 E05
1.8415 E02
1.87 E04
1.87 E04
C
0.000 0.000 0.000 2.69
E05
2.69 E05

1.8415 E02
1.87 E04
1.87 E04
D
0.000 0.000 0.000 7.61
E04
1.6 E05
1.8869 E02
3.849 E02
9.68 E04
B1 M122 0.000 0.000 0.000 8.75
E04
1.149 E03
1.217 E03
3.266 E03
1.5614 E01
B1 M146 0.000 0.000 0.000 2.21
E04
3.149 E03
9.47 E04
3.148 E03
1.5117 E01
D1 M11
-
-
-
-
-
-
1.4437 E01
4.336 E03
D1 M14 0.000 0.000 0.000 1.446
E03
4.34 E04
4.30 E04
1.6235 E01
9.371 E03
Difference
Not
NR NR
NR
M
M

M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000
-0.66%
-0.531% 4.36
E07 0.019
0.02
O M158
- - -
-
-
-
0.022
0.018
O M132
- - -
-
-
-
-0.019
-0.02
O M156
- - -
-
-
-
0.022
-0.018
With
0.000 0.000 0.000 7.61
E04 1.6
E05 0.673% 0.038 9.68
E04
B

0.000 0.000 0.000 -2.69
E05 2.69
E05 3.065%
1.87 E04
1.87 E04
C
0.000 0.000 0.000 -2.69
E05 2.69
E05 3.065%
1.87 E04
1.87 E04
D
0.000 0.000 0.000 7.61
E04 1.6
E05 0.673% 0.038 9.68
E04
B1 M122 0.000 0.000 0.000 8.75
E04
0.001 0.001 -0.003 -1.891%
B1 M146 0.000 0.000 0.000 2.21
E04
0.003 -9.47
E04 0.003 5.013%
D1 M11
- - -
-
-
-
-9.29%
0.004
D1 M14 0.000 0.000 0.000
0.001
4.34
E04 4.30
E04 2.013%
0.009
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

Code_Aster ®
Version
6.0

10.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
7.38 seconds

11 Modeling E

11.1 Characteristics of modeling

Element of hull COQUE_3D triangle.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1
Not B
Net: M266
Not C
Net: M288
Not D
Net: M23

Not B1
Meshs: M122, M146
Not D1
Meshs: M14, M11

11.2 Characteristics

grid

A number of nodes: 626
A number of meshs and type: 288 TRIA6

11.3 Functionalities
tested

Orders

AFFE_MODELE
"MECHANICAL"
"COQUE_3D"

CREA_MAILLAGE MODI_MAILLE
"TRIA6_7"

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

DDL_IMPO
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

---

12 Results of modeling E

12.1 Values
tested
Identification
Reference
Aster Difference
Tolerance
Not O

M134

on lower layer
18.990 18.920
-0.364%
1.0%
xx

on lower layer
18.990 19.099 0.579 1.0%
yy

on lower layer
0.000 -1.2540
E01
-0.125
0.2
xy

on lower layer
0.000 -1.688
E02
-0.017 0.02
xz

on lower layer
0.000 7.210

E02 0.072 0.08
yz
Constraints
on layer medium
0.000
4 E15
4 E15
0.01
xx

on layer medium
0.000
2 E14
2 E14
0.01
yy

on layer medium
0.000
4 E15
4 E15
0.01
xy

on layer medium
0.000 -1.688
E02
-0.017 0.02
xz

on layer medium
0.000 7.210
E02 0.072 0.08
yz

on higher layer
-18.990 -18.920

-0.364% 1.0%
xx

on higher layer
-18.990 -19.099 0.579% 1.0%
yy

on higher layer
0.000 1.2540
E01 0.125 0.2
xy

on higher layer
0.000 -1.688
E02
-0.017 0.02
xz

on higher layer
0.000 7.210
E02 0.072 0.08
yz
Displacement DZ
-1.1549
-1.2029 4.164%
4.2%
Not B1

M122

on lower layer
0.000 6.291
E02 0.063 0.08
xx

on lower layer
0.000 1.448
E01 0.145 0.2
yy

on lower layer
0.000 -2.025
E02 0.02
0.03
xy

on lower layer
0.000 -4.916

E02
-0.049
0.05
xz

on lower layer
0.000 -1.542
-1.543
1.6
yz

on layer medium
0.000
5 E16
5 E16
0.01
xx

on layer medium
0.000
2 E15
2 E15
0.01
yy
Constraints
on layer medium
0.000
4 E15
4 E15
0.01
xy

on layer medium
0.000 -4.916
E02
-0.049
0.06
xz

on layer medium
-2.39732 -1.5426 -35.651%
36.0%
yz

on higher layer
0.000 -6.291
E02
-0.063
0.08
xx

on higher layer
0.000 -1.448
E01
-0.145
0.2
yy

on higher layer
0.000 2.025
E02 0.02
0.03
xy

on higher layer
0.000 -4.916
E02
-0.049
0.05
xz

---

on higher layer
0.000 -1.5426
-1.543
1.6
yz
Reference
Not
NR NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1662E02 3.1662E02
0.000 0.000 0.000
O M158
- - -
-
-
-
0.000
0.000
O M132
- - -
-
-
-
0.000
0.000
O M156
- - -
-
-

-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B1 M122 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M146 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
D1 M11
- - -
-
-
-
1.5915E01 0.000
D1 M14 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000
Aster

Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1534
E02 3.1833 E02
2.09 E04
1.688 E03
7.210 E03
O M158
-
-
-
-
-
-
1.494 E03
8.008 E03
O M132
-
-
-
-
-
-
1.283 E03
1.248 E03
O M156
-
-
-

-
-
-
1.910 E03
3.90 E04
With
0.000 0.000 0.000 3.69
E04
2.18 E04
1.9133 E02
5.387 E03
7.027 E03
B
0.000 0.000 0.000 1.71
E04
1.61 E04
1.8932 E02
1.511 E03
1.513 E03
C
0.000 0.000 0.000 1.70
E04
1.56 E04
1.8815 E02
1.463 E03
1.508 E03
D
0.000 0.000 0.000 3.66
E04
2.13 E04
1.8998 E02
5.066 E03
6.800 E03
B1 M122 0.000 0.000 0.000 1.04
E04
2.41 E04
3.4 E05
4.916 E03
1.5426 E01
B1 M146 0.000 0.000 0.000 2.9
E05
1.64 E04
6.5 E07

2.7681 E01
1.8932 E01
D1 M11
-
-
-
-
-
-
1.8488 E01
2.7113 E02
D1 M14 0.000 0.000 0.000 4.30
E04
3.07 E04
4.2 E05
1.4791 E01
1.1165 E02
Difference
Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 0.404%
0.538% 2.09
E04 0.002
0.007
O M158
- - -
-
-
-

-0.001
0.008
O M132
- - -
-
-
-
-0.001
0.001
O M156
- - -
-
-
-
-0.002 -3.90
E04
With
0.000 0.000 0.000 3.69
E04
2.18 E04
0.716%
-0.005
0.007
B
0.000 0.000 0.000 1.71
E04
1.61 E04
-0.344%
-0.002
0.002
C
0.000 0.000 0.000 1.70
E04
1.56 E04
-0.958%
-0.001
-0.002
D
0.000 0.000 0.000 3.66
E04
2.13 E04
0.003%
-0.005

-0.007
B1 M122 0.000 0.000 0.000 1.05
E04 2.41
E04 3.4
E05 0.005 3.072%
B1 M146 0.000 0.000 0.000 2.9
E05
1.65 E04
6.5 E07
0.028
18.955%
D1 M11
- - -
-
-
-
16.17%
-0.027
D1 M14 0.000 0.000 0.000 4.31
E04
3.07 E04
4.2 E05
-7.06%
-0.011

12.2 Parameters

of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
11.05 seconds

13 Modeling
F

13.1 Characteristics of modeling

Element of hull COQUE_3D quadrangle.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M66, M67, M78, M79
Not A
Net: M1
Not B
Net: M12
Not C
Net: M144
Not D
Net: M133
Not B1
Meshs: M6, M7
Not D1
Meshs: M73, M61

13.2 Characteristics

grid

A number of nodes: 482
A number of meshs and type: 144 QUAD8

13.3 Functionalities tested

Orders

AFFE_MODELE "MECHANICAL" "COQUE_3D"

CREA_MAILLAGE MODI_MAILLE "QUAD8_9"

AFFE_CARA_ELEM HULL THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE NEAR

DDL_IMPO ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

---

14 Results of modeling F

14.1 Values tested

Identification
Reference
Aster Difference
Tolerance
Not O

M78

on lower layer
18.990 19.306 1.665%
2.0%
xx

on lower layer
18.990 19.763 4.073%
5.0%
yy

on lower layer
0.000 -5.19
E01
-0.52

0.6
xy

on lower layer
0.000 -4.85
E02
-0.049 0.06
xz

on lower layer
0.000 1.4700 0.147 0.2
yz
Constraints
on layer medium
0.000
8.9 E15
8.9 E15
0.01
xx

on layer medium
0.000
1.0 E14
1.0 E14
0.01
yy

on layer medium
0.000
1.8 E14
1.8 E14
0.01
xy

on layer medium
0.000 -4.85
E02
-0.049 0.1
xz

on layer medium
0.000 1.470
E01 0.147 0.2
yz

on higher layer
-18.990 -19.306 1.665% 2.0%
xx

on higher layer
-18.990 -19.763 4.073% 5.0%
yy

on higher layer
0.000 5.199
E01 0.520 0.6
xy

on higher layer
0.000 -4.853
E02
-0.049 0.06
xz

on higher layer
0.000 1.470
E01 0.147 0.2
yz
Displacement DZ
-1.1549
-1.2038
4.24%
4.5%
Not B1

M6

on lower layer
0.000 1.924
E02 0.019 0.05
xx

on lower layer
0.000 3.190
E02 0.032 0.05
yy

on lower layer
0.000 -3.526
E02
-0.035
0.05
xy

on lower layer
0.000 -3.425
E03
-0.003
0.01
xz

on lower layer
0.000 -1.671
-1.671
2.0
yz

on layer medium
0.000
4.2 E015
4.2 E15
0.01
xx

on layer medium
0.000
1.6 E14
1.6 E14
0.01
yy
Constraints
on layer medium
0.000
1.2 E14
1.2 E14
0.01
xy

on layer medium
0.000 -3.425

E03
-0.003
0.01
xz

on layer medium
-2.39732 -1.671 -30.274%
35.0%
yz

on higher layer
0.000 -1.924
E02
-0.019
0.05
xx

on higher layer
0.000 -3.190
E02
-0.032
0.05
yy

on higher layer
0.000 3.526
E02 0.035
0.05
xy

on higher layer
0.000 -3.425
E03
-0.003
0.01
xz

Titrate:
SSLS118 - Square plate subjected to a sinusoidal pressure
Date:
16/11/01
Author (S):
P. MASSIN, NR. RAHNI Key
:
V3.03.118-A Page:
29/62

on higher layer
0.000 -1.671
-1.671
2.0
yz
Reference
Not
NR
NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000 3.1662E02
3.1662E02
0.000 0.000 0.000
O M79
- - -
-
-
-

0.000
0.000
O M66
- - -
-
-
-
0.000
0.000
O M67
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B1 M6
0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M7
0.000 0.000 0.000

0.000
0.000 0.000 0.000
1.5915E01
D1 M61
- - -
-
-
-
1.5915E01 0.000
D1 M73 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000

Aster
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000 -3.2177
E02 3.2939 E02
8.66 E04
4.853 E03
1.4700 E02
O M79
- - -
-
-

-
-2.326
E03
1.3977
E02
O M66
- - -
-
-
-
-1.927
E03
1.4404
E02
O M67
- - -
-
-
-
-5.255
E03
1.5122
E02
With
0.000 0.000 0.000 -6.2
E08
6.2 E08
1.9225 E02
1.63 E04
1.26 E04
B
0.000 0.000 0.000 7.7
E08
8.5 E08
1.9315 E02
2.11 E04
8.0 E05
C
0.000 0.000 0.000 -8.7
E08
7.7 E08
1.8856 E02
3.0 E07

1.70 E04
D
0.000 0.000 0.000 6.7
E08
6.0 E08
1.8705 E02
2.49 E05
2.17 E05
B1 M6
0.000 0.000 0.000 -3.20
E05
5.31 E05
5.87 E05
3.42 E04
1.6715 E01
B1 M7
0.000 0.000 0.000 -3.20
E05
5.31 E05
2.24 E05
3.32 E04
1.6714 E01
D1 M61
- - -
-
-
-
-1.5743
E01
-2.81
E04
D1 M73 0.000 0.000 0.000 1.72
E05
2.15 E05
2.34 E04
1.5743 E01
3.12 E04

Difference
Not
NR
NR
NR

M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M78
0.000 0.000 0.000
1.624%
4.031% 8.67
E04 0.005
0.015
O M79
- - -
-
-
-
-0.002
0.014
O M66
- - -
-
-
-
-0.002
0.014
O M67
- - -
-
-
-
-0.005
0.015
With
0.000 0.000 0.000 -6.2
E08 6.2

E08 1.192% 1.63 E04
1.26 E04
B
0.000 0.000 0.000 7.7
E08 8.5
E08 1.672% 2.11 E04
8.0 E05
C
0.000 0.000 0.000 -8.7
E08 7.7
E08 0.742% 3.0 E07
1.70 E04
D
0.000 0.000 0.000 6.7
E08 6.0
E08 1.541% 2.49 E05
2.17 E05
B1 M6
0.000 0.000 0.000 -3.20
E05
5.31 E05
8.87 E05 3.42
E04 5.026%
B1 M7
0.000 0.000 0.000 -3.20
E05
5.31 E05
2.24 E05 3.32
E04 5.023%
D1 M61
- - -
-
-
-
-1.078% -2.81
E04
D1 M73 0.000 0.000 0.000 1.73
E05
2.15 E05
2.34 E04 1.082% 3.12
E04
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls

14.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
9.83 seconds

15 Modeling G

15.1 Characteristics of modeling

Triangular element of hull DST.
The model of plate associated with modeling D is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta. The classification of the meshs is identical to that of modeling D.

Limiting conditions:

LIAISON_OBLIQUE

(GROUP_NO: AB, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, ANGL_NAUT= (20. , 30. , 0.), DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, ANGL_NAUT= (20. , 30. , 0.), DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1

Not B
Net: M266
Not C
Net: M288
Not D
Net: M23
Not B1
Meshs: M122, M146
Not D1
Meshs: M14, M11

15.2 Characteristics

grid

A number of nodes: 170
A number of meshs and type: 288 TRIA3

15.3 Functionalities
tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

15.4 Remarks

The value of reference of displacement to the point O is obtained by projecting calculated displacement
for modeling D in the reference mark turned (displacement for modeling D being vertical, it new displacement is a function of the projection of axis Z).
In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =

.

30

cos

In addition, the expression of the sinusoidal pressure in the turned reference mark becomes:

Error! Objects cannot be created starting from the field codes of working.

---

16 Results of modeling G

16.1 Values
tested

Identification
Reference
Aster Difference
Tolerance
Not O

M134

on lower layer
18.990 18.872
-0.62% 1.0%
xx

on lower layer
18.990 18.896
-0.49% 1.0%
yy

on lower layer
0.000
2.61 E04
2.61 E04
0.2
xy

on lower layer
0.000 0.000 0.000
0.02
xz

on lower layer
0.000 0.000 0.000
0.08
yz
Constraints
on layer medium
0.000
3. E14
3. E14
0.01
xx

on layer medium
0.000
7. E14
7. E14
0.01
yy

on layer medium
0.000
8. E14

8. E14
0.01
xy

on layer medium
0.000 -2.8134
E01
-0.281
0.02
xz

on layer medium
0.000 3.0148
E01 0.301 0.08
yz

on higher layer
-18.990 -18.872 -0.62% 1.0%
xx

on higher layer
-18.990 -18.896 -0.49 1.0%
yy

on higher layer
0.000
2.61 E04
2.61 E04
0.2
xy

on higher layer
0.000 0.000 0.000
0.02
xz

on higher layer
0.000 0.000 0.000
0.08
yz
Displacement DZ
-1.0002
-1.0350 3.484%
4.2%

Not B1

M122

on lower layer
0.000 -5.2518
E01
-0.525 0.08
xx

on lower layer
0.000 -6.8948
E01
-0.689 0.2
yy

on lower layer
0.000 -7.305
E01
-0.731
0.03
xy

on lower layer
0.000 0.000 0.000 0.05
xz

on lower layer
0.000 0.000 0.000 1.6
yz

on layer medium
0.000
1. E15
1. E15
0.01
xx

on layer medium
0.000
4. E15
4. E15

0.01
yy
Constraints
on layer medium
0.000
9. E15
9. E15
0.01
xy

on layer medium
0.000 -4.900
E02
-0.049
0.06
xz

on layer medium
-2.39732 -2.3421 -2.3% 36.0%
yz

on higher layer
0.000 5.2518
E01 0.525
0.08
xx

on higher layer
0.000 6.8948
E01 0.689
0.2
yy

on higher layer
0.000 7.3051
E01 0.731
0.03
xy

on higher layer
0.000 0.000 0.000 0.05
xz

on higher layer

0.000 0.000 0.000 1.6
yz

Reference
Not
NR NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1662E02
3.1662E02 0.000
0.000
0.000
O M158
- - -

-
-
-
0.000
0.000
O M132
- - -
-
-
-
0.000
0.000
O M156
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B1 M122 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01

B1 M146 0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
D1 M11
- - -
-
-
-
1.5915E01 0.000
D1 M14 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000
Aster
Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1453
E02
3.1494 E02
4.36 E07
1.8756 E02
2.009 E02
O M158
-
-
-
-

-
-
2.2389 E02
1.7581 E02
O M132
-
-
-
-
-
-
1.8756 E02
2.009 E02
O M156
-
-
-
-
-
-
2.2389 E02
1.7581 E02
With
0.000 0.000 0.000 7.61
E04
1.6 E05
1.8869 E02
3.8490 E02
9.68 E04
B
0.000 0.000 0.000 -2.69
E05
2.69 E05
1.8415 E02
1.87 E04
1.87 E04
C
0.000 0.000 0.000 2.69
E05
2.69 E05
1.8415 E02
1.87 E04
1.87 E04

D
0.000 0.000 0.000 7.61
E04
1.6 E05
1.8869 E02
3.849 E02
9.68 E04
B1 M122 0.000 0.000 0.000 8.75
E04
1.149 E03
1.217 E03
3.266 E03
1.5614 E01
B1 M146 0.000 0.000 0.000 2.21
E04
3.149 E03
9.47 E04
3.148 E03
1.5117 E01
D1 M11
-
-
-
-
-
-
1.4437 E01
4.336 E03
D1 M14 0.000 0.000 0.000 1.446
E03
4.34 E04
4.30 E04
1.6235 E01
9.371 E03
Difference
Not
NR
NR
NR
M
M
M
Q

Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 0.66%
-0.531% 4.36
E07 0.019
0.02
O M158
- - -
-
-
-
0.022
0.018
O M132
- - -
-
-
-
-0.019
-0.02
O M156
- - -
-
-
-
0.022
-0.018
With
0.000 0.000 0.000 7.61
E04 1.6
E05 0.673% 0.038
-9.68
E04
B
0.000 0.000 0.000 -2.69
E05 2.69

E05 3.065% 1.87 E04
1.87 E04
C
0.000 0.000 0.000 -2.69
E05 2.69
E05 3.065% 1.87 E04
1.87 E04
D
0.000 0.000 0.000 7.61
E04 1.6
E05 0.673% 0.038 9.68
E04
B1 M122 0.000 0.000 0.000 8.75
E04
0.001 0.001 -0.003
-1.891%
B1 M146 0.000 0.000 0.000 2.21
E04
0.003 -9.47
E04 0.003 5.013%
D1 M11
- - -
-
-
-
-9.29%
0.004
D1 M14 0.000 0.000 0.000
0.001
4.34
E04 4.30
E04 2.013%
0.009

16.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
7.98 seconds

17 Modeling H

17.1 Characteristics of modeling

Triangular element of hull COQUE_3D.
The model of plate associated with modeling E is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta. The classification of the meshs is identical to that of modeling E.

Limiting conditions:

LIAISON_OBLIQUE

(GROUP_NO: AB, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, ANGL_NAUT= (20. , 30. , 0.), DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, ANGL_NAUT= (20. , 30. , 0.), DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1
Not B
Net: M266
Not C
Net: M288
Not D
Net: M23
Not B1

Meshs: M122, M146
Not D1
Meshs: M14, M11

17.2 Characteristics

grid

A number of nodes: 626
A number of meshs and type: 288 TRIA6

17.3 Functionalities
tested

Orders

AFFE_MODELE
“MECHANICAL”
“COQUE_3D”

CREA_MAILLAGE MODI_MAILLE
“TRIA6_7”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

17.4 Remarks

The value of reference of displacement to the point O is obtained by projecting calculated displacement
for modeling E in the reference mark turned (displacement for modeling E being vertical, it new displacement is a function of the projection of axis Z).
In the local reference mark, the projection of axis Z is as follows:

sin cos

sin sin, with = 20. and =
.
30

cos

In addition, the expression of the sinusoidal pressure in the turned reference mark becomes:

cos cos X + sin cos y - sin Z
cos y - sin X
P = F sin

0

sin
has
has

---

18 Results of modeling H
18.1 Values
tested
Identification
Reference
Aster Difference
Tolerance
Not O

M134

on lower layer
18.990 18.920
-0.364%
1.0%
xx

on lower layer
18.990 19.099 0.579 1.0%
yy

on lower layer
0.000 -1.2540
E01
-0.125
0.01
xy

on lower layer
0.000 -1.688
E02
-0.017 0.01
xz

on lower layer
0.000 7.210
E02 0.072 0.01
yz
Constraints
on layer medium
0.000 1.E13 1.
E13
0.01
xx

on layer medium
0.000
3. E14
3. E14
0.01
yy

on layer medium
0.000
2. E13
2. E13
0.01
xy

on layer medium
0.000 -1.688
E02
-0.017 0.02
xz

on layer medium
0.000 7.210
E02 0.072 0.08
yz

on higher layer
-18.990 -18.920

-0.364% 1%
xx

on higher layer
-18.990 -19.099 0.579% 1%
yy

on higher layer
0.000 1.2540
E01 0.125 0.2
xy

on higher layer
0.000 -1.688
E02
-0.017 0.02
xz

on higher layer
0.000 7.210
E02 0.072 0.08
yz
Displacement DZ

-1.0002
-1.0418 4.161%
4.2%
Not B1

M122

on lower layer
0.000 6.291
E02 0.063 0.08
xx

on lower layer
0.000 1.448
E01 0.145 0.2
yy

on lower layer
0.000 -2.025
E02 0.02
0.03
xy

on lower layer
0.000 -4.916
E02
-0.049
0.05
xz

on lower layer
0.000 -1.542
E01
-1.543
1.6
yz

on layer medium
0.000
2. E14
2. E14
0.01

xx

on layer medium
0.000
8. E14
8. E14
0.01
yy
Constraints
on layer medium
0.000
2. E15
2. E15
0.01
xy

on layer medium
0.000 -4.916
E02
-0.049
0.06
xz

on layer medium
-2.39732 -1.5426 -35.651%
36%
yz

on higher layer
0.000 -6.291
E02
-0.063
0.08
xx

on higher layer
0.000 -1.448
E01
-0.145
0.2
yy

on higher layer
0.000 2.025

E02 0.02
0.03
xy

on higher layer
0.000 -4.916
E02
-0.049
0.05
xz

on higher layer
0.000 -1.5426
-1.543
1.6
yz
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

Reference
Not
NR NR
NR
M
M
M
T
T

xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 3.1662E02 3.1662E02
0.000 0.000 0.000
O M158
- - -
-
-
-
0.000
0.000
O M132
- - -
-
-
-
0.000
0.000
O M156
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02
0.000
0.000
C

0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02
0.000
0.000
B1 M122 0.000 0.000 0.000
0.000
0.000 0.000 0.000 1.5915E01
B1 M146 0.000 0.000 0.000
0.000
0.000 0.000 0.000 1.5915E01
D1 M11
- - -
-
-
-
1.5915E01
0.000
D1 M14 0.000 0.000 0.000
0.000
0.000 0.000 1.5915E01
0.000
Aster
Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X

y
O M134 0.000 0.000 0.000 3.1534
E02 3.1833 E02
2.09 E04
1.688 E03
7.210 E03
O M158
-
-
-
-
-
-
1.494 E03
8.008 E03
O M132
-
-
-
-
-
-
1.283 E03
1.248 E03
O M156
-
-
-
-
-
-
1.910 E03
3.90 E04
With
0.000 0.000 0.000 3.69
E04
2.18 E04
1.9133 E02
5.387 E03
7.027 E03
B
0.000 0.000 0.000 1.71
E04

1.61 E04
1.8932 E02
1.511 E03
1.513 E03
C
0.000 0.000 0.000 1.70
E04
1.56 E04
1.8815 E02
1.463 E03
1.508 E03
D
0.000 0.000 0.000 3.66
E04
2.13 E04
1.8998 E02
5.066 E03
6.800 E03
B1 M122 0.000 0.000 0.000 1.04
E04
2.41 E04
3.4 E05
4.916 E03
1.5426 E01
B1 M146 0.000 0.000 0.000 2.9
E05
1.64 E04
6.5 E07
2.7681 E01
1.8932 E01
D1 M11
-
-
-
-
-
-
1.8488 E01
2.7113 E02
D1 M14 0.000 0.000 0.000 4.30
E04
3.07 E04
4.2 E05

1.4791 E01
1.1165 E02
Difference
Not
NR NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M134 0.000 0.000 0.000 0.404%
0.538% 2.09
E04 0.002
0.007
O M158
- - -
-
-
-
-0.001
0.008
O M132
- - -
-
-
-
-0.001
0.001
O M156
- - -
-
-
-
-0.002

-3.90
E04
With
0.000 0.000 0.000 3.69
E04
2.18 E04
0.716%
-0.005
0.007
B
0.000 0.000 0.000 1.71
E04
1.61 E04
-0.344%
-0.002
0.002
C
0.000 0.000 0.000 1.70
E04
1.56 E04
-0.958%
-0.001
-0.002
D
0.000 0.000 0.000 3.66
E04
2.13 E04
0.003%
-0.005
-0.007
B1 M122 0.000 0.000 0.000 1.05
E04 2.41
E04 3.4
E05 0.005 3.072%
B1 M146 0.000 0.000 0.000 2.9
E05 1.65 E04
6.5 E07
0.028
18.955%
D1 M11
- - -
-
-

-
16.17%
-0.027
D1 M14 0.000 0.000 0.000 4.31
E04 3.07
E04 4.2
E05 7.06%
-0.011
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

18.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
11.9 seconds

19 Modeling I

19.1 Characteristics of modeling

Quadrangular element of hull DSQ. The plate is modelled with a grid 24x24.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M276, M277, M300, M301
Not A
Net: M1
Not B
Net: M24
Not C
Net: M576

Not D
Net: M553
Not B1
Meshs: M12, M13
Not D1
Meshs: M289, M265

19.2 Characteristics

grid

A number of nodes: 626
A number of meshs and type: 576 QUAD4

19.3 Functionalities tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

DDL_IMPO
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

20 Results of modeling I

20.1 Values
tested
Identification
Reference
Aster Difference
Tolerance
Not O

M300

on lower layer
18.990 18.989
-0.005%
1.0%
xx

on lower layer
18.990 18.989
-0.005%
1.0%
yy

on lower layer
0.000 -1.0
E14
1.0E14
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
Constraints
on layer medium
0.000 0.000 0.000

0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -0.1554
-0.155 0.26
xz

on layer medium
0.000 0.1554 0.155 0.26
yz

on higher layer
-18.990 -18.989 -0.005 1.0%
xx

on higher layer
-18.990 -18.989 -0.005 1.0%
yy

on higher layer
0.000 1.0
E14 1.0E14
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz

Displacement DZ
-1.1549
-1.2120
4.95%
5.0%
Not B1

M12

on lower layer
0.000 -9.1146
E02
-0.091 0.1
xx

on lower layer
0.000 -3.6678
E01
-0.367 0.4
yy

on lower layer
0.000 -3.7119
E01
-0.371
0.74
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz

on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01

yy
Constraints
on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000
3.80 E05
3.80 E05
0.26
xz

on layer medium
-2.39732 -2.3712 1.086% 21%
yz

on higher layer
0.000 9.1146
E02 0.091
0.1
xx

on higher layer
0.000 3.6678
E01 0.367
0.4
yy

on higher layer
0.000 3.7119
E01 0.371
0.74
xy

on higher layer
0.000 0.000 0.000 0.01
xz

on higher layer
0.000 0.000 0.000 0.01
yz
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls

Reference
Not
NR
NR
NR
M
M
M
T
T
xx
yy
xy
xx
yy
xy
X
y
O M300
0.000 0.000 0.000 3.1662E02
3.1662E02
0.000 0.000 0.000
O M301
- - -
-
-
-
0.000

0.000
O M276
- - -
-
-
-
0.000
0.000
O M277
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B1 M12
0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M13
0.000 0.000 0.000
0.000

0.000 0.000 0.000
1.5915E01
D1 M265
- - -
-
-
-
1.5915E01 0.000
D1 M289 0.000 0.000 0.000
0.000
0.000 0.000
1.5915E01
0.000
Aster
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M300
0.000 0.000
0.000 -3.1648
E02 3.1648 E02
1.0 E17
1.0361 E02
1.0361 E02
O M301
-
-
-
-

-
-
1.0361 E02
1.0361 E02
O M276
-
-
-
-
-
-
1.0361 E02
1.0361 E02
O M277
-
-
-
-
-
-
1.0361 E02
1.0361 E02
With
0.000 0.000
0.000 1.86
E05
1.86 E05
1.8877 E02
3.87 E05
3.87 E05
B
0.000 0.000
0.000 1.86
E05
1.86 E06
1.8877 E02
3.87 E05
3.87 E05
C
0.000 0.000
0.000 1.86
E05
1.86 E05

1.8877 E02
3.87 E05
3.87 E05
D
0.000 0.000
0.000 1.86
E05
1.86 E05
1.8877 E02
3.87 E05
3.87 E05
B1 M12
0.000 0.000
0.000 1.52
E04
6.11 E04
6.19 E04
2.54 E06
1.5808 E01
B1 M13
0.000 0.000
0.000 1.52
E04
6.11 E04
6.19 E04
2.54 E06
1.5808 E01
D1 M265
-
-
-
-
-
-
1.5808 E01
2.54 E06
D1 M289
0.000 0.000
0.000 6.11
E04
1.51 E04
6.18 E04
1.5808 E01

2.56 E06
Difference
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M300
0.000 0.000
0.000 -0.046%
-0.046% 1.0
E17
-0.01
0.01
O M301
- - -
-
-
-
0.01
0.01
O M276
- - -
-
-
-
-0.01
-0.01
O M277
- - -
-

-
-
0.01
-0.01
With
0.000 0.000
0.000 1.86
E05 1.86
E05 0.631% 3.87 E05
3.87 E05
B
0.000 0.000
0.000 1.86
E05 1.86
E05 0.631% 3.87 E05
3.87 E05
C
0.000 0.000
0.000 1.86
E05 1.86
E05 0.631% 3.87 E05
3.87 E05
D
0.000 0.000
0.000 1.86
E05 1.86
E05 0.631% 3.87 E05
3.87 E05
B1 M12
0.000 0.000
0.000 1.52
E04
6.11 E04
6.19 E04 2.54
E06 0.672%
B1 M13
0.000 0.000
0.000 1.52
E04
6.11 E04
6.19 E04 2.54
E06 0.672%
D1 M265

- - -
-
-
-
-0.672% 2.54
E06
D1 M289
0.000 0.000
0.000 6.11
E04
1.51 E04
6.18 E04 0.672% 2.54
E06

20.2 Parameters
of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
9.88 seconds

42/62

21 Modeling
J

21.1 Characteristics of modeling

Quadrangular element of hull DSQ. The plate is modelled with a grid 48x48.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M1128, M1129, M1176, M1177
Not A
Net: M1
Not B
Net: M48
Not C
Net: M2304

Not D
Net: M2257
Not B1
Meshs: M24, M25
Not D1
Meshs: M1153, M1105

21.2 Characteristics

grid

A number of nodes: 2402
A number of meshs and type: 2304 QUAD4

21.3 Functionalities
tested

Orders

AFFE_MODELE
"MECHANICAL"
"DST"

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

DDL_IMPO
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls

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22 Results of modeling J
22.1 Values
tested
Identification
Reference
Aster Difference
Tolerance
Not O

M1176

on lower layer
18.990 18.995 0.029%
1.0%
xx

on lower layer
18.990 18.995 0.029%
1.0%
yy

on lower layer
0.000
2.7 E12

2.7 E12
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
Constraints
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -7.802
E02
-0.078 0.26
xz

on layer medium
0.000 7.802
E02 0.078 0.26
yz

on higher layer
-18.990 -18.995 0.029% 1.0%
xx

on higher layer
-18.990 -18.995 0.029 1.0%
yy

on higher layer
0.000
2.7 E12
2.7 E12
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.2148 5.187%
5.2%
Not B1

M24

on lower layer
0.000 -4.6366
E02
-0.046 0.1
xx

on lower layer
0.000 -1.8574
E01
-0.186 0.4
yy

on lower layer
0.000 -1.8628

E01
-0.186
0.74
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz

on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy
Constraints
on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000
2.47 E06
2.47 E07
0.26
xz

on layer medium
-2.39732 -2.3833 -0.583% 21%
yz

on higher layer
0.000 4.6366
E02 0.046
0.1
xx

on higher layer
0.000 1.8574

E01 0.186
0.4
yy

on higher layer
0.000 1.8628
E01 0.186
0.74
xy

on higher layer
0.000 0.000 0.000 0.01
xz

on higher layer
0.000 0.000 0.000 0.01
yz

Reference
Not
NR
NR
NR
M
M
M
T

T
xx
yy
xy
xx
yy
xy
X
y
O M1176
0.000 0.000 0.000 3.1662E02
3.1662E02
0.000 0.000 0.000
O M1177
- - -
-
-
-
0.000
0.000
O M1128
- - -
-
-
-
0.000
0.000
O M1129
- - -
-
-
-
0.000
0.000
With
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B
0.000 0.000 0.000
0.000
0.000 -1.8997

E02 0.000
0.000
C
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
D
0.000 0.000 0.000
0.000
0.000 1.8997E02 0.000
0.000
B1 M24
0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
B1 M25
0.000 0.000 0.000
0.000
0.000 0.000 0.000
1.5915E01
D1 M1105
- - -
-
-
1.5915E01 0.000
D1 M1153 0.000 0.000 0.000 0.000
0.000 0.000
1.5915E01
0.000
Aster
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy

xy
xx
yy
xy
X
y
O M1176
0.000 0.000 0.000
-3.1659
E02 3.1659 E02
4.5 E15
5.201 E03
5.201 E03
O M1177
-
-
-
-
-
-
5.201 E03
5.201 E03
O M1128
-
-
-
-
-
-
5.201 E03
5.201 E03
O M1129
-
-
-
-
-
-
5.201 E03
5.201 E03
With
0.000 0.000 0.000 4.83
E06

4.83 E06
1.8967 E02
5.03 E06
5.03 E06
B
0.000 0.000 0.000 4.83
E06
4.83 E06
1.8967 E02
5.03 E06
5.03 E06
C
0.000 0.000 0.000 4.83
E06
4.83 E06
1.8967 E02
5.03 E06
5.03 E06
D
0.000 0.000 0.000 4.83
E06
4.83 E06
1.8967 E02
5.03 E06
5.03 E06
B1 M24
0.000 0.000 0.000 7.73
E05
3.10 E04
3.10 E04
1.65 E07
1.5889 E01
B1 M25
0.000 0.000 0.000 7.73
E05
3.10 E04
3.10 E04
1.65 E07
1.5889 E01
D1 M1105
-
-
-

-
-
-
1.5889 E01
1.6 E07
D1 M1153 0.000 0.000 0.000 3.10
E04
7.73 E05
3.10 E04
1.5889 E01
1.6 E07
Difference
Not
NR
NR
NR
M
M
M
Q
Q
xx
yy
xy
xx
yy
xy
X
y
O M1176
0.000 0.000 0.000 -0.011
-0.011 4.5
E15 0.005 0.005
O M1177
- - -
-
-
-
0.005
0.005
O M1128
- - -
-

-
-
-0.005 -0.005
O M1129
- - -
-
-
-
0.005
0.005
With
0.000 0.000 0.000 4.83
E06 4.83
E06 0.159% 5.03 E06
5.03 E06
B
0.000 0.000 0.000 4.83
E06 4.83
E06 0.159% 5.03 E06
5.03 E06
C
0.000 0.000 0.000 4.83
E06 4.83
E06 0.159% 5.03 E06
5.03 E06
D
0.000 0.000 0.000 4.83
E06 4.83
E06 0.159% 5.03 E06
5.03 E06
B1 M24
0.000 0.000 0.000 7.73
E05
3.10 E04
3.10 E04 1.65
E07 0.166%
B1 M25
0.000 0.000 0.000 7.73
E05
3.10 E04
3.10 E04 1.65
E07 0.166%
D1 M1105

- - -
-
-
-
-0.166% 1.6
E07
D1 M1153
0.000 0.000 0.000 3.10
E04
7.73 E05
3.10 E04 0.166% 1.6
E07

22.2 Parameters
of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:

21.89 seconds

23 Modeling
K

23.1 Characteristics of modeling

Isotropic multi-layer plate (5 layers in the thickness). Triangular element of hull DST.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1
Not B
Net: M266
Not C
Net: M288
Not D
Net: M23
Not B1
Meshs: M122, M146
Not D1
Meshs: M14, M11

23.2 Characteristics

grid

A number of nodes: 170
A number of meshs and type: 288 TRIA3

23.3 Functionalities
tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS_ORTH
E_L

E_T

E_N

G_TN

G_LT

G_LN

NU_LT

DEFI_COQU_MULT SLEEP

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

DDL_IMPO
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

---

24 Results of modeling K

24.1 Values tested

Identification
Reference
Aster Difference
Tolerance
Not O

M134
Lay down 1
on lower layer
18.990 18.872
-0.62% 1.0%
xx

on lower layer
18.990 18.896
-0.49% 1.0%
yy

on lower layer
0.000
2.61 E04
2.61 E04

0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -2.8134
E01
-0.281
0.4
xz

on layer medium
0.000 3.0148
E01 0.301 0.4
yz
5 sleep
on higher layer
-18.990 -18.872 -0.62% 1%
xx

on higher layer
-18.990 -18.896 -0.49% 1%
yy

on higher layer
0.000
2.61 E04
2.61 E04
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.1951 3.487%
4.1%
Not B1

M122
Lay down 1
on lower layer
0.000 -5.2518
E01
-0.525 0.8
xx

on lower layer
0.000 -6.8948
E01
-0.689 0.8
yy

on lower layer
0.000 -7.305

E01
-0.731
0.8
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy

on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 -4.900
E02
-0.049
0.05
xz

on layer medium
-2.39732 -2.3421 -2.3%
3%
yz
5 sleep
on higher layer
0.000 5.2518
E01 0.525
0.8
xx

on higher layer

0.000 6.8948
E01 0.689
0.8
yy

on higher layer
0.000 7.3051
E01 0.731
0.8
xy

on higher layer
0.000 0.000 0.000 0.01
xz

---

on higher layer
0.000 0.000 0.000 0.01
yz

Evolution of the constraints in the plate

Not O

xx
yy
xy
xz
yz
Lower Couche1
18.8724 18.8969
-2.61426
E04
0
0
Higher Couche1
11.3234 11.3381
-1.56856
E04 1.80063 E01
1.92951 E01
Lower Couche2
11.3234 11.3381
-1.56856
E04 1.80063 E01
1.92951 E01
Higher Couche2
3.77447 3.77937
-5.22853
E05 2.70094 E01
2.89426 E01
Lower Couche3
3.77447 3.77937
-5.22853
E05 2.70094 E01
2.89426 E01
Average Couche3
6.54766 E16
6.55617 E16 9.07005 E21 2.81348 E01
3.01485 E01
Higher Couche3
-3.77447 -3.77937
5.22853
E05
2.70094 E01
2.89426 E01
Lower Couche4
-3.77447 -3.77937

5.22853
E05
2.70094 E01
2.89426 E01
Higher Couche4
-11.3234 -11.3381
1.56856
E04
1.80063 E01
1.92951 E01
Lower Couche5
-11.3234 -11.3381
1.56856
E04
1.80063 E01
1.92951 E01
Higher Couche5
-18.8724 -18.8969
2.61426
E04
3.33183 E17
3.57030 E17

Not B1

xx
yy
xy
xz
yz
Lower Couche1
5.25182 E01 6.89486 E01
7.30513 E01
0
0
Higher Couche1 3.15109 E01 4.13691 E01 4.38308 E01 3.13609 E02
-1.49899
Lower Couche2
3.15109 E01 4.13691 E01
4.38308 E01 3.13609 E02

-1.49899
Higher Couche2 1.05036 E01 1.37897 E01 1.46103 E01 4.70414 E02
-2.24848
Lower Couche3
1.05036 E01 1.37897 E01
1.46103 E01 4.70414 E02
-2.24848
Average Couche3
1.82209 E17 2.39231 E17
2.53448 E17 4.90014 E02
2.34217
Higher Couche3
1.05036 E01
1.37897 E01
1.46103 E01 4.70414 E02
-2.24848
Lower Couche4
1.05036 E01
1.37897 E01
1.46103 E01 4.70414 E02
-2.24848
Higher Couche4
3.15109 E01
4.13691 E01
4.38308 E01 3.13609 E02
-1.49899
Lower Couche5
3.15109 E01
4.13691 E01
4.38308 E01 3.13609 E02
-1.49899
Higher Couche5
5.25182 E01
6.89486 E01
7.30513 E01
5.80293 E18
2.77369 E16

24.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
seconds

---

25 Modeling
L

25.1 Characteristics of modeling

Isotropic multi-layer plate (5 layers in the thickness). Triangular element of hull DST.
The model of plate associated with modeling K is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta. The classification of the meshs is identical to that of modeling K.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M132, M156, M134, M158
Not A
Net: M1
Not B
Net: M266
Not C
Net: M288
Not D

Net: M23
Not B1
Meshs: M122, M146
Not D1
Meshs: M14, M11

25.2 Characteristics

grid

A number of nodes: 170
A number of meshs and type: 288 TRIA3

25.3 Functionalities
tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS_ORTH
E_L

E_T

E_N

G_TN

G_LT

G_LN

NU_LT

DEFI_COQU_MULT SLEEP

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

---

26 Results of modeling L

26.1 Values
tested
Identification
Reference
Aster Difference
Tolerance
Not O

M134
Lay down 1
on lower layer
18.990 18.872
-0.62% 1.0%
xx

on lower layer
18.990 18.896

-0.49% 1.0%
yy

on lower layer
0.000
2.61 E04
2.61 E04
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -2.8134
E01
-0.281
0.4
xz

on layer medium
0.000 3.0148

E01 0.301 0.4
yz
5 sleep
on higher layer
-18.990 -18.872 -0.62% 1%
xx

on higher layer
-18.990 -18.896 -0.49% 1%
yy

on higher layer
0.000
2.61 E04
2.61 E04
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.1951 3.487%
4.1%
Not B1

M122
Lay down 1
on lower layer
0.000 -5.2518
E01
-0.525 0.8
xx

on lower layer

0.000 -6.8948
E01
-0.689 0.8
yy

on lower layer
0.000 -7.305
E01
-0.731
0.8
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy

on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 -4.900
E02
-0.049
0.05
xz

on layer medium
-2.39732 -2.3421 -2.3%
3%
yz
5 sleep

on higher layer
0.000 5.2518
E01 0.525
0.8
xx

on higher layer
0.000 6.8948
E01 0.689
0.8
yy

on higher layer
0.000 7.3051
E01 0.731
0.8
xy

on higher layer
0.000 0.000 0.000 0.01
xz

---

on higher layer
0.000 0.000 0.000 0.01
yz

Evolution of the constraints in the plate

Not O

xx
yy
xy
xz
yz
Lower Couche1
18.8724 18.8969
-2.61426
E04
0
0
Higher Couche1
11.3234 11.3381
-1.56856
E04 1.80063 E01
1.92951 E01
Lower Couche2
11.3234 11.3381
-1.56856
E04 1.80063 E01
1.92951 E01
Higher Couche2
3.77447 3.77937
-5.22853
E05 2.70094 E01
2.89426 E01
Lower Couche3
3.77447 3.77937
-5.22853
E05 2.70094 E01
2.89426 E01
Average Couche3
2.70652 E14 2.69295 E14
1.22884 E13 2.81348 E01
3.01485 E01
Higher Couche3

-3.77447 -3.77937
5.22853
E05
2.70094 E01
2.89426 E01
Lower Couche4
-3.77447 -3.77937
5.22853
E05
2.70094 E01
2.89426 E01
Higher Couche4
-11.3234 -11.3381
1.56856
E04
1.80063 E01
1.92951 E01
Lower Couche5
-11.3234 -11.3381
1.56856
E04
1.80063 E01
1.92951 E01
Higher Couche5
-18.8724 -18.8969
2.61426
E04
3.33183 E17
3.57030 E17

Not B1

xx
yy
xy
xz
yz
Lower Couche1
5.25182 E01 6.89486 E01
7.30513 E01

0
0
Higher Couche1 3.15109 E01 4.13691 E01 4.38308 E01 3.13609 E02
-1.49899
Lower Couche2
3.15109 E01 4.13691 E01
4.38308 E01 3.13609 E02
-1.49899
Higher Couche2 1.05036 E01 1.37897 E01 1.46103 E01 4.70414 E02
-2.24848
Lower Couche3
1.05036 E01 1.37897 E01
1.46103 E01 4.70414 E02
-2.24848
Average Couche3
8.54411 E16 5.45131 E16
2.48746 E14 4.90014 E02
-2.34217
Higher Couche3
1.05036 E01
1.37897 E01
1.46103 E01 4.70414 E02
-2.24848
Lower Couche4
1.05036 E01
1.37897 E01
1.46103 E01 4.70414 E02
-2.24848
Higher Couche4
3.15109 E01
4.13691 E01
4.38308 E01 3.13609 E02
-1.49899
Lower Couche5
3.15109 E01
4.13691 E01
4.38308 E01 3.13609 E02
-1.49899
Higher Couche5
5.25182 E01
6.89486 E01
7.30513 E01
5.80293 E18

2.77369 E16

26.2 Parameters
of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
26.17 seconds

---

27 Modeling
M

27.1 Characteristics of modeling

Isotropic multi-layer plate (5 layers in the thickness). Quadrangular element of hull DSQ.
The reference mark user is confused with the reference mark of orthotropism.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M66, M67, M78, M79
Not A
Net: M1
Not B
Net: M12
Not C
Net: M144
Not D
Net: M133
Not B1
Meshs: M6, M7
Not D1
Meshs: M73, M61

27.2 Characteristics

grid

A number of nodes: 171
A number of meshs and type: 144 QUAD4

27.3 Functionalities
tested

Orders

AFFE_MODELE
“MECHANICAL”
“DST”

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL
THICK

ANGLE_REP

DEFI_MATERIAU ELAS_ORTH
E_L

E_T

E_N

G_TN

G_LT

G_LN

NU_LT

DEFI_COQU_MULT SLEEP

DEFI_COQU_MULT SLEEP
THICK

ORIENTATION

AFFE_CHAR_MECA FORCE_COQUE
NEAR
ALL

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

MECA_STATIQUE

CALC_CHAM_ELEM SIGM_ELNO_DEPL

---

28 Results of modeling M

28.1 Values
tested
Identification
Reference
Aster Difference
Tolerance
Not O

M134
Lay down 1
on lower layer
18.990 18.959
-0.158%
1.0%
xx

on lower layer
18.990 18.959
-0.158%

1.0%
yy

on lower layer
0.000 4.73E08 4.73E08
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -0.306
-0.306 0.31
xz

on layer medium
0.000 0.306 0.306
0.31
yz
5 sleep
on higher layer

-18.990 -18.959 -0.158% 1.0%
xx

on higher layer
-18.990 -18.959 -0.158% 1.0%
yy

on higher layer
0.000 4.73E08
4.73E08
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.2012 4.017%
4.1%
Not B1

M122
Lay down 1
on lower layer
0.000 1.695E01 0.17 0.7
xx

on lower layer
0.000 6.933E01
-0.693 0.7
yy

on lower layer
0.000 7.316E01
-0.732 0.74

xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy

on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 5.256E04
5.26E04 0.26
xz

on layer medium
-2.39732 -2.32183 -3.149% 3.2%
yz
5 sleep
on higher layer
0.000 1.695E01 0.17
0.7
xx

on higher layer
0.000 6.933E01 0.693
0.7
yy

on higher layer
0.000 7.316E01 0.732 0.74
xy

on higher layer
0.000 0.000 0.000 0.01
xz

---

on higher layer
0.000 0.000 0.000 0.01
yz

Evolution of the constraints in the plate

Not O

xx
yy
xy
xz
yz
Lower Couche1
18.9599 18.9599
4.72681
E08 0
0

Higher Couche1
11.3760 11.3760
2.83603
E08
1.95632 E01
1.95632 E01
Lower Couche2
11.3760 11.3760
2.83603
E08
1.95632 E01
1.95632 E01
Higher Couche2
3.79199 3.79199
9.45342
E09
2.93448 E01
2.93448 E01
Lower Couche3
3.79199 3.79199
9.45342
E09
2.93448 E01
2.93448 E01
Average Couche3
6.57805 E16
6.57805 E16
1.63991 E24 3.05675 E01
3.05675 E01
Higher Couche3
-3.79199 -3.79199
-9.45342
E09 2.93448 E01
2.93448 E01
Lower Couche4
-3.79199 -3.79199
-9.45342
E09 2.93448 E01
2.93448 E01
Higher Couche4
-11.3760 -11.3760
-2.83603
E08 1.95632 E01

1.95632 E01
Lower Couche5
-11.3760 -11.3760
-2.83603
E08 1.95632 E01
1.95632 E01
Higher Couche5
-18.9599 -18.9599
4.72681
E08
3.61992 E17
3.61992 E17

Not B1

xx
yy
xy
xz
yz
Lower Couche1
1.69553 E01 6.93351 E01
7.31643 E01
0
0
Higher Couche1 1.01732 E01 4.16010 E01 4.38986 E01 3.36438 E04
-1.48597
Lower Couche2
1.01732 E01 4.16010 E01
4.38986 E01
3.36438 E04
-1.48597
Higher Couche2 3.39106 E02 1.38670 E01 1.46329 E01 5.04657 E04
-2.22896
Lower Couche3
3.39106 E02 1.38670 E01
1.46329 E01
5.04657 E04
-2.22896
Average Couche3

5.88254 E18 2.40554 E17
2.53840 E17
5.25684 E04
-2.32184
Higher Couche3
3.39106 E02
1.38670 E01
1.46329 E01
5.04657 E04
-2.22896
Lower Couche4
3.39106 E02
1.38670 E01
1.46329 E01
5.04657 E04
-2.22896
Higher Couche4
1.01732 E01
4.16010 E01
4.38986 E01
3.36438 E04
-1.48597
Lower Couche5
1.01732 E01
4.16010 E01
4.38986 E01
3.36438 E04
-1.48597
Higher Couche5
1.69553 E01
6.93351 E01
7.31643 E01 6.22535 E20
2.74961 E16

28.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
14.91 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

---

29 Modeling NR

29.1 Characteristics of modeling

Isotropic multi-layer plate (5 layers in the thickness). Quadrangular element of hull DSQ.
The model of plate associated with modeling M is turned of 20 degrees according to the nautical angle
alpha and of 30 degrees according to beta. The classification of the meshs is identical to that of modeling Mr.

Limiting conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY: 0.)

(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)

(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY: 0. , DRZ: 0.)

FORCE_ARETE

(GROUP_NO: AB MY: 0.)

(GROUP_NO: BC MX: 0.)

(GROUP_NO: CD MY: 0.)

(GROUP_NO: DA MX: 0.)

Not O
Meshs: M66, M67, M78, M79
Not A
Net: M1
Not B
Net: M12
Not C
Net: M144
Not D
Net: M133
Not B1
Meshs: M6, M7
Not D1
Meshs: M73, M61

29.2 Characteristics

grid

A number of nodes: 171
A number of meshs and type: 144 QUAD4

29.3 Functionalities tested

Orders

AFFE_MODELE "MECHANICAL" "DST"

MODI_MAILLAGE ORIE_NORME_COQUE

AFFE_CARA_ELEM HULL THICK

ANGLE_REP

DEFI_MATERIAU ELAS_ORTH E_L

E_T

E_N

G_TN

G_LT

G_LN

NU_LT

DEFI_COQU_MULT SLEEP

FORMULATE

AFFE_CHAR_MECA FORCE_COQUE
NEAR

LIAISON_OBLIQUE
ANGLE_NAUT

GROUP_NO

FORCE_ARETE

MECA_STATIQUE

CREA_CHAMP

CALC_CHAM_ELEM SIGM_ELNO_DEPL

DEGE_ELNO_DEPL

---

30 Results of modeling NR

30.1 Values tested

Identification
Reference
Aster Difference
Tolerance
Not O

M134
Lay down 1
on lower layer
18.990 18.959
-0.158%
1.0%
xx

on lower layer
18.990 18.959
-0.158%
1.0%
yy

on lower layer
0.000 0.000 0.000
0.01
xy

on lower layer
0.000 0.000 0.000
0.01
xz

on lower layer
0.000 0.000 0.000
0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000
0.01
xx

on layer medium
0.000 0.000 0.000
0.01
yy

on layer medium
0.000 0.000 0.000
0.01
xy

on layer medium
0.000 -0.306
-0.306 0.31
xz

on layer medium
0.000 0.306 0.306
0.31
yz
5 sleep
on higher layer
-18.990 -18.959 -0.158% 1.0%
xx

on higher layer
-18.990 -18.959 -0.158% 1.0%
yy

on higher layer
0.000 0.000 0.000
0.01
xy

on higher layer
0.000 0.000 0.000
0.01
xz

on higher layer
0.000 0.000 0.000
0.01
yz
Displacement DZ
-1.1549
-1.2012 4.017%
4.1%
Not B1

M122
Lay down 1
on lower layer
0.000 1.695E01 0.17 0.7
xx

on lower layer
0.000 6.933E01
-0.693 0.7
yy

on lower layer
0.000 7.316E01
-0.732 0.74
xy

on lower layer
0.000 0.000 0.000 0.01
xz

on lower layer
0.000 0.000 0.000 0.01
yz
3 sleep
on layer medium
0.000 0.000 0.000 0.01
xx

on layer medium
0.000 0.000 0.000 0.01
yy

on layer medium
0.000 0.000 0.000 0.01
xy

on layer medium
0.000 5.256E04
5.26E04 0.26
xz

on layer medium
-2.39732 -2.32183 -3.149% 3.2%
yz
5 sleep
on higher layer
0.000 1.695E01 0.17
0.3
xx

on higher layer
0.000 6.933E01 0.693
0.8
yy

on higher layer
0.000 7.316E01 0.732
0.8
xy

on higher layer
0.000 0.000 0.000 0.01
xz

---

on higher layer
0.000 0.000 0.000 0.01
yz

Evolution of the constraints in the plate

Not O

xx
yy
xy
xz
yz
Lower Couche1
18.9599 18.9599
-2.21998
E13
0
0
Higher Couche1
11.3760 11.3760
-1.64964
E13 1.95632 E01
1.95632 E01
Lower Couche2
11.3760 11.3760
-1.64964
E13 1.95632 E01
1.95632 E01
Higher Couche2

3.79199 3.79199
-1.07931
E13 2.93448 E01
2.93448 E01
Lower Couche3
3.79199 3.79199
-1.07931
E13 2.93448 E01
2.93448 E01
Average Couche3
1.26875 E13
1.05848 E13 7.94143 E14 3.05675 E01
3.05675 E01
Higher Couche3
-3.79199 -3.79199
-5.08976
E14 2.93448 E01
2.93448 E01
Lower Couche4
-3.79199 -3.79199
-5.08976
E14 2.93448 E01
2.93448 E01
Higher Couche4
-11.3760 -11.3760
6.13577
E15
1.95632 E01
1.95632 E01
Lower Couche5
-11.3760 -11.3760
6.13577
E15
1.95632 E01
1.95632 E01
Higher Couche5
-18.9599 -18.9599
6.31692
E14
3.61992 E17
3.61992 E17

Not B1

xx
yy
xy
xz
yz
Lower Couche1
1.69553 E01 6.93351 E01
7.31643 E01
0
0
Higher Couche1 1.01732 E01 4.16010 E01 4.38986 E01 3.36437 E04
-1.48597
Lower Couche2
1.01732 E01 4.16010 E01
4.38986 E01
3.36437 E04
-1.48597
Higher Couche2 3.39106 E02 1.38670 E01 1.46329 E01 5.04656 E04
-2.22896
Lower Couche3
3.39106 E02 1.38670 E01
1.46329 E01
5.04656 E04
-2.22896
Average Couche3
4.87415 E15 4.93108 E14
3.39767 E15
5.25683 E04
-2.32184
Higher Couche3
3.39106 E02
1.38670 E01
1.46329 E01
5.04656 E04
-2.22896
Lower Couche4
3.39106 E02
1.38670 E01
1.46329 E01

5.04656 E04
-2.22896
Higher Couche4
1.01732 E01
4.16010 E01
4.38986 E01
3.36437 E04
-1.48597
Lower Couche5
1.01732 E01
4.16010 E01
4.38986 E01
3.36437 E04
-1.48597
Higher Couche5
1.69553 E01
6.93351 E01
7.31643 E01 6.22534 E20
2.74961 E16

30.2 Parameters of execution

Version: 6.0.37

Machine: SGI - ORIGIN 2000

Obstruction memory:
32 Mo
Time CPU To use:
15.32 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

Code_Aster ®
Version
6.0

Titrate:

31 Summary of the results

The results obtained show that:

· modeling DSQ provides a more precise estimate of the constraints and efforts edges (<5%) that modeling DKQ (=20%). The estimate of the moments is equivalent for two modelings,
· the estimate of the constraints is more precise with modeling DKT (<2%) compared to modeling DST (<3,5%). The shearing action is on the other hand better estimated by DST (<10% for DST and <20% for DKT),
· for the configurations COQUE_3D triangle or quadrangle, the estimate of the constraint of transverse shearing is constant in the thickness of the plate, in accordance with assumptions of modeling,

-
results expressed in the reference mark user for the DST configurations and COQUE_3D are identical to those expressed in the total reference mark,

-
the refinement of the grid for configuration DSQ improves the estimate of constraints, of the sharp efforts and the moments; the tendency is reversed in what relate to displacement,

-
the multi-layer configuration makes it possible to visualize the distribution of the plane constraints and
of transverse shearing in the thickness of the plate, and to confirm the theory, with to know a linear for the plane constraints and parabolic distribution for shear stresses; in addition, the rotation of the reference mark does not influence the values constraints,

-
in a general way, with the nodes where one awaits constraints or efforts analytically null, the numerical results obtained are not correct owing to the fact that the estimates are made mesh by mesh then extrapolated with the nodes. Even them values realised with the nodes in question are not inevitably null.

Code_Aster ®
Version
5.0

Titrate:
SSLS119 - Embedded hook subjected to a sharp effort

Date:
05/02/02
Author (S):
P. Key MASSIN, A LACHAIZE
:
V3.03.119-A Page:
1/10

Organization (S): EDF/AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.119

SSLS 119 - Subjected embedded hook
with a sharp effort at its end

Summary:

This test represents a static calculation of an embedded hook subjected to a shearing force, consisted of one
elastic material. This test makes it possible to validate following modelings finite elements:

.
DST (QUAD4),
.
DKT (QUAD4),
.
COQUE_3D (QUAD9),
.
COQUE_3D (TRIA7),
.
linear 3D (HEXA8) and quadratic (HEXA20).

One studies blocking in transverse shearing particularly there.

1
Problem of reference

1.1 Geometry

Y
Height H =0.508 m

t=0.0508 m
R=0.3536 m
R=1.1684 m
WITH, B
X
30°
C

1.2
Properties of material

The properties of material constituting the beam are:

E = 22752510 Pa
Young modulus
= 0.35
Poisson's ratio

1.3
Boundary conditions and loadings

·
C.L. : Embedded side AB
·
Linear force Fz=8.7594 N/m for the hulls.
·
Surface force Fz=172.4307 N/m2 for the 3D.

1.4 Conditions
initial

Without object

5.0

Titrate:
SSLS119 - Embedded hook subjected to a sharp effort

Date:
05/02/02
Author (S):
P. Key MASSIN, A LACHAIZE
:
V3.03.119-A Page:
3/10

2
Reference solution

This test makes it possible to test blocking in transverse shearing as well as the effects of the rigidity of
rotation around the normal. It makes it possible to validate the choice COEF_RIGI_DRZ = 1. E05, value by
defect of this coefficient. This multiplicative factor makes it possible to affect a fictitious rigidity around
normal of the elements of plate by multiplying minimal rigidity according to the other directions by it
coefficient in order to avoid the singular matrices of rigidity.

2.1
Results of reference

The results of reference result from a calculation by finite elements voluminal:

Value of the deflection out of C: 4.93 in is 1.252 E-01 Mr.

2.2
Uncertainties on the solution

A few % following the refinement of the grid.

2.3 References
bibliographical

[1]
Raasch Challenge for Shell Elements, N.F. Knight Jr., AIAA Newspaper, vol. 35, N°2, 1997,

pp 375-381.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

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3 Modeling
With

3.1
Characteristics of modeling

DST modeling

Boundary conditions: side AB: U = v =w = 0

z= X = y =0
Fz = 8.7594 N/m

3.2
Characteristics of the grid

A number of nodes: 2877
A number of meshs and type: 20 (according to Z) x136 (length) QUAD4

3.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE MODELING
DST

AFFE_CARA_ELEM HULL

THICK

COEF_RIGI_DRZ
1.E-05

MECA_STATIQUE

4
Results of modeling A

4.1 Values
tested

grid Identification Reference
Aster %
difference
5 X 34
DZ
1.252 E-01
1.48268 E-01
18.42 %
10 X 68
DZ
1.252 E-01
2.38825 E-01
90.75 %
20 X 136
DZ
1.252 E-01
4.45694 E-01
256.00 %

4.2 Parameters
of execution

Version: NEW 6.01.08

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 15.67 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

Modeling DKT

Boundary conditions: side AB: U = v =w = 0

z= X = y =0

Fz = 8.7594 N/m

5.2
Characteristics of the grid

A number of nodes: 2877
A number of meshs and type: 20 (according to Z) x136 (length) QUAD4

5.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE MODELING
DKT

AFFE_CARA_ELEM HULL

THICK

COEF_RIGI_DRZ
1.E-05

MECA_STATIQUE

6
Results of modeling B

6.1 Values
tested

grid Identification Reference
Aster %
difference
5 X 34
DZ
1.252 E01
1.19617 E01

-4.81 %
10 X 68
DZ
1.252 E01
1.16733 E01
-6.76 %
20 X 136
DZ
1.252 E01
1.06726 E01
-14.75 %

6.2 Parameters of execution

Version: NEW 6.01.08

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 13.23 seconds

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V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

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7 Modeling C

7.1 Characteristics of modeling

Modeling COQUE_3_D

Boundary conditions: side AB: U = v =w = 0

=0
z= X = y
Fz = 8.7594 N/m

7.2 Characteristics of the grid

A number of nodes: 11193
A number of meshs and type: 20 (according to Z) x136 (length) QUAD9

7.3 Functionalities tested

Orders Key word factor

Key word

AFFE_MODELE MODELING
COQUE_3D

AFFE_CARA_ELEM HULL

THICK

COEF_RIGI_DRZ
1.E-05

MECA_STATIQUE

8
Results of modeling C

8.1 Values tested

grid Identification Reference
Aster *%*
difference
5 X 34
DZ
1.252 E-01
1.31964 E-01
5.40 %
10 X 68
DZ
1.252 E-01
1.31574 E-01
5.10 %
20 X 136
DZ
1.252 E-01
1.31195 E-01
4.79 %

8.2 Parameters

of execution

Version: NEW 6.01.08

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 83.67 seconds

9 Modeling D

9.1 Characteristics of modeling

Modeling 3D CUB8

Boundary conditions: side AB: U = v =w = 0

Fz = 172.4307 N/m2

9.2 Characteristics of the grid

A number of nodes: 6072

A number of meshs and type: 10 (according to Z) X 68 (length) X 1 (thickness) HEXA8

***9.3 Functionalities
tested***

***Orders Key word
factor
Key word***

*AFFE_MODELE MODELING
3D*

MECA_STATIQUE

10 Results of modeling D

***10.1 Values
tested***

***grid Identification Reference
Aster %
difference
5 X 34
DZ
1.252 E01
1.23233 E01
-1.57%
10 X 68
DZ
1.252 E01
1.28808 E01
2.88 %
20 X 136 X 2
DZ
1.252 E01
1.32292 E01
5.66 %***

***10.2 Parameters
of execution***

Version: NEW 6.01.08

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 8.47 seconds

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

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11 Modeling
E

11.1 Characteristics of modeling

Modeling 3D CU20

Boundary conditions: side AB: U = v =w = 0

Fz = 172.4307 N/m2

11.2 Characteristics of the grid

A number of nodes: 5160
A number of meshs and type: 10 (according to Z) X 68 (length) X 1 (thickness) HEXA20

11.3 Functionalities

tested

Orders Key word
factor
Key word
AFFE_MODELE MODELING
3D

MECA_STATIQUE

12 Results of modeling E

12.1 Values
tested

grid Identification Reference
Aster %
difference
5 X 34
DZ
1.252 E-01
1.32077 E-01
5.49 %
10 X 68
DZ
1.252 E-01
1.33518 E-01
6.64 %
20 X 136 X 2
DZ
1.252 E-01
1.34315 E-01
7.28 %

12.2 Parameters
of execution

Version: NEW 6.01.08

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 22.54 seconds

13 Modeling
F

13.1 Characteristics of modeling

Modeling COQUE_3_D

Boundary conditions: side AB: U = v =w = 0

=0
z= X = y
Fz = 8.7594 N/m

13.2 Characteristics of the grid

A number of nodes: 11193
A number of meshs and type: 40 (according to Z) x272 (length) TRIA7

13.3 Functionalities tested

Orders Key word factor Key word

AFFE_MODELE MODELING COQUE_3D

AFFE_CARA_ELEM HULL

THICK

COEF_RIGI_DRZ 1.E-05

MECA_STATIQUE

14 Results of modeling F

14.1 Values tested

grid Identification Reference Aster % difference
10 X 68
DZ
1.252 E-01
1.3224 E-01
5.62 %
20 X 136
DZ
1.252 E-01
1.31835 E-01
5.30 %
40 X 272
DZ
1.252 E-01

1.31536 E-01
5.06 %

14.2 Parameters
of execution

Version: NEW 6.01.08

Machine: SGI-Origin2000 R12000

Obstruction memory: 16 megabytes
Time CPU To use: 103.52 seconds

---

15 Summary of the results

The DST element with taking into transverse account of shearing does not seem to converge on it specific case-test. The elements COQUE_3D triangles and quadrangles with taking into account of transverse shearing do not present the same behavior and behave rather well on it test.

6.0

Titrate:
SSLS120 - Thin hull under hydrostatic pressure

Date:
12/12/02
Author (S):
J. Key Mr. PROIX
:
V3.03.120-A Page:
1/12

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and the hulls
Document: V3.03.120

SSLS120 - Cylindrical thin hull under pressure
hydrostatic

Summary:

This test represents a static calculation of thin cylindrical tank filled with water. It makes it possible to validate the maid

taking into account of the pressures function of the geometry, as well as the orthotropic materials rubber band. 3
modelings finite elements are used: AXIS, COQUE_3D with meshs QUAD9, COQUE_3D with meshs TRIA7 and DKT with meshs QUAD4. Displacements and the constraints obtained are compared with
an analytical reference solution.

1
Problem of reference

1.1 Geometry

Cylindrical reserve of average radius R = 5.7 m, thickness E = 0.04 m and height L = 16 m, simply supported at its base (rotation is free), and subjected to an internal hydrostatic pressure.

Average radius: R
= 5.7 m
Thickness:
E = 0.04 m
Height:
L = 16 m

1.2
Material properties

The properties of materials constituting the plate are:

Material 1: isotropic rubber band:
Young modulus
E = 2.1 1011 Pa

Poisson's ratio
= 0.3

Material 2: orthotropic rubber band:
E_L = 1.E10 Pa

E_T = 2.1E11 Pa
G_LT = 0.45E10 Pa
G_TN = 0.35E10 Pa
NU_LT = 0.075

The axis L is confused with axis Z.

1.3
Boundary conditions and loadings

Base Z = 0 simply supported

internal pressure varying linearly according to Z: p (Z) = P0. (L-z) /L
with P0 = 15000 Pa.

1.4 Conditions
initial

Without object.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and the hulls
HT-66/02/001/A

Code_Aster ®
Version
6.0

Titrate:
SSLS120 - Thin hull under hydrostatic pressure

Date:
12/12/02
Author (S):
J. Key Mr. PROIX
:
V3.03.120-A Page:
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2
Reference solution

2.1
Method of calculation used for the reference solution

· Isotropic Matériau: Analytical solution [bib1], obtained with the mean assumption of hull:

= 0
zz

(L - Z)
= PoR

PoR2
Z

U =
1 -

R
Ee
L

PoRLvz
Z
U =
1 -

Z
Ee

2L

PoR2
Radial displacement at the base of the cylinder: U (Z =)
0 =

R
Ee

PoRLv
Vertical displacement in top of the cylinder: U (Z = L) = -

Z
2Ee

PoR
Circumferential constraint in bottom of the cylinder (Z =)
0 =

· Orthotropic Matériau: The solution can be deduced from the preceding one: constraints being statically determined, it is enough to amend the law of behavior, and to integrate them deformations.

PoR2
Raidal displacement at the base of the cylinder: U (Z =)
0 =

R
E E
T

PoRLv
Vertical displacement in top of the cylinder: U (Z = L
LT
) = -

Z
2nd E
T

PoR
Circumferential constraint in bottom of the cylinder (Z =)
0 =

2.2
Results of reference

Isotropic material:

Radial displacement at the base of the cylinder:
Ur (A1) = 5.8017857E05 m
Vertical displacement in top of the cylinder:
Uz (A3) = 2.442857E05 m
Circumferential constraint in bottom of the cylinder:
STT (A1) = 2.1375E+06 Pa

Orthotropic material:

Radial displacement at the base of the cylinder:
Ur (A1) = 5.8017857E05 m
Vertical displacement in top of the cylinder:
Uz (A3) = 6.107143E06 m
Circumferential constraint in bottom of the cylinder:
STT (A1) = 2.1375E+06 Pa

2.3
Uncertainty on the solution

· Analytical Solution.

2.4 References
bibliographical

[1]
PILKEY W.D.: "Formulated for stress, Strain and Structural Matrices". Wiley & Idiots, New York, 1994.

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V3.03 booklet: Linear statics of the plates and the hulls
HT-66/02/001/A

Code_Aster ®
Version
6.0

Titrate:
SSLS120 - Thin hull under hydrostatic pressure

Date:
12/12/02

Author (S):
J. Key Mr. PROIX

3 Modeling
With

3.1
Characteristics of modeling

Modeling AXIS. One nets only one generator of the cylinder. 2 meshs QUAD8 in the thickness and 400 on the height.

3.2
Characteristics of the grid

A number of nodes: 3206

A number of meshs and types: 800 QUAD8

3.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING = `AXIS `
MASSIVE AFFE_CARA_ELEM
ANGL_REP
AFFE_CHAR_MECA_F FORCE_CONTOUR
FX
DEFI_MATERIAU ELAS_ORTH

3.4 Values
tested

Isotropic material

Value Identification
Reference
Aster %
difference
Ur (z=0)
DX (PM)
5.8018E05
5.7875E05
0.25
Uz (z=L)
DY (A3)
2.4429E05
2.433E05
0.4
Uz (z=L)
DY (A4)
2.4429E05
2.4185E05
1
SigmaTT (z=0)
SIZZ (PM)
2.1375E+06
2.13 E6
0.4

Orthotropic material

Value Identification
Reference
Aster %
difference
Ur (z=0)
DX (A1)
5.8018E05
5.7828E05
0.33
Uz (z=L)
DY (A3)
6.10714E06
5.992E06
1.9

Uz (z=L)
DY (A4)
2.4429E05
6.1367E06
0.5
SigmaTT (z=0)
SIZZ (PM)
2.1375E+06
2.13E6
0.4

Handbook of Validation
V3.03 booklet: Linear statics of the plates and the hulls
HT-66/02/001/A

---

4 Modeling B

4.1 Characteristics of modeling

Modeling COQUE_3D. One nets only half of the cylinder (symmetry compared to the y=0 plan)
10 meshs QUAD9 in the height and 20 on the semicircumference.

4.2 Characteristics of the grid

A number of nodes: 664

A number of meshs and type: 200 QUAD9

4.3 Functionalities tested

Orders Key word factor
Key word
AFFE_MODELE
AFFE
MODELING = COQUE_3D
AFFE_CARA_ELEM HULL

ANGL_REP
AFFE_CHAR_MECA_F FORCE_COQUE
NEAR
DEFI_MATERIAU ELAS_ORTH

4.4 Values
tested

Isotropic material

Value Identification
Reference
Aster *%*
difference
Ur (z=0)
DX (PM)
5.8018E05
5.7982E05
0.06
Ur (z=0)
DX (A1)
5.8018E05
5.7982E05
0.06

Ur (z=0)
DX (A2)
5.8018E05
5.7982E05
0.06
Uz (z=L)
DZ (A3)
2.4429E05 2.4429E05
2.E4
Uz (z=L)
DZ (A4)
2.4429E05 2.4429E05
2.E4
SigmaTT (z=0)
SIZZ (PM) 2.1375E+06
2.1371E+06 0.02

Orthotropic material

Value Identification
Reference
***Aster** %*
difference
Ur (z=0)
DX (PM)
5.8018E05 5.8018E05 2.E5
Ur (z=0)
DX (A1)
5.8018E05 5.8018E05
2.E5
Ur (z=0)
DX (A2)
5.8018E05 5.8018E05
2.E5
Uz (z=L)
DZ (A3)
6.10714E06 6.10716E06
3.E4
Uz (z=L)
DZ (A4)
6.10714E06 6.10716E06
3.E4
SigmaTT (z=0)

SIZZ (PM) 2.1375E+06
2.1371E+06 0.02

5 Modeling C

5.1 Characteristics of modeling

Modeling COQUE_3D. One nets only half of the cylinder (symmetry compared to the y=0 plan)
10 meshs TRIA7 in the height and 20 on the semicircumference.

5.2 Characteristics of the grid

A number of nodes: 864

A number of meshs and types: 400 TRIA7

5.3 Functionalities tested

Orders Key word
factor

Key word
AFFE_MODELE
AFFE
MODELING = COQUE_3D
AFFE_CARA_ELEM HULL
ANGL_REP
AFFE_CHAR_MECA_F FORCE_COQUE
NEAR
DEFI_MATERIAU ELAS_ORTH

5.4 Values
tested

Isotropic material

Value Identification Reference
Aster *%*
difference
Ur (z=0)
DY (PM)
5.8018E05
5.799E05
0.4
Ur (z=0)

DX (A1)
5.8018E05
5.793E05
0.15
Ur (z=0)
DX (A2)
5.8018E05
5.806E05
0.06
Uz (z=L)
DZ (A3)
2.4429E05
2.4428E05
0.004
Uz (z=L)
DZ (A4)
2.4429E05
2.4428E05
0.004
SigmaTT (z=0)
SIZZ (PM) 2.1375E+06
2.1377E+06 0.008

Orthotropic material

Value Identification Reference
***Aster** %*
difference
Ur (z=0)
DX (PM)
5.8018E05
5.8013E05
0.008
Ur (z=0)
DX (A1)
5.8018E05
5.7904E05
0.2
Ur (z=0)
DX (A2)
5.8018E05
5.8122E05

0.18
Uz (z=L)
DZ (A3)
6.10714E06
6.1044E06
0.045
Uz (z=L)
DZ (A4)
6.10714E06
6.1070E06
0.002
SigmaTT (z=0)
SIZZ (PM) 2.1375E+06
2.1377E+06 0.008

6 Modeling D

6.1 Characteristics of modeling

Modeling DKT. One nets only half of the cylinder (symmetry compared to the y=0 plan) 30 meshs QUAD4 in the height and 60 on the semicircumference.

6.2
Characteristics of the grid

A number of nodes: 1894

A number of meshs and types: 1800 QUAD4

6.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
MODELING = DKT
AFFE_CARA_ELEM HULL
ANGL_REP
AFFE_CHAR_MECA_F FORCE_COQUE
NEAR
DEFI_MATERIAU ELAS_ORTH

DEFI_COQU_MULT SLEEP
ANGL_REP

6.4 Values tested

Isotropic material

Value	***Identification***	***Reference***	***Aster***	***% difference***
Ur (z=0)	*DY (PM)*	*5.8018E05*	*5.7916E05*	*0.18*
Ur (z=0)	*DX (A1)*	*5.8018E05*	*5.7916E05*	*0.18*
Ur (z=0)	*DX (A2)*	*5.8018E05*	*5.7916E05*	*0.18*
Uz (z=L)	*DZ (A3)*	*2.4429E05*	*2.4420E05*	*0.03*
Uz (z=L)	*DZ (A4)*	*2.4429E05*	*2.4420E05*	*0.03*
SigmaTT (z=0)	*SIZZ (PM)*	*2.1375E+06*	*2.1371E+06*	*0.02*

Orthotropic material

Value Identification
Reference
Aster *%*

difference
Ur (z=0)
DY (PM)
5.8018E05
5.798E05
0.06
Ur (z=0)
DX (A1)
5.8018E05
5.798E05
0.06
Ur (z=0)
DX (A2)
5.8018E05
5.798E05
0.06
Uz (z=L)
DZ (A3)
6.10714E06
6.105E06
0.03
Uz (z=L)
DZ (A4)
6.10714E06
6.105E06
0.03
SigmaTT (z=0)
SIZZ (PM) 2.1375E+06 2.1371E+06 0.02

6.5 Remarks

To obtain a correct result, it is necessary to take guard with the convention adopted for NU_LT for hulls multi layers (DEFI_COQU_MULT), which is different from that used for ELAS_ORTH:

Here, it is necessary to take Nu_LT such as NuTL=ET/EL*NuLT, that is to say NU_LT = 0.014285714).

6.0

Titrate:
SSLS120 - Thin hull under hydrostatic pressure

Date:
12/12/02
Author (S):
J. Key Mr. PROIX
:
V3.03.120-A Page:
12/12

7
Summary of the results

The results of four modelings are very close to the analytical solution: to the maximum 0.4% variation for modelings COQUE_3D and DKT, and less than 2% of variation for modeling axisymmetric, which is explained by the fact why the analytical solution is a mean solution hull.

This test thus validates on the one hand the efforts of pressure varying linearly with the geometry, for thin hulls, and in addition the taking into account of orthotropic elasticity.

Code_Aster ®
Version
6.2

Titrate:
SSLS121 - Plate laminated subjected to elementary loadings
Date:
19/08/02
Author (S):
Key J.M. PROIX
:
V3.03.121-A Page:
1/6

Organization (S): EDF/AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.121

SSLS121 - Plate laminated subjected
with elementary loadings

Summary:

This test represents the quasi-static calculation of a laminated plate, composed of 3 layers of material orthotropic, subjected to 4 elementary loadings.

The plate is modelled in finite elements DST (meshs QUAD4), it is located in a plan XZ and is inclined
48,5 degrees compared to X (to check the changes of reference mark).

In this test, the plane constraints and stresses shear transverse, are compared with one analytical reference solution.

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
6.2

1
Problem of reference

1.1 Geometry

Z, W
y, v
B
C
p
Stacking
With
T
D
X, U
Z
0°
90°
has
0°

L
Width a=100mm, thickness h=1mm.

1.2
Properties of material

The properties of material constituting each of the three layers of the plate are as follows:

Orthotropic material:
E = 25 MPa
E = 1 MPa

L
T

G = G = 0.5 MPa
G = 0.2 MPa
lt
lz
tz
= 0.25

lt
Stacking:
· orientation:
[0 / 90 / 0]
· thickness:
[h/4/h/2/h/4]

1.3
Boundary conditions and loadings

The loadings are applied in order to obtain uniform states of stresses in plate:

· Loading case 1: Mxx=1 in the plate
-
Embedding on AD
-
Moment distributed on BC: MX=1

· Loading case 2: Myy=1 in the plate
-
Embedding on AB
-
Moment distributed on CD: MY=1

· Loading case 3: QX=1 in the plate
-
Embedding on AD
-
Effort distributed on BC: FZ=1

· Loading case 4: QY=1 in the plate
-
Embedding on AB

-
Effort distributed on CD: FZ=1

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution [bib1].

2.2
Results of reference

The results of reference are as follows:

Forced loading cases
Value (Mpa) Comments
Mxx=1 SIXX (z=h/2)
-6.82
Constraint xx on the lower skin of
Lay down 1
lay down 1

SIXX (z=h/4) layer 2
-0.135
Constraint xx on the lower skin of

2 sleep
Myy=1 SIYY (z=h/2)
-1.5
Constraint yy on the lower skin of
Lay down 1
lay down 1

SIYY (z=h/4) layer 2
-18.76
Constraint yy on the lower skin of
2 sleep
QX=1 SIXZ
(z=h/4)
1.279
Constraint xz on the lower skin of
2 sleep
2 sleep
SIXZ
(z=0) 1.296
Constraint xz on the average skin of
2 sleep
2 sleep
QY=1 SIYZ
(z=h/4)
0.28125
Constraint yz on the lower skin of
2 sleep
2 sleep
SIYZ
(z=0) 2.62625
Constraint yz on the average skin of
2 sleep
2 sleep

The pace of the distribution of the constraints in the thickness of the plate is as follows:

0.135
1.296
2.626
1.279
0.281

2.3

Uncertainties on the solution

Null (analytical solution).

2.4 References bibliographical

[1]
Dhatt-Batoz "Modeling of the structures by finite elements, Volume 2" Pages 246-250 Hermes edition.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

---

3 Modeling With

3.1 Characteristics of modeling

Z
Modeling DST (QUAD4)
C
- The plate is located in the plan Y =0.5
- Not A (0.4; 0.5; 0.25)
y
X
B
D
Y
48°5
With
X

3.2 Characteristics of the grid

A number of nodes: 49
A number of meshs and type: 36 QUAD4

3.3 Functionalities tested

Orders Key word factor
Key word
AFFE_MODELE
AFFE
“DST”
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA
FORCE_CONTOUR
NEAR
CALC_CHAM_ELEM
NUME_COUCHE
NIVE_COUCHE
“SUP” “MOY”
OPTION
“SIGM_ELNO_DEPL”
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
6.2

Titrate:
SSLS121 - Plate laminated subjected to elementary loadings
Date:
19/08/02
Author (S):
Key ***J.M. PROIX***
:

4
Results of modeling A

4.1 Values
tested

Loading case
Identification
Reference
Aster *Difference*
(%)
Mxx=1 SIXX (z=h/2) layer 1
-6.82
-6.818
0.03

SIXX (z=h/4) layer 2
-0.135
-0.13636
1
Myy=1 SIYY (z=h/2) Layer 1
-1.5
-1.5
0

SIYY (z=h/4) layer 2
-18.76
-18.75
0.05
QX=1
SIXZ (z=h/4) Layer 2
1.279
1.278
0.05

SIXZ (z=0) Layer 2
1.296
1.295
0.09

QY=1
SIYZ (z=h/4) Layer 2
0.28125
0.2812
0.09

SIYZ (z=0) Layer 2
2.62625
2.625
0.04

5
Summary of the results

The very good agreement of the results with the analytical solution validates the calculation of the constraints
for a composite plate in an unspecified reference mark, at various levels thickness.

Titrate:
SSLS123 - Sphere under uniform external pressure

Date:
03/11/03
Author (S):
***J.M. PROIX**, S. BAGUET*
Key
:
V3.03.123-A Page:
1/6

Organization (S): EDF-R & D /AMA, INSA-LYON

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.123

SSLS123 - Sphere under uniform external pressure

Summary:

One treats the case of the sphere under uniform pressure external in linear elasticity, which makes it possible to evaluate

quality of the modeling of the compressive forces.

The values tested are radial displacements at the points of intersection with the axes.

One has 2 modelings:

.
A: elements 3D in HEXA8
.
B: elements SHB8

---

1 Problem of reference

1.1 Geometry

Z
Z
C
P
C
y

B
B
y
With
With
X
X
Ray
R = 10. m
Thickness
T = 0.04 m

Co-ordinates of the points:

With
B
C
X 10.
0.
0.
y 0.
10.
0.
Z 0.
0.
10.

1.2
Material properties

E = 6.825 107 Pa, = 0.3

1.3
Boundary conditions and loadings

On a quarter of the hemisphere:

Side AC
symmetry compared to the xz plan
Side BC
symmetry compared to the yz plan

Side AB
symmetry compared to the xy plan

External pressure uniform P=1.Pa

2
Reference solution

2.1
Method of calculation used for the reference solution

Radial displacement in any node of the sphere under external pressure is given by:
C
U =.
B R +

R
2
R
With
1 - 2
R 3
1+

R 3r 3
B
E
=
.
P
. and C
I
E
=
.
P
.
E
R 3 - R 3
2nd R 3 - R 3
I
E
I
E

T
T
where R = R -
and R = R +

I
2
E
2

2.2
Results of reference

Displacement of point A following X, displacement of the point B following y, displacement of the point C following
Z.

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HT-66/03/008/A

3 Modeling
With

3.1
Characteristics of modeling

Element hull SHB8
C2
C1
A1
B1
A2
B2

Modeling of a quarter of the sphere in SHB8.

Names of the nodes:

Not A1
N40
Not A2
N42

Not B1
N01
Not B2
N02

Not C1
N662
Not C2
N658

3.2
Characteristics of the grid

A number of nodes: 662
A number of meshs and types: 300 SHB8 for the sphere and 300 QUAD4 for external surface.

3.3 Functionalities
tested

Orders

MODI_MAILLAGE ORIE_SHB8
GROUP_MA
ALL
MODI_MAILLAGE ORIE_PEAU_3D GROUP_MA
SEXT
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

PRES_REP
GROUP_MA
“MECHANICAL” AFFE_MODELE
SHB8 ALL
DEFI_MATERIAU ELAS

4
Results of modeling A

4.1 Values

tested

Identification Reference Aster %
difference
Not A2
-1.28279.10-5 -1.27928.10-5
0.27
displacement U
Not B2
-1.28279.10-5 -1.27929.10-5
0.27
displacement v
Not C2
-1.28279.10-5 -1.3034.10-5
1.7
displacement W

---

5 Modeling
B

5.1
Characteristics of modeling

Voluminal element 3D HEXA8

C2
C1
A1
B1
A2
B2

Modeling of a quarter of the sphere in HEXA8.

Names of the nodes:

Not A1
N40
Not A2
N42

Not B1
N01
Not B2
N02

Not C1
N662
Not C2
N658

5.2
Characteristics of the grid

A number of nodes: 662
A number of meshs and types: 300 HEXA8 for the sphere and 300 QUAD4 for external surface.

5.3 Functionalities
tested

Orders

MODI_MAILLAGE ORIE_PEAU_3D

SEXT

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "3D"
ALL

DEFI_MATERIAU ELAS

6
Results of modeling B

6.1 Values
tested

Identification Reference Aster %
difference
Not A2
-1.28279.10-5 -1.28298.10-5
0.015
displacement U
Not B2
-1.28279.10-5 -1.28298.10-5
0.015
displacement v
Not C2
-1.28279.10-5 -1.28662.10-5
0.30
displacement W

7
Summary of the results

Results in conformity with the reference solution.

One could expect to find exactly same displacement to the three point A, B and C.
difference at the point C comes from not-symmetry from the grid. The grid is slightly more distorted around this point, which explains the fall of precision, which remains nevertheless very good,
as well for element HEXA8 for the SHB8.

1/8

Organization (S): EDF-R & D /AMA, INSA LYON

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.124

SSLS124 - Beam in inflection with various twinges

Summary:

This test represents a calculation quasi-static of a beam in inflection, embedded at an end, and subjected to
a vertical force at the other end. This test makes it possible to validate for a linear elastic design, and four
values of twinge (variable thicknesses) in each of two modelings:

· Finite elements SHB8 for a regular grid (modeling A)
· Finite elements SHB8 for a nonregular grid (modeling B)

Displacements obtained are compared with the elastic analytical solution of a beam in inflection. This test
allows to assemble the limits of the elements in term of twinge, on the one hand, and to show their good

convergence for a very irregular grid, in addition.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

1
Problem of reference

1.1 Geometry

Z
C
y
O
H
L
F
With
X
B
L

L= length 100 m, width l=10 Mr.
Thickness: case 1 h=10 m, cases 2 h=1 m, cases 3 h=0.1 m, cases 4 h=0.05 m, cases 5 h=0.02 m

1.2
Material properties

E = 2. 1011 Pa

= 0.3

1.3
Boundary conditions and loadings

Embedded on side OC: U = v = W = 0, X = y = Z = 0

At end AB, a load uniformly distributed of resultant:
Force parallel with axis Z; Fz = 1 NR

2
Reference solution

2.1
Method of calculation used for the reference solution

The results of reference are obtained by the theory of the elastic beams.

Vertical displacement at end AB is given by:
Uy = F.L3/3.E.Iz

With
Iz = l.h3/12

2.2
Results of reference

Displacement of points A and B following Z.

---

3 Modeling
With

3.1
Characteristics of modeling

Element SHB8

Z
X
y

Cutting: a regular grid is considered in this modeling.

Regular grid:

10 meshs SHB8: 1 according to the width, 10 according to the length, 1 according to the thickness
thickness: case 1 h=10 m, cases 2 h=1 m, cases 3 h=0.1 m, cases 4 h=0.05 m, cases 5 h=0.02 m

Boundary conditions:

In all the nodes on the side OC: blocked displacement following X
in C1: blocked displacement following Y and Z
in C2: blocked displacement following Y
in O1: blocked displacement following Z

Loading:
in A2: nodal force according to X: FX = 0,5
in B2: nodal force following Y: FY = 0,5

Name of the nodes:

Not O1
N40
Not O2
N44
Not A1
N03
Not A2
N01
Not B1
N04
Not B2
N02
Not C1
N43
Not C2
N39

3.2
Characteristics of the grid

A number of nodes: 44
A number of meshs and types: 11 SHB8
In the case of the regular grid, each element is a perfect square on side length 10m

3.3 Functionalities
tested

Orders

MODI_MAILLAGE ORIE_SHB8
GROUP_MA
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MODELE AFFE
MODELING
:
SHB8
MECA_STATIQUE SOLVEUR
NPREC

4
Results of modeling A

4.1 Values
tested

Regular grid:

Thickness
Not
Size in unit
Reference
Aster
% difference
Case 1
A2
displacement W (m)
2. 10-9
2.008 10-9
+0.41
H = 10m
B2
displacement W (m)
2. 10-9
2.008 10-9
+0.41
Case 2
A2
displacement W (m)
2. 10-6
1.995 10-6
-0.27
H = 1m
B2
displacement W (m)
2. 10-6
1.995 10-6
-0.27
Case 3
A2
displacement W (m)
2. 10-3
1.994 10-3
-0.28
H = 0.1m
B2
displacement W (m)
2. 10-3

1.994 10-3
-0.28
Case 4
A2
displacement W (m)
1.6 10-2
1.597 10-2
-0.2
H = 0.05m
B2
displacement W (m)
1.6 10-2
1.595 10-2
-0.3
Case 5
A2
displacement W (m)
0.25
2.380 10-1
+4.8
H = 0.02m
B2
displacement W (m)
0.25
2.416 10-1
+3.4

4.2 Remarks

For the strong twinges, (case 3, 4, 5), it is necessary to increase the number of decimals lost with the resolution, using key word NPREC. This does not prevent from obtaining a correct solution (at least for cases 3 and 4).

The twinges are (h/min report/ratio (I, L/10)) :

Case 1: 1
Case 2: 0.1
Case 3: 0.01
Case 4: 0.005
Case 5: 0.002
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls

5 Modeling B

5.1 Characteristics of modeling

Element SHB8

Cutting: an irregular grid is considered in this modeling.

Not-regular grid:

10 meshs SHB8: 1 according to the width, 10 according to the length, 1 according to the thickness
thickness: case 1 h=10 m, cases 2 h=1 m, cases 3 h=0.1 m, cases 4 h=0.05 m, cases 5 h=0.02 m

Boundary conditions:

In all the nodes on the side OC: blocked displacement following X
in C1: blocked displacement following Y and Z
in C2: blocked displacement following Y
in O1: blocked displacement following Z

Loading:
in A2: nodal force according to X: FX = 0,5
in B2: nodal force following Y: FY = 0,5

Names of the nodes:

Not O1
N40
Not O2
N44
Not A1
N03
Not A2
N01
Not B1
N04
Not B2
N02
Not C1
N43
Not C2
N39

5.2
Characteristics of the grid

A number of nodes: 44
A number of meshs and types: 11 SHB8

5.3 Functionalities
tested

Orders

MODI_MAILLAGE ORIE_SHB8
GROUP_MA
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_NODALE
GROUP_NO
AFFE_MODELE AFFE
MODELING
:
SHB8

6
Results of modeling B

6.1 Values tested

Not-regular grid:

Thickness
Not
Size in unit
Reference
Aster
% difference
Case 1
A2
displacement W (m)
2. 10-9
1.939 10-9
-3.03

H = 10m
B2
displacement W (m)
2. 10-9
1.921 10-9
-3.94
Case 2
A2
displacement W (m)
2. 10-6
1.925 10-6
-3.73
H = 1m
B2
displacement W (m)
2. 10-6
1.907 10-6
-4.64
Case 3
A2
displacement W (m)
2. 10-3
1.925 10-3
-3.75
H = 0.1m
B2
displacement W (m)
2. 10-3
1.907 10-3
-4.65
Case 4
A2
displacement W (m)
1.6 10-2
1.542 10-2
-3.60
H = 0.05m
B2
displacement W (m)
1.6 10-2
1.528 10-2
-4.51
Case 5

A2
displacement W (m)
0.25
2.479 10-1
-0.83
H = 0.02m
B2
displacement W (m)
0.25
2.45710-1
-1.72

6.2 Remarks

For the strong twinges, (case 3, 4, 5), it is necessary to increase the number of decimals lost with the resolution, using key word NPREC. This does not prevent from obtaining a correct solution (at least for cases 3 and 4).

The twinges are (h/min report/ratio (I, L/10)) :

Case 1: 1
Case 2: 0.1
Case 3: 0.01
Case 4: 0.005
Case 5: 0.002

7
Summary of the results

In the case of the regular grid, from good solutions are obtained. The quality of the solution declines nevertheless when the twinge of the element (side ratio/thickness) reached 200.

In the case of the not-regular grid, whatever the twinge of the element, one tends to underestimate the rigidity of the beam from approximately 4%.

This test can be supplemented by a modeling 3D and to be applied to the elements of COQUE_3D MEC3QU9H like with elements DKT.

Author (S):
J.M. PROIX, Key S. BAGUET
:

Organization (S): EDF-R & D /AMA, INSA LYON

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.125

SSLS125 - Buckling of a free cylinder under
external pressure

Summary:

This test represents a calculation of stability of a free thin cylindrical envelope at its ends subjected to an external pressure. One calculates the critical loads leading to the elastic buckling of Euler. The matrix
of geometrical rigidity used in the resolution of the problem to the eigenvalues is that which is due to initial constraints.

He makes it possible to validate modeling finite elements SHB8.

The critical load and the clean mode obtained are compared with an analytical reference solution.

V3.03.125-A Page:
2/6

1
Problem of reference

1.1 Geometry

=
Z, W
Free cylinder at the ends
Z
O'
C
D
L/2
O
B
y
With
y, v
X
X, U

The symmetry of the problem makes it possible to model a quarter of cylinder length L, with conditions
of symmetry specific to the lower edge.

L = 2m
Average radius R = 2m
Thickness E = 0.02m

1.2
Properties of material

The properties of material constituting the plate are:

E = 2. 1011 Pa
Young modulus
= 0.3
Poisson's ratio

1.3
Boundary conditions and loadings

.
Loading:
- pressure uniformly distributed of pcr= 1. Pa on the cylindrical part.
- Conditions of symmetry:
- on AB: DZ = 0
- on BC: DX=0
- on DA: DY=0

1.4 Conditions
initial

Without object

2
Reference solution

2.1
Method of calculation used for the reference solution

The critical pressure is given in [bib1] or [bib2] by the following expression:

Pcr = E/12/(1-naked ²) .n ². (e/R) 3
with N number of the mode (here N = 2,4,6)

2.2
Results of reference

The pressures criticize (out of Pa) are:

Mode (N)	Reference
2	73260
4	293040
6	659340

2.3
Uncertainties on the solution

Analytical solution

2.4 References
bibliographical

[1]
S.P. TIMOSHENKO, J.M. MANAGES: Theory of elastic stability, page 500, second edition, DUNOD 1966.
[2]
BO O. ALMROTH, D.O. BRUSH: Buckling of bars, punts and shells, page 173, Mc Graw-Hill, New York, 1975.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/03/008/A

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3 Modeling With

3.1 Characteristics of modeling

Z, W
Modeling SHB8
Z
G
48
H
O'
F

E
4
L/2
C
D
O
B
y
P1,
y, v
P12
X

X, U

3.2
Characteristics of the grid

A number of nodes: 882
A number of meshs and types: 400 HEXA8

3.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE AFFE
MODELISATION=SHB8

AFFE_CHAR_MECA PRES_REP NEAR

CALC_MATR_ELEM OPTION
"RIGI_MECA"
"RIGI_GEOM"
MODE_ITER_SIMULT METHOD
"SORENSEN"

OPTION
"PLUS_PETITE"

4
Results of modeling A

4.1 Values
tested

Identification Mode
(N)

Reference
Aster *%*
difference
Pressure criticizes (Pa)
2
73260
72492
1
4
293040
293481
0.2
6
659340
673600
2

5
Summary of the results

The results obtained are satisfactory. Uncertainties on the critical pressure do not exceed 2%.

The modal deformation obtained corresponds well to the awaited circumferential mode: n=2 for both modelings.

This test made it possible to test modeling SHB8 in linear buckling of Euler of a mean structure subjected to an external pressure.

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Code_Aster ®
Version
7.2

Titrate:
SSLS128 - Validation of option CRIT_ELNO_RUPT of CALC_ELEM
Date:
05/03/04
Author (S):
Key ***J.M. PROIX***
:
V3.03.128-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.128

SSLS128 - CALC_ELEM: Validation of the option
CRIT_ELNO_RUPT

Summary:

This option allows, in the case of the multi-layer hulls to calculate in a layer the constraints in locate this one as well as the corresponding criterion of Tsai-Hill.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/04/005/A

1
Problem of reference

1.1 Geometry

LEFT
RIGHT-HAND SIDE
N1

It is about a composite material made up of 16 superimposed layers of the same material and of fibre directions different forming plate a 4.48 m thickness. The longitudinal direction or feel fibres of each layer is defined by the first direction of orthotropism.

1.2
Property of material

The properties of material are:

· longitudinal modulus Young: E_L = 59000 MPa

· transverse modulus Young: E_T = 59000 MPa
· modulus of rigidity in plan LT: G_LT = 3700 MPa
· Poisson's ratio in plan LT: NU_LT = 0.08
· criterion of rupture in traction in the longitudinal direction: XT = 560 MPa
· criterion of rupture in compression in the longitudinal direction: XC = -475 MPa
· criterion of rupture in traction in the transverse direction: YT = 560 MPa
· criterion of rupture in compression in the transverse direction: YC = -475 MPa
· criterion of rupture in shearing in plan LT: S_LT = 48 MPa

The orientation of the first layer is 0° compared to the reference mark of reference, for the second layer
45°, for the third 0° and so on.

1.3
Boundary conditions and loadings

· N1
DY=0, DZ=0, DRX=0, DRY=0, DRZ=0
· LEFT
DX=0
· RIGHT
FX= -784 NR

2
Reference solution given by the software "Plates"

In the first layer with 0°

Sxx Syy Szz
-242 -67 0
Constraints in the reference mark of the plate

SL ST
SLT
-242 -67 0
Constraints in the reference mark of the layer

Criterion of Tsai-Hill C
= 0.344
TH

In the second with 45°

Sxx Syy Szz
-108 -67 0
Constraints in the reference mark of the plate

SL ST
SLT
-88 -88 21
Constraints in the reference mark of the layer

Criterion of Tsai-Hill C
= 0.223
TH

SL is the constraint in the first direction of orthotropism of the layer, ST the second and SLT shear stress.
Sxx, Syy, Szz are the constraints in the reference mark of the user.

---

3 Modeling
With

3.1
Characteristics of modeling

The hull is modelled by elements DKT. Its characteristics are defined in
AFFE_CARA_ELEM:

· thickness: 16 X 0.28 = 4.48 m
· reference mark of reference of the hull defined by ANGL_REP = 0.

The various layers are defined by the operator DEFI_COQU_MULT who gives for each
its thickness, its material and its orientation compared to the reference mark of reference sleep defined in
AFFE_CARA_ELEM.

3.2
Characteristics of the grid

A number of nodes: 624

A number of meshs and types: 48 SEG2 and 576 QUA4

3.3 Functionalities
tested

Orders

THICK DEFI_COQU_MULT

MATER
ORIENTATION
CALC_ELEM SIGM_ELNO_DEPL

CRIT_ELNO_RUPT

4
Results of modeling A

4.1 Values
tested

For the layer with 0°

Identification Reference
Aster %
difference
Sxx -242 -2.41623E+02
0.15
Syy 67
6.66229E+01
0.56
SL -242
-2.41623E+02
0.15
ST 67
6.66229E+01
0.56
|SLT| 0
2.82232E-12
0
CTH 0.344
3.44256E-01
0.06

For the layer with 45°

Identification Reference
Aster %
difference
Sxx -108 -1.08377E+02

0.35
Syy -67
-6.66229E+01
0.56
SL -88
-8.75000E+01
0.57
ST -88
-8.75000E+01
0.57
|SLT| 21
2.08771E+01
0.58
CTH 0.223
2.23106E-01
0.05

---

5 Synthesis

The results obtained are satisfactory. The maximum of difference is approximately 0.6% and it is due to
fact that the results resulting from the software “Plate” are given with little precision.

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Titrate:
DEMO006 Optimization of the radius of curvature of a bent piping
Date:
05/09/05
Author (S):
J. LAVERNE, F. LEBOUVIER
Key: V3.03.131-A
Page:
1/6

Organization (S): EDF-R & D /AMA, DeltaCAD

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
V3.03.131 document

DEMO006 Optimization of the radius of curvature of a bent piping

Summary:

This test of demonstration illustrates the use of the language python in Code_Aster.

The objective of this case-test is to optimize the value of the radius of curvature of a piping via a loop python.

The radius of curvature is modified repeatedly. The optimal value is obtained when the maximum constraint of Von Mises is lower than a threshold.

The language python, in this case-test allows repeatedly:

- ***to modify the file describing the geometry of the elbow,***
- ***of launching GMSH in order to net the elbow,***
- ***to recover the maximum constraint of Von Mises,***
- ***to evaluate a criterion of stop of the iterations,***
- ***of launching GMSH to carry out an interactive postprocessing.***

This case-test takes again the problem of the case-test forma01f: bent piping, made up of an elastic material linear, subjected to a force applied at its end, modelled by elements of hulls DKT.

Note:

To have the interactive functions of visualization, to put interactive = 1 at the beginning of the file of order.

1
Problem of reference

1.1 Geometry

The study relates to a piping including/understanding two right pipes and an elbow [Figure 1.1-a].

The geometrical data of the problem are as follows:

·
length LG of the two right pipes is 3 m,
·
initial the Rc ray of the elbow is 0.3 m,
·
the angle of the elbow is 90 degrees,
·
the thickness of the right pipes and the elbow is 0.02 m,
·
and the ray external Re of the right pipes and the elbow is of 0.2 Mr.

LG

D
B
section D
section B
RC
C
O
section C

Z
Y
E
L
Z
G
X
Re
X
With
section A

Appear 1.1-a
Note:

The geometry of the problem has a symmetry compared to the plan (A, X, Y).

1.2
Material properties

Isotropic linear elastic material. The properties of material are those of A42 steel:

.
the Young modulus:

E = 1.8 1011 Pa,
.
the Poisson's ratio:
= 0.3,

1.3
Boundary conditions and loadings

· Boundary conditions: embedding on the level of section A,

· Chargement: force constant FY directed according to the axis Y and applied to the section B.

The value of FY is calculated to leave:
average radius: *RMOY* = 0.19,
total force applied:
2
***FTOT* = 500000 *NR/m*,**
Its expression is as follows:
***FY* = *FTOT* (2 *RMOY*) (418828.8)**

· The limiting constraint of Von Mises is of 2.0E+09 N/m ²

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is obtained numerically. It is thus only about one test of not regression.

2.2
Results of modeling

The optimal value of the radius of curvature, respecting the criterion put < 2.109 N.m-2 is of 1.1m, obtained after 5 iterations. With each iteration the radius of curvature is increased by 0.2m.

Rays of
Constraint max of
Iterations
curve
Von Mises
1

0.3 m
3.3315 E+09 N/m ²
2
0.5 m
2.7647 E+09 N/m ²
3
0.7 m
2.4256 E+09 N/m ²
4
0.9 m
2.1727 E+09 N/m ²
5
1.1 m
1.9670 E+09 N/m ²

2.3
Uncertainty on the solution

Solution of nonregression.

3 Modeling
With

3.1
Characteristics of modeling

Modeling in elements hulls (DKT).

Appear 3.1-a: geometry and grid of the half roll (initial RC)

3.2
Characteristics of the grid

The grid is regenerated with each iteration because of the modification of the radius of curvature of
geometry. However the topological characteristics of the grid are unchanged:

- **1013 meshs (900 TRIA3, 110 SEG2, 3POI3)**
- **507 nodes.**

The groups of meshs correspond to:

- **GM30 <=> surface of the PIPE**
- **GM28 <=> section B (effort)**
- **GM31 <=> not A1 (- R, 0, 0)**
- **GM27 <=> section A (embedding)**
- **GM29 <=> SYMMETRY**

3.3 Orders
Aster

This paragraph describes the algorithm used in the command file and presents the orders *Code_Aster* used.

.
Initialization of certain variables:
Radius of curvature: Rc = 0.3
Criterion of convergence: crit = 2.0E+09 (forced of Von Mises targets)

.
One enters the loop python whose criterion of stop relates to the constraint max of Von Settings. As long as the criterion is not respected, the following instructions are carried out:

Rebuilding of the grid:
one
redefines
Rc in the geometrical file .geo of GMSH
one launches gmsh via python to generate the file of grid .msh

Reading of grid (PRE_GMSH) and generation of grid (LIRE_MAILLAGE). One uses DEFI_GROUP to re-elect the groups of meshs according to the correspondence:

 # GM30 <=> PIPE
 # GM28 <=> EFOND

 # GM31 <=> A1

 # GM27 <=> ENCAST
#

GM29
<=>
SYMMETRY

Definition of the finite elements used (AFFE_MODELE). The right pipes and the elbow are modelled by elements of hull (DKT).

Reorientations of the normals to the elements: one uses MODI_MAILLAGE to direct all elements in the same way, with a normal turned towards the interior.

Definition and assignment of material (DEFI_MATERIAU and AFFE_MATERIAU). mechanical characteristics are identical on all the structure.

Assignment of the characteristics of the elements hulls (AFFE_CARA_ELEM): thickness, vector V defining the reference mark of examination (key word ANGL_REP)

Definition of the boundary conditions and loading (AFFE_CHAR_MECA).

Piping is embedded in its base, on all the nodes located in the Y=0 plan.
Piping presents a symmetry plane Z=0.

One calculates an effort distributed FY directed according to the axis Y and applied to the section B, (the effort
distributed is such as the resultant 2Pi* RMOY. FY = FTOT, FTOT being the total force that one wishes to apply). To apply the effort to the section B, one will use FORCE_ARETE.

Resolution of the linear elastic problem (MECA_STATIQUE).

Calculation of the stress field by elements to the nodes for each loading case
(option “SIGM_ELNO_DEPL”). The constraints are calculated in the definite local reference mark
for each element using the vector V (preceding key word ANG_REP). To use NIVE_COUCHE to define the level of calculation in the thickness.

Calculation of the stress field equivalent by elements to the nodes calculated from stress field (option “EQUI_ELNO_SIGM”).

Calculation of the preceding fields to the nodes (options “SIGM_NOEU_DEPL”,
Buckle python of optimization of the radius of curvature
“EQUI_NOEU_SIGM”)

Impression of results (IMPR_RESU).

Determination of a table containing calculations of averages of the stress field equivalent to the nodes. ("POST_RELEVE_T")

Extraction of component VMIS of the preceding table via python.
Test of stop:
If VMIS is higher than CRIT, then one reiterates with Rc=Rc+0.2
If not one leaves the loop python.
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/05/005/A

4
Results of modeling A

4.1 Values
tested

Rays of
Constraint max of Von
Iterations
curve
Settings
1
0.3 m
3.3315E+09 N/m ²
2
0.5 m

2.7647E+09 N/m ²
3
0.7 m
2.4256E+09 N/m ²
4
0.9 m
2.1727E+09 N/m ²
5
1.1 m
1.9670E+09 N/m ²

5
Summary of the results

The optimal radius of curvature respecting the criterion: constraint max of Von Mises < to 2.0E +09 is of 1.1m. It was obtained after 5 iterations, and the maximum constraint of Von Mises found is of 1.9670E+09 N/m ².

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.501

SSLS501 - Roll infinitely long subjected
with two lines of load

Summary:

This test represents a quasi-static calculation of an infinitely long cylinder subjected to two lines of load
diametrically opposite. It makes it possible to validate modeling finite elements COQUE_D_PLAN with catch in
count variation of curve between the under-surface and suction face (AFFE_CARA_ELEM: MODI_METRIQUE).

Displacements and the efforts obtained are compared with an analytical reference solution.

1
Problem of reference

1.1 Geometry

y, v
, y
Q
X
X, U
, X
Ray: R = 1 m
Thickness: H = 0.1 m
, Z
R
Z, W

1.2
Properties of material

The properties of material constituting the cylinder are:

E = 105 Pa
Young modulus
= 0
Poisson's ratio

1.3
Boundary conditions and loadings

.
CL: displacement following Z is null for the whole of the points of the cylinder
.
Force per unit of length: Q = 1.5 N/m

1.4 Conditions
initial

Without object

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution obtained by KOITER-SANDERS [bib1] [bib2] is based on the theory of deep hulls.

2.2
Results of reference

The results of reference are:

.
Displacement following y to point a: 13.455
10-3 m
.
Displacement following X to point b: 12.255

10-3 m
.
Normal effort at point A
: 0.0
NR
.
Bending moment at point A
:
0.477 N.m

2.3 Uncertainties on the solution

Analytical solution

2.4 References bibliographical

[1]
GEOFFROY P.: "Development and evaluation of a finite element for the non-linear analysis statics and dynamics of thin hulls ", Thesis of Doctor Engineer UTC, 1983.
[2]
BATOZ J.L. : "Non-linear Analysis of the elastic thin hulls of arbitrary form by curved triangular elements ", Thesis of science doctorate (pH. D thesis), Department from civil engineering, Laval University, Quebec, Mars 1977.

---

3 Modeling
With

3.1
Characteristics of modeling

Grid of the arc of circle AB with 32 finite elements of type COQUE_D_PLAN

y, v
F
With
Conditions of symmetry:
32
- Not a: U = =0
Z
- Not b: v = =0
Z
B
X, U
Loading:
Z
- Not a: F = q/2
Z

3.2
Characteristics of the grid

A number of nodes: 17
A number of meshs and type: 8 SEG3

3.3 Functionalities
tested

Orders Key word
factor Key word
AFFE_MODELE AFFE
"COQUE_D_PLAN"
AFFE_CARA_ELEM HULL
THICK
A_CIS: 0.833

MODI_METRIQUE: “YES”
AFFE_CHAR_MECA FORCE_NODALE
FY

4
Results of modeling A

4.1 Values tested

Identification Reference
Aster %
difference
Displacement following y to the point
13.455 E3 m
13.603 E3
1.099
With
Displacement following X to the point
12.255 E3 m
12.360 E3
0.857
B

Normal effort at point A
0.0 NR
-0.183
****
Bending moment at point A
0.477 N.m
-0.478
0.210

4.2 Parameters
of execution

Version:
NEW 5.04.17

Machine:
SGI-Origin2000 R12000

Obstruction memory:
16 megabytes
Time CPU To use: 1.31 seconds
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HI-75/01/010/A

5
Summary of the results

As a whole, the results obtained are very satisfactory:

.
the maximum change is 1.1%. on displacements,
.
the maximum change is 0.21% at the bending time.

The value of the normal effort is far away from the reference solution. The result would be more precise if one
used a finer grid [bib1].

Organization (S): EDF/AMA, DeltaCAD

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
Document: V3.03.502

SSLS502 - Orthotropic cylinder subjected to a line of load

Summary:

This test represents quasi-static calculation, of a short orthotropic cylinder and an orthotropic long cylinder
subjected to a line of load. Their ends, the cylinders rest on rigid diaphragms. This case
test makes it possible to validate modeling finite elements DST with meshs TRIA3 and QUAD4, a material
homogeneous orthotropic.

Displacements and the efforts obtained are compared with a reference solution experimental like to an analytical solution.

1
Problem of reference

1.1 Geometry

Q
Y
Z
H
Diaphragm
rigid
X
R
Steel wire
L
Plastic
(ac
has rylic)
y
L = 0.560 m
H = 0.0061 m
roll short:
R = 0.13595 m
Q = 2357.143 N/m
L = 2.465 m
H = 0.0061 m
roll long:
R = 0.13595 m
Q = 896.552 N/m

1.2
Properties of material

The material constituting the cylinder is homogeneous orthotropic. The axes of orthotropism correspond
with the curvilinear directions X and Y.

[H
] = [hH; [H
= 0
H
= h3 H /12
membrane inflection] []
membrane
]
; [inflection]
[ ]

H11= 3.0644 X 109 N/m ²; H12= 1.1048 X 109 N/m ²; H13= 0
H22= 18.597 X 109 N/m ²; H23= 0
; H33=1.250 X 109 N/m ²

1.3
Boundary conditions and loadings

- CL: The ends of the cylinder rest on rigid diaphragms

- Modelings A and b: Forces per unit of length: Q = -2357.143 N/m
- Modelings C and D: Force per unit of length: Q = -896.552. N/m

1.4 Conditions
initial

Without object

2
Reference solution

2.1
Method of calculation used for the reference solution

We will use for this test two reference solutions, one experimental, resulting from work from Schwaighofer and Microys [bib2], the other drawn from work of Batoz in theory of the deep hulls [bib1].

2.2
Results of reference

The results of reference are as follows:

Roll (A and B) short
Batoz [bib1]
Experiment [bib2]
Displacement W at the point F
0.35 104 m 0.6
104 m
Displacement W at the point C
0.7 103 m
0.6 103 m
Displacement W at the point D
0.25 104 m
0.1 103 m
Constraint xx at the point F
0.35 MPa

0.325 MPa
Constraint yy at the point F
0.50 MPa
0.60 MPa

Roll long (C and D)
Batoz [bib1]
Experiment [bib2]
Displacement W at the point F
1.32 103 m
1.35 103 m
Displacement W at the point C
2.45 103 m
2.46 103 m
Displacement W at the point D
0.35 103 m
0.51 103 m
Constraint xx at the point F
1.68 MPa
1.9 MPa
Constraint yy at the point F
1.8 MPa
1.55 MPa

2.3
Uncertainties on the solution

~ 5% with regard to the solution of Batoz, undoubtedly much more - ~30% - for the solution experimental.

2.4 References
bibliographical

[1]
BATOZ J.L., DHATT G.: Modeling of the structures by finite elements, Flight 3, Hulls, HERMES.
[2]
SCHWAIGHOFER J., MICROYS H.F. : Orthotropic Cylindrical shells under line load, Newspaper of applied Mechanics, June 1979, Flight 46.
[3]
GEOFFROY P., Development and evaluation of a finite element for the non-linear analysis statics and dynamics of thin hulls, Thesis of Doctor Engineer, University of Technology of Compiegne, 27/04/83.

---

3 Modeling
With

3.1
Characteristics of modeling

Z
DST modeling (one models a half rolls)
Y
C
Z
- 8 elements in the circumferential direction
y
- 12 elements in the longitudinal direction
B
Z
F
R, W
X
- Boundary conditions: Side AB:
U = W = y=0
- Conditions of symmetry: Sides AD and BC: U =
E
y= z= 0
X

Side cd.:
v = x= z= 0
D

- Force per unit of length side BC: q/2 = 1178.5715 N/m
With
L/2

3.2
Characteristics of the grid

A number of nodes: 224
A number of meshs and type: 192 QUAD4

3.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
"DST"
DEFI_MATERIAU
ELAS_COQUE
MEMB_L
MEMB_LT
MEMB_T
MEMB_G_LT
FLEX_L
FLEX_LT
FLEX_T
FLEX_G_LT
CISA_L
CISA_T
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA

4
Results of modeling A

4.1 Values
tested

Identification Reference Reference
Aster %
differences
numerical
expériementale
[bib1]
[bib2]
Displacement W at the point F
0.35x104m 0.6
104m 0.373
104m 6.703 [bib1]
37.757 [bib2]
Displacement W at the point C
0.7 103 m
0.6 103 m
0.721 x103

3.033 [bib1]
20.205 [bib2]
Displacement W at the point D
0.25 104 m
0.1 103 m
0.369 10-4
47.689 [bib1]
-63.078 [bib2]

Constraint SIXX at the point F
0.350 MPa
0.325 MPa
0.480 MPa
37.339 [bib1]
47.904 [bib2]
Constraint SIYY at the point F
0.500 MPa
0.600 MPa
0.490 MPa
-1.901 [bib1]
-18.259 [bib2]

4.2
Value of normal displacement W along CD

EDF
Mechanical department and Digital Models
Electricity
W according to the angle along CD
from France
0.6
ROLL SHORT ORTHOTROPIC
DKT 8 X 12 QUAD4
0.4
0.2
0.0
mm)
T (
L
acemen

W (total reference mark)
é
p
D
-0.2
W normal Batoz reference
W normal
W normal experimental
-0.4
-0.6
-0.8
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 19/04/2001 (c) EDF/DER 1992-1999

One can note that beyond the variations observed on the points tested C, F, D, normal displacement calculated along CD is close to the solution in theory "deep hulls" adopted by Batoz [bib1]. One can charge the errors relating to the points F and D to the low value of the displacement (of the order of 105 m).

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLS502 - Orthotropic cylinder subjected to a line of load
Date:
19/09/02
Author (S):

4.3
Value of the constraints along CD

EDF
Mechanical department and Digital Models
Electricity
Sigma XX along CD
from France
2
ROLL SHORT ORTHOTROPIC
DKT 8 X 12 QUAD4
1
0
-1
has
)
P
-2
M
(
your
T
R
has
in
N
sigma XX
Co
-3
Experimental ref. Schwaighofer/Microys
Ref. Batoz
-4
-5
-6
-7
0
20
40

60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

EDF
Mechanical department and Digital Models
Electricity
sigma YY along CD
from France
3
ROLL SHORT ORTHOTROPIC
DKT 8 X 12 QUAD4
2
1
0
has
)
P
-1
M
(
your
T
R
has
in
N
sigma YY
Co
-2
Experimental ref. Schwaighofer/Microys
Ref. Batoz
-3
-4
-5
-6

0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

One can note that the constraints calculated along CD are overall in agreement with the solution in theory "deep hulls" adopted by Batoz [bib1].

4.4 Remarks

· The values of coefficients CISA_L and CISA_T are not available. Like the structure is thin (h/R=0.045), one supposes that the effects of transverse shearing are negligible, we thus imposed CISA_L=CISA_T=1010.
· Displacement W normal (figure of [§4.2]) is expressed in the local cylindrical reference mark (R, Z), it acts of normal displacement to the element of hull. Displacement W tested with [§4.1] is as for

he expressed in the total reference mark (displacement following Z).

---

5 Modeling
B

5.1
Characteristics of modeling

Z
DST modeling (one models a half rolls)
Y
C
Z
- 8 elements in the circumferential direction
y
- 12 elements in the longitudinal direction
B
Z
F
R, W
X
- Boundary conditions: Side AB:
U = W = y=0
- Conditions of symmetry: Sides AD and BC: U =
E

y= z= 0
X

Side cd.:
v = x= z= 0
D

- Force per unit of length side BC: q/2 = 1178.5715 N/m
With
L/2

5.2
Characteristics of the grid

A number of nodes: 224
A number of meshs and type: 384 TRIA3

5.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
“DST”
DEFI_MATERIAU
ELAS_COQUE
MEMB_L
MEMB_LT
MEMB_T
MEMB_G_LT
FLEX_L
FLEX_LT
FLEX_T
FLEX_G_LT
CISA_L
CISA_T
AFFE_CARA_ELEM
HULL
THICK

ANGL_REP
AFFE_CHAR_MECA
FORCE_ARETE
FZ

6
Results of modeling B

6.1 Values
tested

Identification Reference
Reference
Aster %
differences
[bib1]
[bib2]
Displacement W at the point F
0.35 10-4m 0.6
104m 0.383
10-4
9.571 [bib1]
36.084 [bib2]
Displacement W at the point C
0.7 10-3m 0.6

103 m
-7.138 10-4
1.985 [bib1]
18.982 [bib2]
Displacement W at the point D
0.25 10-4m 0.1
103 m
0.350 10-4
40.368 [bib1]
64.908 [bib2]

Constraint SIXX at the point F
0.350 MPa
0.325 MPa
0.470 MPa
34.348 [bib1]
44.682 [bib2]
Constraint SIYY at the point F
0.500 MPa
0.600 MPa
0.400 MPa
19.929 [bib1]
33.274 [bib2]

6.2 Remarks

· The values of coefficients CISA_L and CISA_T are not available. Like the structure is thin (h/R=0.045), one supposes that the effects of transverse shearing are negligible, we thus imposed CISA_L=CISA_T=1010.
· Displacement W normal is expressed in the local cylindrical reference mark (R, Z), it acts of normal displacement with the element of hull.

6.3
Value of normal displacement along CD

The results obtained with a grid TRIA3 are very close to those obtained by the grid QUAD4.
Handbook of Validation

V3.03 booklet: Linear statics of the hulls and the plates HT-66/02/001/A

6.4
Value of the constraints along CD

Sigma XX along CD
2
ROLL SHORT ORTHOTROPIC
DKT 8 X 12 TRIA3
1
0
-1
has
)
P
-2
M
(
your
T
R
has
in
N
sigma XX
Co

-3
Experimental ref. Schwaighofer/Microys
Ref. Batoz
-4
-5
-6
-7
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

Handbook of Validation
V3.03 booklet: Linear statics of the hulls and the plates
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLS502 - Orthotropic cylinder subjected to a line of load
Date:
19/09/02
Author (S):
***P. MASSIN**, F. LEBOUVIER Key*
:
V3.03.502-A Page:
11/18

EDF
Mechanical department and Digital Models
Electricity
sigma YY along CD
from France
3

ROLL SHORT ORTHOTROPIC
DKT 8 X 12 TRIA3
2
1
0
has
)
P
-1
M
(
your
T
R
has
in
N
sigma YY
Co
-2
Experimental ref. Schwaighofer/Microys
Ref. Batoz
-3
-4
-5
-6
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

The profiles of the constraints obtained by modeling B with TRIA3 are as a whole near to the solutions of Batoz.

---

7 Modeling
C

7.1
Characteristics of modeling

Z
DST modeling (one models a half rolls)
Y
C
Z
- 8 elements in the circumferential direction
y
- 12 elements in the longitudinal direction
B
Z
F
R, W
X
- Boundary conditions: Side AB:
U = W = y=0
- Conditions of symmetry: Sides AD and BC: U =
E
y= z= 0

X

Side cd.:
v = x= z= 0
D

- Force per unit of length side BC: q/2 = 448.276 N/m
With
L/2

7.2
Characteristics of the grid

A number of nodes: 224
A number of meshs and type: 384 TRIA3

7.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
“DST”
DEFI_MATERIAU
ELAS_COQUE
MEMB_L
MEMB_LT
MEMB_T
MEMB_G_LT
FLEX_L
FLEX_LT
FLEX_T
FLEX_G_LT
CISA_L
CISA_T
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP

AFFE_CHAR_MECA
FORCE_ARETE
FZ

8
Results of modeling C

8.1 Values
tested

Identification Reference
Reference
***Aster** %*
difference
numerical
experimental
[bib1]
[bib2]
Displacement W at the point F
1.325 103 m
1.35 103 m
1.327 103 m
0.154 [bib1]
1.701 [bib2]

Displacement W at the point C
2.45 103 m
2.46 103 m
2.379 103 m
2.881 [bib1]
3.275 [bib2]

Displacement W at the point D
0.51 103 m
0.35 103 m
0.529 103 m
3.859 [bib1]
51.337 [bib2]

Constraint SIXX at the point F
1.68 MPa

1.9 MPa
1.643 MPa
2.155 [bib1]
13.484 [bib2]
Constraint SIYY at the point F
1.8 MPa
1.55 MPa
1.782 MPa
0.986 [bib1]
14.984 [bib2]

8.2 Remarks

· The value of coefficients CISA_L and CISA_T are not available. As the structure is thin (h/R=0.045), that the effects of transverse shearing are negligible, us are supposed thus imposed CISA_L=CISA_T=1010.
· Displacement W normal is expressed in the local cylindrical reference mark (R, Z), it acts of normal displacement with the element of hull.

8.3
Value of normal displacement along CD

W according to the angle along CD
from France
1.5
ROLL LONG ORTHOTROPIC
DKT 8 X 12 TRIA3
1.0
0.5
0.0
mm)
T (
-0.5
L
acemen
W normal
é
p
D
W normal Batoz reference
W normal experimental
-1.0
-1.5
-2.0
-2.5
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 19/04/2001 (c) EDF/DER 1992-1999

One can note that beyond the variation observed on the experimental value at the point D, displacement normal calculated along CD is very close to the solution in adopted theory "deep hulls" by Batoz [bib1].

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8.4
Value of the constraints along CD

EDF
Mechanical department and Digital Models
Electricity
Sigma XX along CD
from France
3
ROLL LONG ORTHOTROPIC
DKT 12 X 8 TRIA3
2
1
0
has
)
P
M
(
your
-1
T
R
has
in
N
Experimental ref. Schwaighofer/Microys

Co
Ref. Batoz
sigma XX
-2
-3
-4
-5
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

EDF
Mechanical department and Digital Models
Electricity
sigma YY along CD
from France
3
ROLL LONG ORTHOTROPIC
DKT 12 X 8 TRIA3
2
1
0
has
)
P
M
(
your
-1
T
R
has
in

N
Experimental ref. Schwaighofer/Microys
Co
Batoz theory "deep hulls"
sigma YY
-2
-3
-4
-5
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

The profiles of the constraints calculated by the code are overall in agreement with work of Batoz.

---

9 Modeling
D

9.1
Characteristics of modeling

Z
DST modeling (one models a half rolls)
Y
C
Z
- 8 elements in the circumferential direction
y
- 12 elements in the longitudinal direction
B
Z
F
R, W
X
- Boundary conditions: Side AB:
U = W = y=0
- Conditions of symmetry: Sides AD and BC: U =
E
y= z= 0
X

Side cd.:
v = x= z= 0
D

- Force per unit of length side BC: q/2 = 448.276 N/m
With
L/2

9.2
Characteristics of the grid

A number of nodes: 224
A number of meshs and type: 192 QUAD4

9.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
“DST”
DEFI_MATERIAU
ELAS_COQUE
MEMB_L
MEMB_LT
MEMB_T
MEMB_G_LT
FLEX_L
FLEX_LT
FLEX_T
FLEX_G_LT
CISA_L
CISA_T
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA
FORCE_ARETE
FZ

10 Results of modeling D

10.1 Values tested

Identification Reference
Reference
Aster %
difference
[bib1]
[bib2]
Displacement W at the point F
1.325 103 m
1.35 103 m
1.329 103 m
0.365 [bib1]

1.494 [bib2]

Displacement W at the point C
2.45 103 m
2.46 103 m
2.369 103 m
3.274 [bib1]
3.667 [bib2]

Displacement W at the point D
0.51 103 m
0.35 103 m
0.528 103 m
3.634 [bib1]
51.009 [bib2]

Constraint SIXX at the point F
1.68 MPa
1.9 MPa
1.79 MPa
6.616 [bib1]
5.729 [bib2]
Constraint SIYY at the point F
1.8 MPa
1.55 MPa
1.84 MPa
2.465 [bib1]
18.991 [bib2]

10.2 Remarks

· The value of coefficients CISA_L and CISA_T are not available. As the structure is thin (h/R=0.045), that the effects of transverse shearing are negligible, us are supposed thus imposed CISA_L=CISA_T=1010.
· Displacement W normal is expressed in the local cylindrical reference mark (R, Z), it acts of normal displacement with the element of hull. Displacement W tested is that of the total reference mark (displacement following Z).

10.3 Value of displacement along CD

EDF
Mechanical department and Digital Models
Electricity
W according to the angle along CD
from France
1.5
ROLL LONG ORTHOTROPIC
DKT 8 X 12 QUAD4
1.0
0.5
0.0
mm)
T (
-0.5
L
acemen
W normal Batoz reference
é
p
D
W normal
W normal experimental
-1.0

-1.5
-2.0
-2.5
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 19/04/2001 (c) EDF/DER 1992-1999

One can note that beyond the variation observed on the experimental value at the point D, displacement normal calculated along CD is very close to the solution in adopted theory "deep hulls" by Batoz [bib1].

10.4 Values of the constraints along CD

Electricity
Sigma XX along CD
from France
3
ROLL LONG ORTHOTROPIC
DKT 12 X 8 QUAD4
2
1
0
has
)
P
M
(
your
-1
T
R
has
in
N
sigma XX
Co
Experimental ref. Schwaighofer/Microys
Ref. Batoz
-2
-3
-4
-5
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

EDF
Mechanical department and Digital Models
Electricity
sigma YY along CD
from France
3
ROLL LONG ORTHOTROPIC
DKT 12 X 8 QUAD4
2
1
0
has
)
P
M
(
your
-1
T
R
has
in
N
sigma YY
Co
Experimental ref. Schwaighofer/Microys
Batoz theory “deep hulls”
-2
-3
-4
-5
0
20
40
60
80
100
120
140
160
180
angle (deg)
agraf 05/06/2001 (c) EDF/DER 1992-1999

---

11 Summary of the results

The results are as a whole satisfactory. The specific variations which appear at the points tested, in particular the point D, seem due to the experimental uncertainty, undoubtedly reinforced by an uncertainty as for the graphic taking away.
A contrario, the solutions suggested by Batoz in theory "deep hulls" are well checked by four modelings, with relative errors of less than 5% for the long cylinder.

It appears that:

· modelings TRIA3 and QUAD4 are appreciably equivalent for this problem,
· the relative errors are much weaker for the long cylinder (modelings C and D) that for the cylinder runs (modelings A and B): at the point F, the error is reduced of a factor 10 compared to the reference solution of Batoz,
· the refinement of the grid does not minimize in a decisive way the relative variations, so much with TRIA3 that with the QUAD4.

It is thus noted that the results are degraded when the report/ratio length on the diameter decrease, indeed the geometrical effects become important with this type of modeling. It would be desirable to be able to carry out a calculation in finite elements of hulls in orthotropic medium, in order to
to better take into account the curve, the plates constituting a borderline case.

Code_Aster ®
Version
5.0

Titrate:
SSLS503 - Plate laminated in antisymmetric inflection stacking
Date:
17/06/02
Author (S):
J.M. PROIX, P. MASSIN, F. LEBOUVIER Key
:
V3.03.503-A Page:
1/12

Organization (S): EDF/AMA, DeltaCAD

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.503

SSLS503 - Plate laminated in inflection stacking
antisymmetric simply supported

Summary:

This test represents a quasi-static calculation of a laminated plate, in antisymmetric inflection stacking,
simply supported, subjected to a pressure uniformly distributed.

4 modelings make it possible to validate:

· modelings finite elements DKT (QUAD4, TRIA3) and DST (QUAD4, TRIA3) in the case of one composite material (3 different layers of orientation),
· stresses shear transverse.

Displacements and the constraints obtained are compared with an analytical reference solution.
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V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

Z, W
y, v
B
C
= 1.2 m have
H = 0.012 m
p
Stacking
With
T
D
X, U
Z
0°
90°
has
0°

L

1.2
Properties of material

The properties of material constituting the plate are as follows:

One-way (U):
E = 4. 1010 Pa
E = 0.16 1010 Pa
(L X; T y)
L
T
G = G = 8. 108 Pa
G = 3.2.108 Pa

lt
lz
tz
= 0.25

lt
Stacking:
· orientation:
[0 / 90 / 0]
· natural:
[U/U/U]
· thickness:
[h/3/h/3/h/3]

1.3
Boundary conditions and loadings

· CL: the plate is simply supported on its contour

· Pression uniformly distributed: p = 3000 Pa

1.4 Conditions
initial

Without object
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V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:

2
Reference solution

2.1
Method of calculation used for the reference solution

Displacement: analytical solution obtained by decomposition in series of the form:
I X
jy
W = W sin
sin

ij

I
J
has
B
Constraints: numerical solution [bib1], [bib2]

2.2
Results of reference
y
Z
Average plan
B
C
h/2

3
A/2
X
h/6
With
2
D
1
- h/2
A/2

The results of reference are as follows:

W (0, 0, 0)
0.01507 m
Displacement W in the center of plate (not A),
SIXX (0, 0, h/2)
2.4216 107 Pa Forced xx on the higher skin of the layer
3 (z=h/2) in the center of plate (not A),
SIYY (0, 0, h/6) layer 5.7810 106 Pa Forced yy on the higher skin of the layer
with 90°
2 (z=h/6) in the center of plate (not A),
SIXY (A/2, A/2, h/2)
1.2825 106 Pa Forced xy at the point C on the higher skin of
layer 3,
SIXZ (A/2, 0, 0)
2.3526 105 Pa Forced xz at the point D on the average skin of
2 sleep (z=0),
SIYZ (0, A/2, 0)
8.8950 104 Pa Forced yz at the point B on the average skin of
2 sleep (z=0),

2.3
Uncertainties on the solution

· The reference solution is given for a number of terms in the series equal to 25.
· The factor of correction of transverse shearing used is 5/6.
· With an important twinge (a/h=100), the transverse level of shearing is weak and thus difficult to obtain with precision. There is then an uncertainty on the values of constraint ij calculated during the validation of test VPCS, the differences obtained by software on the components of shearing is about 10%.

2.4 References
bibliographical

[1]
VPCS: Software package of composite structural analysis; Examples of validation. Review of composites and of advanced materials, Volume 5 - number except series 1995. Hermes edition.
[2]
PUTCHA, N.S. and REDDY, J.N. : With mixed shear flexible finite element for the analysis of laminated punts, computer meth. in applied mech. Eng. 44 (1984).

---

3 Modeling With

3.1 Characteristics of modeling

Z
C
Modeling DKT (TRIA3)
- The plate is located in the plan Y =0.5
y
- Not A (0.4; 0.5; 0.25)
X
- Boundary conditions:
B
D
. Dimensioned BC: v = 0

. Dimensioned CD: v = 0
Y
- Conditions of symmetry: (local reference mark)
48°5
. Dimensioned AB: U = = 0
y
With
X
. Dimensioned AD: v = = 0
X

3.2
Characteristics of the grid

A number of nodes: 49
A number of meshs and types: 72 TRIA3

3.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
"DKT"
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA
FORCE_COQUE
NEAR
CALC_CHAM_ELEM
NUME_COUCHE

NIVE_COUCHE
“SUP” “MOY”
OPTION
“SIGM_ELNO_DEPL”

4
Results of modeling A

4.1 Values
tested

Identification Reference Aster %
difference
v (0, 0, 0)
0.01507
0.01500
-0.492
SIXX (0, 0, h/2)
2.4216 107
2.4307 107 0.376
SIYY (0, 0, h/6) layer with
5.7810 107
5.7438 107 -0.644
90°
SIXY (A/2, A/2, h/2)

1.2825 106
1.2838 106 0.102
SIXZ (A/2, 0, 0)
-2.3526 105
-3.1855 105
35

SIYZ (0, A/2, 0)
8.8950 104
8.6968 104 2.2

4.2 Remarks

The constraints are expressed in the reference mark of orthotropism defined by ANGL_REP (AFFE_CARA_ELEM),
and by the normal of the element.

Components SIXX, SIYY and SIYZ are the average values of the two convergent meshs with points A and C.

The variation obtained on SIXZ is due to the difference in modeling of transverse shearing: in reference, one uses a coefficient of transverse correction of shearing of 5/6. In Code_Aster, one calculates the distribution of shearings in the thickness, presumedly parabolic in each sleep.
The sign of SIXZ is opposed to that of the reference solution.

---

5 Modeling
B

5.1
Characteristics of modeling

Z
Modeling DKT (QUAD4)
C
- The plate is located in the plan Y =0.5
- Not A (0.4; 0.5; 0.25)
y
X
- Boundary conditions:
B
D
. Dimensioned BC: v = 0
. Dimensioned CD: v = 0
Y
- Conditions of symmetry: (local reference mark)
48°5
. Dimensioned AB: U = = 0
y
With
X
. Dimensioned AD: v = = 0
X

5.2
Characteristics of the grid

A number of nodes: 49
A number of meshs and types: 36 QUAD4

5.3 Functionalities
tested

Orders Key word
factor
Key word

AFFE_MODELE
AFFE
“DKT”
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA
FORCE_COQUE
NEAR
CALC_CHAM_ELEM
NUME_COUCHE
NIVE_COUCHE
“SUP” “MOY”
OPTION
“SIGM_ELNO_DEPL”

6
Results of modeling B

***6.1 Values
tested***

***Identification Reference Aster %
difference***
v (0, 0, 0)
0.01507
0.01500
-0.431
SIXX (0, 0, h/2)
2.4216 107
2.4397 107 0.745
SIYY (0, 0, h/6) layer with
5.7810 106
5.7321 106 -0.845
90°
SIXY (A/2, A/2, h/2)
1.2825 106
1.2184 106 -4.995
SIXZ (A/2, 0, 0)
-2.3526 105
-2.0112 105 14.5
SIYZ (0, A/2, 0)
8.8950 104
8.6060 104 3.2

6.2 Remarks

Components SIXX, SIYY and SIYZ are the average values of the two convergent meshs with points A and C.

The variation obtained on SIXZ is due to the difference in modeling of transverse shearing: in reference, one uses a coefficient of transverse correction of shearing of 5/6. In Code_Aster, one calculates the distribution of shearings in the thickness, presumedly parabolic in each sleep.

The sign of SIXZ is opposed to that of the reference solution.

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HT-66/02/001/A

---

7 Modeling C

7.1 Characteristics of modeling

Z
Modeling DST (TRIA3)
C
- The plate is located in the plan Y =0.5
- Not A (0.4; 0.5; 0.25)
y
X
- Boundary conditions:
B
D
. Dimensioned BC: v = 0
. Dimensioned CD: v = 0
Y
- Conditions of symmetry: (local reference mark)
48°5
. Dimensioned AB: U = = 0
y
With
X
. Dimensioned AD: v = = 0
X

7.2
Characteristics of the grid

A number of nodes: 49
A number of meshs and types: 72 TRIA3

7.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
“DST”
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA
FORCE_COQUE
NEAR
CALC_CHAM_ELEM
NUME_COUCHE
NIVE_COUCHE
“SUP” “MOY”
OPTION
“SIGM_ELNO_DEPL”

8
Results of modeling C

8.1 Values
tested

Identification Reference
***Aster** %*
difference
v (0, 0, 0)
0.01507
0.01517
0.655
SIXX (0, 0, h/2)
2.4216 107
2.132 107 12
SIYY (0, 0, h/6) layer with 90°
5.7810 106
6.96 106
20.
SIXY (A/2, A/2, h/2)
1.2825 106
1.284 106
0.1
SIXZ (A/2, 0, 0)
-2.3526 105
-1.5474103
34
SIYZ (0, A/2, 0)
8.8950 104

11.099 104 24

8.2 Remarks

Components SIXX, SIYY and SIYZ are the average values of the two convergent meshs with points A and C.

The variation obtained on SIXZ is due to the difference in modeling of transverse shearing: in reference, one uses a coefficient of transverse correction of shearing of 5/6. In Code_Aster, one calculates the distribution of shearings in the thickness, presumedly parabolic in each sleep.
The sign of SIXZ is opposed to that of the reference solution.

The other variations are probably due to the anisotropy of the triangular grid.

---

9 Modeling
D

9.1
Characteristics of modeling

Z
Modeling DST (QUAD4)
C

- The plate is located in the plan Y =0.5
- Not A (0.4; 0.5; 0.25)
y
X
- Boundary conditions:
B
D
. Dimensioned BC: v = 0
. Dimensioned CD: v = 0
Y
- Conditions of symmetry: (local reference mark)
48°5
. Dimensioned AB: U = = 0
y
With
X
. Dimensioned AD: v = = 0
X

9.2
Characteristics of the grid

A number of nodes: 49
A number of meshs and types: 36 QUAD4

9.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
"DST"
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION

AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA
FORCE_COQUE
NEAR
CALC_CHAM_ELEM
NUME_COUCHE
NIVE_COUCHE
“SUP” “MOY”
OPTION
“SIGM_ELNO_DEPL”

---

10 Results of modeling D

10.1 Values tested

Identification Reference Aster %
difference
v (0, 0, 0)
0.01507
0.01513

0.4
SIXX (0, 0, h/2)
2.4216 107
2.439 107 0.7
SIYY (0, 0, h/6) layer with 90°
5.7810 106
5.79 106 0.2
SIXY (A/2, A/2, h/2)
1.2825 106
1.1953 106 -6.8
SIXZ (A/2, 0, 0)
-2.3526 105
-2.0264 105 14
SIYZ (0, A/2, 0)
8.8950 104
8.7485104 2

10.2 Remarks

Components SIXX, SIYY and SIYZ are the average values of the two convergent meshs with points A and C.

The variation obtained on SIXZ is due to the difference in modeling of transverse shearing: in reference, one uses a coefficient of transverse correction of shearing of 5/6. In Code_Aster, *one calculates the distribution of shearings in the thickness, presumedly parabolic in each sleep.*
The sign of SIXZ is opposed to that of the reference solution.

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

---

11 Summary of the results

· Déplacements: some is modeling used (DKT or DST) the results are satisfactory, the maximum error is lower than 0.7%.

· Plane Contraintes: the results are more precise with modeling DKT, the error is lower than 1% except for SIXY (QUAD4) where the error is 5%. For DST modeling the error is higher (<8%) with an important variation on SIXX (28%) for mesh TRIA3.

· Transverse Cisaillement: some is modeling used (DKT or DST) the results obtained with the quadrangular grids are closer to the reference solution than those obtained with triangular grids. In the first case the error on the component SIXZ is lower than 15%, and the error on SIYZ is lower than 3%, while in the second case, the error on SIXZ is 35% and that on SIYZ lies between 2% and 24%. Except worse precision of the triangular grids because of their anisotropy, the variation which remains with quadrangular grids is due to the difference in modeling of shearing transverse: in the reference, one uses a coefficient of transverse correction of shearing of 5/6. In Code_Aster, one calculates the distribution of shearings in the thickness, supposed parabolic in each layer.

23/09/02
Author (S):
J.M. PROIX, F. LEBOUVIER Key
:
V3.03.504-B Page:
1/6

Organization (S): EDF/AMA, DeltaCAD

Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
Document: V3.03.504

SSLS504 - Composite square plate made up of 3 layers, subjected to a loading doubly sinusoidal

Summary:

This test represents the quasi-static calculation of a composite square plate made up of 3 layers, simply supported, subjected to a doubly sinusoidal loading. This case-test makes it possible to validate modeling finite elements DST with meshs TRIA3 and QUAD4, a composite material multi-layer.

Displacements and the constraints obtained are compared with a numerical reference solution.

1
Problem of reference

1.1 Geometry

y, v
L = 1. m
H = 0.1 m
Stacking
p=posin (x/L) sin (y/L)
Z, W
T
D
C
L
Z
0°
90°
0°

With
B
X, U
L
H/4
H/2

H/4

The 3 layers have as a relative thickness: H/4, H/2, H/4

1.2
Properties of material

The axes of orthotropism correspond to the curvilinear directions X and Y.

E = 25.
E = 1. (L X; T y)
L
T
G = G = 0.5
G = 0.2
lt
lz
tz
= 0.25

lt

1.3
Boundary conditions and loadings

· CL: displacement perpendicular to the plate, to its contour is null.

· Chargement: p = Po sin (x/L) sin (y/L) with Po =0.01

1.4 Conditions
initial

Without object
Handbook of Validation
V3.03 booklet: Linear statics of the plates and hulls
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLS504 - Composite square plate made up of 3 layers, simply Date:

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is a numerical solution [bib3].

2.2
Results of reference

The numerical results of reference are as follows:

*DST**
DST (QUAD4)*
Size
(TRIA3)
· Déplacement W at the point C (L/2, L/2,0)
-0.07323 -0.07417
· Contrainte xx at the point C (L/2, L/2, h/2) (layer 3)
-0.478 -0.482
· Contrainte yy at the point C (L/2, L/2, h/4) (layer 2)
-0.339 -0.4
· Contrainte xz at the point D (0, L/2,0) (layer 2)
-0.0203 -0.0305
· Contrainte yz at the point B (L/2,0,0) (layer 2)
-0.0406 -0.0204

** the reference solutions were obtained with a grid 6x6 [bib3].*

2.3
Uncertainties on the solution

< 2%

2.4 References
bibliographical

[1]
BATOZ J.L., DHATT G.: Modeling of the structures by finite elements, Flight 2, Beams and Plates, HERMES.
[2]
PAGANO N.J., Hatfield J.J. : “Elastic behaviour of multilayered bidirectional composite”, AIAA J., Flight 10, N°7, p. 931-933, 1972.
[3]
LARDEUR P.: Development and evaluation of two new finite elements of plates and composite hulls with influence of transverse shearing, Thesis of Doctorate Engineer, University of Technology of Compiegne, 1990.

---

3 Modeling
With

3.1
Characteristics of modeling

y
y, v
C
Modeling DST (QUAD4)
D
- Boundary conditions:

Z, W
. Dimensioned AB: W = =0
y
. Dimensioned AD: W = =0
X

- Conditions of symmetry:
Z
. Dimensioned BC: U = = 0
y
. Dimensioned CD: v = = 0
X
With
B

X, U
X

3.2
Characteristics of the grid

A number of nodes: 49
A number of meshs and type: 36 QUAD4

3.3 Functionalities
tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
"DST"
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION
AFFE_CARA_ELEM
HULL
THICK

ANGL_REP
AFFE_CHAR_MECA_F
FORCE_COQUE
NEAR
CALC_CHAM_ELEM
NUME_COUCHE
NIVE_COUCHE
"SUP" "MOY"
OPTION
"SIGM_ELNO_DEPL"

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster Difference
(%)
Displacement W at the point C (L/2, L/2,0)
-0.07417 -0.07444
0.37
Constraint xx at the point C (L/2, L/2, h/2)
-0.482 -0.474
-1.7
Constraint yy at the point C (L/2, L/2, h/4)
-0.400 -0.412
3
Constraint xz at the point D (0, L/2,0)
-0.0305 -0.03
-1.7
Constraint yz at the point B (L/2,0,0)
-0.0204 -0.021
2.8

Titrate:
SSLS504 - Composite square plate made up of 3 layers, simply Date:
23/09/02
Author (S):
J.M. PROIX, F. LEBOUVIER Key
:
V3.03.504-B Page:
5/6

5 Modeling B

5.1 Characteristics of modeling

y
y, v
D
C
Modeling DST (TRIA3)
- Boundary conditions:
Z, W
. Side AB: W = y=0
. Side AD: W = x=0
Z
- Conditions of symmetry:
. Side BC: U = y= 0
. Side CD: v = x= 0
X, U
With
B
X

5.2 Characteristics of the grid

A number of nodes: 49
A number of meshs and type: 72 TRIA3

5.3 Functionalities tested

Orders Key word
factor
Key word
AFFE_MODELE
AFFE
“DST”
DEFI_MATERIAU
ELAS_ORTH
DEFI_COQU_MULT
SLEEP
THICK
MATER
ORIENTATION
AFFE_CARA_ELEM
HULL
THICK
ANGL_REP
AFFE_CHAR_MECA_F
FORCE_COQUE
NEAR
CALC_CHAM_ELEM
NUME_COUCHE
NIVE_COUCHE
“SUP” “MOY”
OPTION
“SIGM_ELNO_DEPL”

6
Results of modeling B

6.1 Values
tested

Identification Reference
Aster Difference
(%)
Displacement W at the point C (L/2, L/2,0)
-0.07323 -0.07112
-2.9
Constraint xx at the point C (L/2, L/2, h/2)
-0.478 -0.4621 -3.3
Constraint yy at the point C (L/2, L/2, h/4)

-0.339 -0.3413
0.7
Constraint xz at the point D (0, L/2,0)
-0.0203 -0.0217
7.3
Constraint yz at the point B (L/2,0,0)
-0.0406 -0.0435
7.3

7
Summary of the results

· Déplacements: the result obtained with meshs QUAD4 is satisfactory (variation of 0.4%). One observe a more important variation (3%) for meshs TRIA3.

· Contraintes: the result obtained with meshs QUAD4 is satisfactory (maximum change of 3%). One observes a more important variation (7%) for meshs TRIA3.

This test thus makes it possible to validate the calculation of the composite plates under loading function of
geometry, as well in term of displacements of constraints.

6.4

Titrate:
SSLV04 - Hollow roll in plane constraints

Date:
17/06/03
Author (S):
X. DESROCHES, Key P. HERMAN
:
V3.04.004-E Page:
1/36

Organization (S): EDF-R & D /AMA, CS IF

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
V3.04.004 document

SSLV04 - Hollow roll in plane constraints

Summary:

This test is drawn from Guide VPCS (test SSLV04/89) and has as an aim a hollow roll charged in pressure
intern.

This three-dimensional problem is dealt with with various modelings:

· in 3D: 9 modelings (pentahedral, hexahedrons, tetrahedrons and pyramids, degrees 1 and 2),
· in 2D forced plane: 4 modelings (triangles and quadrangles degrees 1 and 2,
quadrangles with 9 nodes),
· in axisymmetric 2D: 3 modelings (triangles and quadrangles degrees 1 and 2, quadrangles with
9 nodes).

The functionalities tested are:

· pressure distributed,
· basic effect (with fixed or variable pressure),
· imposed displacements,
· matrices of rigidity,
· deformations and constraints with the nodes,
· nodal reactions (modeling K).

There are 16 modelings.

1
Problem of reference

1.1 Geometry

y
R
E
F

C
45°
D
P
With
B
Z
X
Internal ray
= 0.1 m has
External ray
B = 0.2 m

Co-ordinates of the points:

WITH B C
D
E F
X 0.100 0.200
0.1 cos (22.5)
0.2 cos (22.5)
2 / 2
2
y 0.
0.
0.1 sin (22.5)
0.2 sin (22.5)
2 / 2
2
Z 0
0.
0.
0.
0.
0.

1.2
Material properties

E = 2.105 MPa

= 0.3

1.3
Boundary conditions and loadings

Internal pressure:

P = 60 MPa

Pressure interns variable (modeling P only):

P varies linearly from 60 MPa with t=1.s with 120 MPa with t=2.s

---

2
Reference solution

2.1
Method of calculation used for the reference solution

In constraint planes (cylinder on free board at the ends)

zz = 0
2

2
B

has
rr
= P
1-

b2 - a2
R 2
2

2
B

has

= P
1+

b2 - a2
R 2
R = 0
P
a2

2
B
ur =
(1) + (1+) R
E b2 - a2
R 2

One obtains:

for
= 0.1
= 59. 10 6
-

for
= 0.2
= 40. 10 6
R
U
R
U
-
R
R
= 60.
-
= 0.
rr
rr

= 100.
= 40.
= = 0.
= = 0.
zz
R
zz
R

Passage in the system of Cartesian axes:

2
2
xx
= rr cos + sin - 2 R sin cos

2
2
yy
= rr sin + cos + 2 R sin cos

2
2
xy
= rr sin cos - sin cos - 2 R (cos - sin)

with:

· = 0° at points A and B,
· = 22.5° at the points C and D,
· = 45° at the points E and F.

2.2
Results of reference

Displacements (U, v) and forced (xx, yy
, zz
, xy
) at the points A, B, C, D, E, F.

2.3 References
bibliographical

[1]
Guide VPCS. SSLV04/89
[2]
Y.C. FUNG. Foundations of solid mechanics. Prentice-hall, Inc. Englewood Cliffs. NJ. 1965
p. 243 to 245.
[3]
J. COURBON. Resistance of the materials p 649
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/03/008/A

---

3 Modeling With

3.1 Characteristics of modeling

Elements 3D (PENTA6 and HEXA8)

Grid obtained by extrusion starting from a grid 2D resembling the grid below (30 elements in the radial direction with déraffinement progressive and 15+15 elements in the direction circumferential).

F
Normally blocked face
y
E
45°
With
B
X
Face with imposed pressure
Face blocked out of Dy

Along axis Z:
1 layer of elements
Total thickness:
0.01

Limiting conditions:

node F: uz = 0

face AB blocked out of Dy
normally blocked face EF
pressure on face AE p = 60.

Names of the nodes:
With = N993
B=N1443
C=N1

D=N31
E=N496
F=N495

3.2
Characteristics of the grid

A number of nodes: 1922
A number of meshs and types: 900 PENTA6, 450 HEXA8 and 90 QUAD4 (faces internal skin).

3.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP

GROUP_MA
"MECHANICAL" AFFE_MODELE "3D"
ALL

DEFI_MATERIAU ELAS

CALC_NO "EPSI_NOEU_DEPL"

"SIGM_NOEU_DEPL"
POST_RELEVE "EXTRACTION"

MODI_REPERE DEFI_REPERE "USER"

"CYLINDRICAL"

---

4 Results of modeling A

4.1 Values

tested

Localization Size
Reference
Aster *%*
difference
With U
5.9
10-5 5.8950
10-5 0.08
v
0.
eps
-

xx 60.
-
59.2225
1.30

yy
100. 100.4159 0.42

zz
0. 0.3093
-

xy
0. -
1.0442 -

xx
-4.5 10-4
- 4.472 10-4 0.62

yy
5.9 10-4 5.904
10-4 0.08

xy
0.
- 6.788 10-5 -
B U

4
10-5 3.9959
10-5 0.10
v
0.
eps
-

xx 0.
-1.7246
-

yy
40. 39.2451
1.89

zz
0. -
0.3761 -

xy
0. -
0.2659 -

xx
-0.6 10-4
- 6.692 10-5 11.54

yy
2. 10-4 1.994
10-4 0.31

xy
0.
- 1.728 10-6 -
E U
4.17193
10-5 4.1708
10-5 0.03
v
4.17193 10-5 4.1708
10-5
0.03

xx 20.
19.0824
4.59

yy
20. 21.1394
5.70

zz
0. 0.0870
-

xy
-80. -
79.8831 0.15

xx
0.7 10-4 0.636
10-4 9.18

yy
0.7 10-4 0.769
10-4 9.92

xy
-5.2 10-4
- 5.192 10-4 0.15
F U
2.82843
10-5 2.8302
10-5 0.06
v
2.82843 10-5 2.8302
10-5 0.06

xx 20.
18.9528
5.24

yy
20. 19.9104
0.45

zz
0. 0.1198
-

xy
-20. -20.1809 0.90

xx
0.7 10-4 0.647
10-4 7.54

yy
0.7 10-4 0.709
10-4 1.35

xy
-1.3 10-4 -1.312
10-4 0.90

---

5 Modeling
B

5.1
Characteristics of modeling

Elements 3D (PENTA15 and HEXA20)

Grid obtained by extrusion starting from the grid 2D below (modeling F)
y
B
Face blocked in dx
F
With
Normally blocked face
E
Face with imposed pressure
45°
X

Along axis Z:
2 layers of elements
Total thickness:
0.01

Limiting conditions:

node F = uz = 0

face AB blocked in dx

normally blocked face EF
pressure on face AE
p = 60.

Names of the nodes:
WITH = NO2
B = NO361
C = NO121

D = NO584
E = NO155
F = NO503

5.2
Characteristics of the grid

A number of nodes: 2115
A number of meshs and types: 400 PENTA15, 100 HEXA20 40 QUAD8 (faces skin interns)

5.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "3D"
ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM "SIGM_ELNO_DEPL"

"EPSI_ELNO_DEPL"
POST_RELEVE "EXTRACTION"

6
Results of modeling B

6.1 Values
tested

Localization Size
Reference
Aster *%*
difference
With U
0. eps
-
v
5.9 10-5 5.8944
10-5
-0.09

xx 100.
99.6056
-0.39

yy
- 60.
- 59.4473
-0.92

zz
0. 0.0196
-

xy
0. 0.2481
-

xx
5.9 10-4 5.87
10-4 -
0.48

yy
- 4.5 10-4
- 4.47 10-4 -
0.74

xy
0. 1.61
10-6 -
B U
0. eps
-
v
4 10-5 3.9974
10-5 -
0.07

xx 40.
39.9711
0.07

yy
0. 0.0781
-

zz
0. 5.7992
10-3 -

xy
0. -
0.0182
-

xx
2. 10-4 1.997
10-4 -
0.13

yy
- 0.6. 10-4
- 0.596 10-4 -
0.67

xy
0. -
1.1810-7 -
E U
4.17193
10-5 4.1680
10-5 -
0.09
v
4.17193 10-5 4.1680
10-5
- 0.09

xx 20.
20.0515
0.26

yy
20. 20.0264
0.13

zz
0. -0.0155
-

xy
80. 79.7918
-

0.26

xx
0.7 10-4 0.702
10-4 0.34

yy
0.7 10-4 0.701
10-4 0.11

xy
5.2 10-4 5.19
10-4 -
0.26
F U
-2.82843
10-5
- 2.82656 10-5 -
0,07
v
2.82843 10-5 2.82656
10-5 -
0.07

xx 20.
20.0099
0.05

yy
20. 19.9980
-
0.01

zz
0.
- 3.90 10-4 -

xy
20. 20.0122
0.06

xx
0.7 10-4 0.7005

10-4 0.08

yy
0.7 10-4 0.6997
10-4 -
0.03

xy
-1.3 10-4 1.3008
10-4 0.06

---

7 Modeling C

7.1 Characteristics of modeling

Elements 3D (TETRA4)

AB is on axis OX

Cutting:
21 equidistant nodes on segments AB, CD and EF

21 equidistant nodes on arcs ACE and BDF

Along axis Z:
1 layer of elements
Total thickness:
0.01

Limiting conditions:

node F: uz = 0

face AB blocked out of Dy

normally blocked face EF
pressure on face AE
p = 60.

Names of the nodes:
With = N165
B = N4
C = N209

D = N82
E = N244
F = N1068

7.2
Characteristics of the grid

A number of nodes: 1115
A number of meshs and types: 3724 TETRA4 and 1760 TRIA3 (faces skin interns)

7.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "3D"
ALL

DEFI_MATERIAU ELAS

CALC_NO "EPSI_NOEU_DEPL"

"SIGM_NOEU_DEPL"

8
Results of modeling C

8.1 Values
tested

Localization Size Reference
***Aster** %*
difference
With U
5.9
10-5 5.8901
10-5 -
0.17
v
0. eps
-

xx
-60.
- 57.2290
- 4.62

yy
100. 97.8711
-
2.13

zz
0. 0.0568
-

xy
0. -
2.6589 -

xx
-4.5 10-4

- 4.33 10-4 -
3.77

yy
5.9 10-4 5.75
10-4 -
2.52

xy
0.
- 1.73 10-5 -
B U
4
10-5 3.9878
10-5 -
0.30
v
0. eps
-

xx 0.
-
1.5296
-

yy
40. 40.9839
2.46

zz
0. -
0.1006 -

xy
0. -
0.8513 -

xx
- 0.6 10-4
- 6.897 10-4 14.95

yy

2. 10-4 2.074
10-4 3.68

xy
0.
- 5.534 10-5 -
E U
4.17193
10-5 4.1655
10-5 -
0.15
v
4.17193 10-5 4.1655
10-5
- 0.15

xx 20.
17.9096
-
10.45

yy
20. 21.8929
9.46

zz
0. -
0.3679 -

xy
- 80.
- 77.6897
- 2.89

xx
0.7 10-4 0.573
10-4 -
18.20

yy
0.7 10-4 0.832
10-4 18.79

xy
- 5.2 10-4
- 5.050
- 2.89
F U
2.82843
10-5 2.8251
10-5 -
0.12
v
2.82843 10-5 2.8251
10-5 -
0.12

xx 20.
18.4444
-
7.78

yy
20. 19.8876
-
0.56

zz
0. -
0.3910 -

xy
- 20.
- 20.1631
0.81

xx
0.7 10-4 0.630
10-4 -
10.05

yy
0.7 10-4 0.723
10-4 3.35

xy

- 1.3 10-4 -1.311
10-4 0.81

9 Modeling D

9.1 Characteristics of modeling

Element 3D (TETRA10)

AB is on axis OX

Cutting:
11 equidistant nodes on segments AB, CD and EF

11 equidistant nodes on arcs ACE and BDF

Along axis Z:
1 layer of elements
Total thickness:
0.01

Limiting conditions:

node F: uz = 0

face AB blocked out of Dy

normally blocked face EF
pressure on face AE
p = 60.

Names of the nodes:
With = N184
B = N4
C = N207

D = N50
E = N22
F = N726

9.2
Characteristics of the grid

A number of nodes: 1395
A number of meshs and types: 652 TETRA10 and 480 TRIA6 (faces skin interns)

9.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO

GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
“MECHANICAL” AFFE_MODELE “3D”
ALL

DEFI_MATERIAU ELAS

CALC_NO “EPSI_NOEU_DEPL”

“SIGM_NOEU_DEPL”

10 Results of modeling D

10.1 Values

tested

Localization Size Reference
Aster %
difference
With U
5.9
10-5 5.8974
10-5 -
0.04
v
0. eps
-

xx
- 60.
- 60.3816
0.64

yy
100. 99.1907
-
0.81

zz
0. -
0.9707
-

xy
0. -
0.2979
-

xx
- 4.5 10-4
- 4.49 10-4 -
0.17

yy
5.9 10-4 5.88
10-4 -
0.34

xy
0.
- 1.94 10-6 -
B U
4
10-5 3.9989
10-5 -
0.03
v
0. eps
-

xx 0.
0.0388
-

yy
40. 40.0725
0.18

zz
0. -
0.0046
-

xy
0. 0.1634
-

xx
- 0.6 10-4
- 0.599 10-4 -
0.15

yy
2. 10-4 2.003
10-4 0.16

xy
0. 1.062
10-6 -
E U

4.17193
10-5 4.17021
10-5 0.04
v
4.17193 10-5 4.17021
10-5 0.04

xx 20.
19.1178
-
4.41

yy
20. 19.6399
-
1.80

zz
0. -
1.0206
-

xy
- 80.
- 79.7804
- 0.27

xx
0.7 10-4 0.677
10-4 -
3.34

yy
0.7 10-4 0.711
10-4 1.50

xy
- 5.2 10-4
- 5.186 10-4 -
0.27
F U
2.82843
10-5 2.82718

10-5 -
0.04
v
2.82843 10-5 2.82718
10-5 -
0.04

xx 20.
20.1903
0.95

yy
20. 19.9023
-
0.49

zz
0. -
0.0016
-

xy
- 20.
- 20.0570
0.28

xx
0.7 10-4 0.711
10-4 1.57

yy
0.7 10-4 0.692
10-4 -
1.10

xy
- 1.3 10-4
- 1.304 10-4 0.28

11 Modeling E

11.1 Characteristics of modeling

C_plan elements (TRIA3 + QUAD4)

Grid 2D resembling the grid below (30 elements in the radial direction with déraffinement progressive and 15+15 elements in the circumferential direction).

F
Normally blocked face
y
E
D
C
45°
With
B
X
Face with imposed pressure
Face blocked out of Dy

Limiting conditions:

side AB blocked out of Dy

normally blocked side EF
pressure on AE p = 60.

Names of the nodes:
With = N1
B = N451
C = N496

D = N495
E = N990
F = N989

11.2 Characteristics of the grid

A number of nodes: 961
A number of meshs and types: 900 TRIA3, 450 QUAD4

11.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "C_PLAN" ALL

DEFI_MATERIAU ELAS

CALC_NO "EPSI_NOEU_DEPL"

"SIGM_NOEU_DEPL"
"CYLINDRICAL" MODI_REPERE DEFI_REPERE

---

12 Results of modeling E

12.1 Values tested

Localization Size Reference
Aster %
difference
With U
5.9
10-5 5.8957
10-5 -
0.07
v
0. eps
-

xx
- 60.
- 59.3645
- 1.06

yy
100. 100.2653 0.26

zz
0. 0. -

xy
0. -
1.0472 -

xx
- 4.5 10-4
- 4.472 10-4 -
0.62

yy
5.9 10-4 5.904
10-4 0.06

xy
0.
- 6.807 10-6 -
B U
4.
10-5 3.9965
10-5 -
0.09
v
0. eps
-

xx 0.
-
1.4986
-

yy
40. 39.4415
-
1.40

zz

0. 0. -

xy
0. -
0.2658 -

xx
- 0.6 10-4
- 0.667 10-5 11.09

yy
2. 10-4 1.995
10-4 -
0.27

xy
0.
- 1.728 10-6 -
E U
4.17193
10-5 4.17101
10-5 -
0.02
v
4.17193 10-5 4.17101
10-5
- 0.02

xx 20.
19.0706
-
4.65

yy
20. 21.1354
5.68

zz
0. 0. -

xy
- 80.

- 79.8720
- 0.16

xx
0.7 10-4 0.636
10-4 -
9.07

yy
0.7 10-4 0.771
10-4 10.10

xy
- 5.2 10-4
- 5.192 10-4 -
0.16
F U
2.82843
10-5 2.82996
10-5 0.05
v
2.82843 10-5 2.82996
10-5 0.05

xx 20.
18.9626
-
5.19

yy
20. 19.8483
-
0.76

zz
0. 0. -

xy
- 20.
- 20.2466
1.23

xx

0.7 10-4 0.650
10-4 -
7.08

yy
0.7 10-4 0.708
10-4 1.14

xy
- 1.3 10-4
- 1.316 10-4 1.23

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HT-66/03/008/A

---

13 Modeling
F

13.1 Characteristics of modeling

C_plan elements (QUAD8 + TRIA6)

y
B
D
Face blocked in dx
F
With
Normally blocked face
C
E
Face with imposed pressure
45°
X

Limiting conditions:

side AB blocked in dx

normally blocked side EF
pressure on AE p = 60.

Names of the nodes:
With = N2
B = N361
C = N121

D = N584
E = N155
F = N503

13.2 Characteristics of the grid

A number of nodes: 591
A number of meshs and types: 200 TRIA6, 50 QUAD8

13.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "C_PLAN"
ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM "SIGM_ELNO_DEPL"

POST_RELEVE "EXTRACTION"

---

14 Results of modeling F

14.1 Values
tested

Localization Size Reference
Aster %
difference
With U
0.
0.
-
v
5.9
10-5 5.8945
10-5 -
0.09

xx 100.
99.6095
-
0.39

yy

- 60.
- 59.4620
- 0.90

zz
0. 0. -

xy
0. 0.2441
-

xx
5.9 10-4 5.872
10-4 -
0.47

yy
- 4.5 10-4
- 4.467 10-4 -
0.73

xy
0. 1.586
10-6 -
B U
0. eps
-
v
4
10-5 3.9974
10-5 -
0.07

xx 40.
39.9774
-
0.06

yy
0. 0.0786
-

zz

0. 0. -

xy
0. -
0.0181
-

xx
2. 10-4 1.998
10-4 -
0.11

yy
- 0.6 10-4
- 0.596 10-4 -
0.67

xy
0.
- 1.176 10-7 -
E U
4.17193
10-5
- 4.16814 10-5 -
0.09
v
4.17193 10-5 4.16814
10-5
- 0.09

xx 20.
20.0024
0.01

yy
20. 20.0045
0.02

zz
0. 0. -

xy

80. 79.8164
-
0.23

xx
0.7 10-4 0.7001
10-4 0.01

yy
0.7 10-4 0.7002
10-4 0.03

xy
5.2 10-4 5.188
10-4 -
0.23
F
U
- 2.82843 10-5
- 2.82655 10-5 -
0.07
v
2.82843 10-5 2.82655
10-5 -
0.07

xx 20.
20.0083
0.04

yy
20. 19.9915
-
0.04

zz
0. 0. -

xy
20. 20.0138
0.07

xx

0.7 10-4 0.7005
10-4 0.08

yy
0.7 10-4 0.6995
10-4 -
0.08

xy
- 1.3 10-4 1.3009
10-4 0.07

15 Modeling G

15.1 Characteristics of modeling

C_plan (QUAD9)

F
Normally blocked face
y

E
D
C
45°
With
B
X
Face with imposed pressure
Face blocked out of Dy

Limiting conditions:

side AB blocked out of Dy

normally blocked side EF
pressure on AE p = 60.

Names of the nodes:
With = N1
B = N347
C = N21

D = N432
E = N39
F = N229

15.2 Characteristics of the grid

A number of nodes: 441
A number of meshs and types: 100 QUAD9

15.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
“MECHANICAL” AFFE_MODELE “C_PLAN”
ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM “SIGM_ELNO_DEPL”

---

16 Results of modeling G

16.1 Values
tested

Localization Size Reference
Aster %
difference
With U

5.9
10-5 5.9000
10-5 0.00
v
0. eps
-

xx
- 60.
- 59.8354
- 0.27

yy
100. 99.8409
-
0.16

zz
0. 0. -

xy
0. 0.0283
-

xx
- 4.5 10-4
- 4.489 10-4 -0.24

yy
5.9 10-4 5.890
10-4 -
0.18

xy
0.
- 1.839 10-7 -
B U
4
10-5 3.9999
10-5 -
0.001
v

0. eps
-

xx 0.
-0.0189
-

yy
40. 40.0182
0.05

zz
0. 0. -

xy
0.
- 3.6815 10-3 -

xx
- 0.6 10-4
- 0.601 10-4 0.20

yy
2. 10-4 2.001
10-4 0.06

xy
0.
- 2.393 10-8 -
E U
4.17193
10-5 4.17195
10-5 0.00
v
4.17193 10-5 4.17195
10-5
0.00

xx 20.
19.9745
-
0.13

yy
20. 20.0311
0.16

zz
0. 0. -

xy
- 80.
- 79.8382
- 0.20

xx
0.7 10-4 0.698
10-4 -
0.25

yy
0.7 10-4 0.702
10-4 0.28

xy
- 5.2 10-4
- 5.189 10-4 -
0.20
F U
2.82843
10-5 2.82839
10-5 -
0.001
v
2.82843 10-5 2.82839
10-5 -
0.001

xx 20.
19.9960
-
0.02

yy
20. 20.0034
0.02

zz
0. 0. -

xy
- 20.
- 20.0185
0.09

xx
0.7 10-4 0.6997
10-4 -
0.04

yy
0.7 10-4 0.7002
10-4 0.03

xy
- 1.3 10-4
- 1.301 10-4 0.09

---

17 Modeling
H

17.1 Characteristics of modeling

Elements axis (TRIA3 + QUAD4)

Center cylinder
Node blocked out of Dy
y
E
F
C
0.01m
D
X
With
B
Face with imposed pressure

Limiting conditions:

node F blocked out of Dy

pressure on AE p = 60.

Names of the nodes:
With = N111
B = N1
C = N112

D = N3
E = N113
F = N4

17.2 Characteristics of the grid

A number of nodes: 113
A number of meshs and types: 40 QUAD4, 80 TRIA3

17.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "AXIS" ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM "SIGM_ELNO_DEPL"

CREA_RESU EVOL_ELAS DEPL

CALC_ELEM "SIGM_ELNO_DEPL"

INTE_MAIL_2D

POST_RCCM

18 Results of modeling H

18.1 Values tested

Localization Size Reference
Aster %
difference
With U
5.9
10-5 5.8992
10-5 -
0.01
v
0. -
-

xx
- 60.
- 56.6060
- 5.66

yy
0. 1.0383 -

zz
100. 101.2924
1.29

xy
0. -
1.1635
-

xx
- 4.5 10-4
- 4.36 10-4 -
2.99

yy
0.
- 6.18 10-5 -

zz
5.9 10-4 5.898
10-4 -
0.03

xy
0.
- 1.06 10-6 -
B U
4
10-5 3.9997
10-5 -
0.01
v
0. -
-

xx 0.
-
0.8951
-

yy
0. -
0.4106
-

zz
40. 39.6001 -

1.00

xy
0. -
0.1281
-

xx
- 0.6 10-4
- 0.632 10-4 5.43

yy
0.
- 6.011 10-5 -

zz
2. 10-4 1.999
10-4 -
0.02

xy
0.
- 8.325 10-7 -
E U
5.9
10-5 5.8992
10-5 -
0.01
v
0. -
-

xx
- 60.
- 56.6060
- 5.66

yy
0. 1.0383 -

zz
100. 101.2924
1.29

xy
0. 1.1635 -

xx
- 4.5 10-4
- 4.365 10-4 -
2.99

yy
0.
- 6.184 10-5 -

zz
5.9 10-4 5.898
10-4 -
0.03

xy
0. 1.063
10-6 -
F U
4
10-5 3.9997
10-5 -
0.01
v
0. -
-

xx 0.
-
0.4221
-

yy
0. -
0.2280
-

zz
40. 39.8015 -
0.50

xy
0. -
0.0020
-

xx
- 0.6 10-4
- 0.615 10-4 2.45

yy
0.
- 6.021 10-5 -

zz
2. 10-4 1.9998
10-4 -
0.01

xy
0.
- 1.280 10-8 -

---

19 Modeling
I

19.1 Characteristics of modeling

Elements axis (TRIA6 + QUAD8)

Center cylinder
Node blocked out of Dy
y
E
F
0.01m
C
D
X
With
B
Face with imposed pressure

Limiting conditions:

Node F blocked out of Dy

pressure on AE p = 60.

Names of the nodes:
With = N8
B = N174
C = N5

D = N170
E = N3
F = N159

19.2 Characteristics of the grid

A number of nodes: 175
A number of meshs and types: 20 QUAD8, 40 TRIA6

19.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO GROUP_NO

FACE_IMPO GROUP_MA DNOR PRES_REP GROUP_MA
“MECHANICAL” AFFE_MODELE “AXIS” ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM “SIGM_ELNO_DEPL”

POST_RELEVE “EXTRACTION”

Author (S):
X. DESROCHES, Key P. HERMAN
:

20 Results of modeling I

20.1 Values tested

Localization Size Reference
Aster %
difference
With U
5.9
10-5 5.9000
10-5 0.00
v
0. -
-

xx
- 60.
- 59.8976
- 0.17

yy
0. -
0.0024
-

zz
100. 99.9089 -
0.09

xy
0. -
0.0137
-

xx
- 4.5 10-4

- 4.493 10-4 -
0.14

yy
0.
- 6.003 10-5 -

zz
5.9 10-4 5.894
10-4 -
0.10

xy
0.
- 8.895 10-8 -
B U
4
10-5 4.0000
10-5 0.00
v
0. -
-

xx 0.
0.0308
-

yy
0. -
0.0020
-

zz
40. 39.9738 -
0.07

xy
0. 0.0131 -

xx
- 0.6 10-4
- 0.598 10-4 -
0.33

yy
0.
- 6.002 10-5 -

zz
2. 10-4 1.998
10-4 -
0.09

xy
0. 8.495
10-8 -
E U
5.9
10-5 5.9000
10-5 0.00
v
0. -
-

xx
- 60.
- 59.8976
- 0.17

yy
0. -
0.0024
-

zz
100. 99.9089 -
0.09

xy
0. 0.0137 -

xx
- 4.5 10-4
- 4.493 10-4 -
0.14

yy
0.
- 6.003 10-5 -

zz
5.9 10-4 5.894
10-4 -
0.10

xy
0. 8.895
10-8 -
F U
4
10-5 4.0000
10-5 0.00
v
0. -
-

xx 0.
0.0308
-

yy
0. -
0.0020
-

zz
40. 39.9738 -
0.07

xy
0. -
0.0131
-

xx
- 0.6 10-4
- 0.598 10-4 -
0.33

yy
0.
- 6.002 10-5 -

zz
2. 10-4 1.998
10-4 -
0.09

xy
0.
- 8.495 10-8 -

---

21 Modeling J

21.1 Characteristics of modeling

Elements axis (QUAD9)

Center cylinder

Node blocked out of Dy
y
E
F
0.01m
C
D
X
With
B
Face with imposed pressure

Limiting conditions:

node F blocked out of Dy

pressure on AE p = 60.

Names of the nodes:
With = N196
B = N1
C = N200

D = N5
E = N202
F = N7

21.2 Characteristics of the grid

A number of nodes: 205
A number of meshs and types: 40 QUAD9

21.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
“MECHANICAL” AFFE_MODELE “AXIS” ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM “SIGM_ELNO_DEPL”

POST_RELEVE “EXTRACTION”

22 Results of modeling J

22.1 Values tested

Localization Size Reference Aster % difference
With U
5.9
10-5 5.9000
10-5 0.00
v
0.
-
-

xx
- 60.
- 59.8997
- 0.17

yy
0. -
0.0035
-

zz
100. 99.9080 -
0.09

xy
0. -
0.0141
-

xx
- 4.5 10-4
- 4.494 10-4 -
0.14

yy
0.
- 6.003 10-5 -

zz
5.9 10-4 5.894
10-4 -
0.10

xy
0.
- 9.156 10-8 -
B U
4.
10-5 4.0000
10-5 0.00
v
0.
-
-

xx 0.
0.0070
-

yy
0. -
0.0001
-

zz
40. 39.9936 -
0.02

xy
0. 0.0010 -

xx
- 0.6 10-4
- 0.5996 10-4 -
0.07

yy
0.
- 6.000 10-5 -

zz
2. 10-4 1.9996
10-4 -
0.02

xy
0. 6.748
10-9 -
E U
5.9
10-5 5.9000
10-5 0.00
v
0.
-
-

xx
- 60.
- 59.8997
- 0.17

yy
0. -
0.0035
-

zz
100. 99.9080 -
0.09

xy
0. 0.0141 -

xx
- 4.5 10-4
- 4.494 10-4 -
0.14

yy
0.
- 6.003 10-5 -

zz
5.9 10-4 5.894
10-4 -
0.10

xy
0.
- 9.156 10-8 -
F U
4.
10-5 4.0000
10-5 0.00
v
0.
-
-

xx 0. 0.0070
-

yy
0. -
0.0001
-

zz
40. 39.9936 -
0.02

xy
0. -
0.0010
-

xx
- 0.6 10-4
- 0.5996 10-4 -
0.07

yy
0.
- 6.000 10-5 -

zz
2. 10-4 1.9996
10-4 -
0.02

xy
0.
- 6.748 10-9 -

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---

23 Modeling K

23.1 Characteristics of modeling

Elements 3D (PENTA6 and HEXA8)

Grid obtained by extrusion starting from the grid 2D below (modeling E)
F
Normally blocked face
y
E
G
45°
H
With
B
X
Face with displacement
radial imposed
Face blocked out of Dy

Along axis Z:
2 layers of elements
Total thickness:
0.01

Limiting conditions:

node F: uz = 0

face AB blocked out of Dy
normally blocked face EF
face AE
radial displacement imposed on 5.9 E-5 m

Names of the nodes:
With = No1
C = No36
D = No166
plan Z = 0.005
A2 = No172
C2 = No242
D2 = No5025
plan Z = 0.01
A3 = No173
C3 = No243
D3 = No503

Names of the nodes:
E = No41
H = No9
G = No38
plan Z = 0.005
E2 = No252
H2 = No188
G2 = No246
plan Z = 0.01
E3 = No253
H3 = No189
G3 = No247

23.2 Characteristics of the grid

A number of nodes: 513
A number of meshs and types: 400 PENTA6, 100 HEXA8 40 QUAD4 (faces skin interns)

23.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
“MECHANICAL” AFFE_MODELE “3D”
ALL

DEFI_MATERIAU ELAS

CALC_NO “REAC_NODA”

MODI_MAILLAGE ORIE_PEAU_3D

23.4 Remarks

The loading is here in imposed displacement, contrary to other modelings. They are tested reactions.
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/03/008/A

Code_Aster ®
Version
6.4

Titrate:
SSLV04 - Hollow roll in plane constraints

Date:
17/06/03

24 Results of modeling K

24.1 Values tested

Localization Size Reference
Aster %
difference
C Fx
1.0884 E3 1.0953 E3 0.64
Fy
4.5084 E4 4.5836 E4 1.67
C2 Fx
2.1768 E3 2.1571 E3
0.91
Fy
9.0170 E4 9.1304 E4 1.26
C3 Fx
1.0884 E3 1.0953

E3 0.64
Fy
4.5084 E4 4.5836 E4 1.67
H Fx
1.1636 E3 1.1709

E3 0.63
Fy
1.8429 E4 1.8527

E4 0.53
G Fx
1.0045 E3 1.0144

E3 0.99
Fy
6.1550 E4 6.2117

E4 0.92
H2 Fx
2.3272 E3 2.3173

E3
0.43
Fy
3.6858 E4 3.6669 E4
0.51
G2 Fx
2.0090 E3 1.9951

E3
0.69
Fy
1.2310 E3 1.2214

E3
0.78

24.2 Remarks

One checks that the nodal forces of reactions are null in all the nodes, except on the nodes of surface AE and surfaces EF and AB.

25 Modeling
L

25.1 Characteristics of modeling

Elements 3D (PYRAM5)

F
Normally blocked face
y
E
D
C
45°
With
B
X
Face with imposed pressure
Face blocked out of Dy

Along axis Z:
each parallélipipède is cut out in 6 pyramids
Total thickness:
0.01

Limiting conditions:

node F: uz = 0

face AB blocked out of Dy
normally blocked face EF
pressure on face AE
p = 60.

Names of the nodes:
With = N267
B = N142

E = N29
F = N1

25.2 Characteristics of the grid

A number of nodes: 342
A number of meshs and types: 600 PYRAM5 620 QUAD4 (faces skin interns)

25.3 Functionalities tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
“MECHANICAL” AFFE_MODELE “3D”
ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM “SIGM_ELNO_DEPL”

“EPSI_ELNO_DEPL”
“SIEF_ELGA_DEPL”
“ENDO_ELNO_SIGM”

26 Results of modeling L

26.1 Values tested

Identification Reference Aster % difference
U-node (A)
5.9 10-5 5.8873
10-5 -
0.21
v-node (A)
0.
eps
-
xx - node (A)
- 60.
- 52.9567
- 11.74
yy - node (A)
100. 91.7830
-
8.22
zz - node (A)
0. -
1.1206 -

xy - node (A)

0. -
4.5121 -
xx - node (A)
- 4.5 10-4
- 4.008 10-4 -
10.94

yy - node (A)
5.9 10-4 5.400
10-4 -
8.47
xy - node (A)
0.
- 2.933 10-5 -

U-node (B)
4. 10-5 3.9936
10-5 -
0.16
v-node (B)
0.
eps
-
xx - node (B)
0.
- 0.7670
-
yy - node (B)
40. 39.5319
-
1.17
zz - node (B)
0. -
0.3115 -

xy - node (B)
0. -
1.5858 -
xx - node (B)
- 0.6 10-4
- 0.627 10-4 4.44

yy - node (B)
2. 10-4 1.993
10-4 -
0.36
xy - node (B)
0.
- 1.031 10-5 -

U-node (E)
4.17193 10-5 4.16293
10-5 -
0.21
v-node (E)
4.17193 10-5 4.16293
10-5 -
0.21
xx - node (E)
20.
19.3586
- 3.21
yy - node (E)
20. 31.5151
57.57
zz - node (E)
0. 2.5686
-

xy - node (E)
- 80.
- 77.2309
- 3.46
xx - node (E)
0.7 10-4 0.457
10-4 -
34.76

yy - node (E)
0.7 10-4 1.247
10-4 78.12
xy - node (E)

- 5.2 10-4
- 5.020 10-4 -
3.46

U-node (F)
2.82843 10-5 2.82393
10-5 -
0.16
v-node (F)
2.82843 10-5 2.82393
10-5 -
0.16
xx - node (F)
20.
18.9523
- 5.24
yy - node (F)
20. 20.9510
4.75
zz - node (F)
0. 0.0035
-

xy - node (F)
- 20.
- 20.9897
4.95
xx - node (F)
0.7 10-4 0.633
10-4 -
9.60

yy - node (F)
0.7 10-4 0.763
10-4 8.96
xy - node (F)
- 1.3 10-4
- 1.364 10-4 4.95

Handbook of Validation

---

27 Modeling M

27.1 Characteristics of modeling

Elements 3D (PYRAM13)

F
Normally blocked face
y
E
D
C
45°
With
B
X
Face with imposed pressure
Face blocked out of Dy

Along axis Z:
each parallélipipède is cut out in 6 pyramids
Total thickness:
0.01

Limiting conditions:

node F: uz = 0

face AB blocked out of Dy
normally blocked face EF
pressure on face AE
p = 60.

Names of the nodes:
With = N1403
B = N734
E = N152
F = N4

27.2 Characteristics of the grid

A number of nodes: 1703
A number of meshs and types: 600 PYRAM13 620 QUAD8 (faces skin interns)

27.3 Functionalities
tested

Orders

MODI_MAILLAGE ORIE_PEAU_3D

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA

“MECHANICAL” AFFE_MODELE “3D”
ALL

DEFI_MATERIAU ELAS

CALC_CHAM_ELEM “SIGM_ELNO_DEPL”

“EPSI_ELNO_DEPL”
“SIEF_ELGA_DEPL”
“ENDO_ELNO_SIGM”

---

28 Results of modeling M

28.1 Values tested

Identification Reference Aster %
difference
U-node (A)
5.9 10-5 5.8999
10-5 -
0.002

v-node (A)
0.
eps
-
xx - node (A)
- 60.
- 59.9880
- 0.02
yy - node (A)
100. 100.1277 0.13
zz - node (A)
0. 0.0425
-

xy - node (A)
0. -
0.0913 -
xx - node (A)
- 4.5 10-4
- 4.502 10-4 0.04

yy - node (A)
5.9 10-4 5.906
10-4 0.09
xy - node (A)
0.
- 5.934 10-7 -

U-node (B)
4. 10-5 4.0000
10-5 0.00
v-node (B)
0.
eps
-
xx - node (B)
0.
- 0.0276
-
yy - node (B)
40. 40.0331

0.08

zz - node (B)

0. 0.0024

-

xy - node (B)

0. 0.0126

-

xx - node (B)

- 0.6 10-4

- 0.602 10-4 0.32

yy - node (B)

2. 10-4 2.002

10-4 0.10

xy - node (B)

0. 8.177

10-8 -

U-node (E)

4.17193 10-5 4.17183

10-5 -

0.002

v-node (E)

4.17193 10-5 4.17183

10-5 -

0.002

xx - node (E)

20.

19.9787

-0.11

yy - node (E)

20. 20.1612

0.81

zz - node (E)

0. 0.0425

-

xy - node (E)

- 80.

- 80.0580

0.07
xx - node (E)
0.7 10-4 0.696
10-4 -
0.59

yy - node (E)
0.7 10-4 0.708
10-4 1.11
xy - node (E)
- 5.2 10-4
- 5.204 10-4 0.07

U-node (F)
2.82843 10-5 2.82844
10-5 0.00
v-node (F)
2.82843 10-5 2.82844
10-5 0.00
xx - node (F)
20.
20.0224
0.11
yy - node (F)
20. 19.9901
-
0.05
zz - node (F)
0. 0.0031
-

xy - node (F)
- 20.
- 19.9818
- 0.09
xx - node (F)
0.7 10-4 0.701
10-5 0.17

yy - node (F)
0.7 10-4 0.699

10-5 -
0.13
xy - node (F)
- 1.3 10-4
- 1.299 10-5 -
0.09

29 Modeling NR

29.1 Characteristics of modeling

Elements 3D (PENTA15 and HEXA20)

Grid obtained by extrusion starting from a grid 2D resembling the grid below
(8 elements in the radial direction, 4+4 elements in the circumferential direction) and duplicated for to have a complete section of the cylinder (on 360°).
F
Normally blocked face
y
E
45°
With
B

X
Face with imposed pressure
Face blocked out of Dy

Along axis Z:
1 layer of elements
Total thickness:
0.01

Limiting conditions:

face AB blocked out of Dy
normally blocked face EF

pressure on face AE
p = 60.
basic effect on the sections p = 60.

Names of the nodes:
With = N5349
B = N6092
C = N433

D = N441
E = N2180
F = N1632

29.2 Characteristics of the grid

A number of nodes: 8832
A number of meshs and types: 1024 PENTA15, 512 HEXA20, 1176 QUAD8 and 2048 TRIA6.

29.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
EFFE_FOND
"MECHANICAL" AFFE_MODELE "3D"
ALL

DEFI_MATERIAU ELAS

CALC_NO "EPSI_NOEU_DEPL"

"SIGM_NOEU_DEPL"
29.4 Remarks

Contrary to preceding modelings, one takes into account the basic effect here applying to sections at the ends of the cylinder.

31/36

30 Results of modeling NR

30.1 Values tested

Identification Reference Aster % difference
U-node (A)
5.6 10-5 5.6000
10-5
0.00
v-node (A)
0.
eps
-
xx - node (A)
-60.
-59.5972
- 0.67
yy - node (A)
100. 99.5187
-
0.48
zz - node (A)
20. 19.9584
-
0.21

xy - node (A)
0. eps
-

U-node (B)
3.4 10-5 3.4000
10-5
0.00
v-node (B)
0.
eps

-
xx - node (B)
0.
2.0877 10-2
-
yy - node (B)
40. 39.9685
-
0.08
zz - node (B)
20. 19.9946
-
0.03

xy - node (B)
0. eps
-

xx - node (E)
20.
20.3287
1.64
yy - node (E)
20. 20.3287
1.64
zz - node (E)
20. 20.1739
0.87

xy - node (E)
-80. -79.9775
-
0.03

xx - node (F)
20.
20.0176
0.09
yy - node (F)

20. 20.0176
0.09
zz - node (F)
20. 20.0072
0.04

xy - node (F)
-20. -20.0027 0.01

---

31 Modeling O

31.1 Characteristics of modeling

C_plan elements (QUAD8 + TRIA6)

Grid 2D resembling the grid below (8 elements in the radial direction, 4+4 elements in the circumferential direction) and duplicated to have a complete section of the cylinder (on 360°).

y

B
D
Face blocked in dx
F
With
Normally blocked face
C
E
Face with imposed pressure
45°
X

Limiting conditions:

side AB blocked in dx

normally blocked side EF
pressure on AE p = 60.

Names of the nodes:
With = N249
B = N992
C = N1667

D = N1588
E = N3776
F = N3228

31.2 Characteristics of the grid

A number of nodes: 3840
A number of meshs and types: 1026 TRIA6, 512 QUAD8

31.3 Functionalities tested

Orders

MODI_MAILLAGE ORIE_PEAU_2D

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
"MECHANICAL" AFFE_MODELE "C_PLAN"
ALL

DEFI_MATERIAU ELAS

CALC_ELEM "SIEF_ELGA_DEPL"

CALC_NO "EPSI_NOEU_DEPL"

"SIGM_NOEU_DEPL"

---

32 Results of modeling O

32.1 Values tested

Identification Reference Aster % difference
U-node (A)
5.9 10-5 5.8999
10-5
- 0.002
v-node (A)
0.
eps
-
xx - node (A)
-60.
-59.5340
- 0.78
yy - node (A)
100. 99.5453
-
0.45
zz - node (A)
0. 0.
-

xy - node (A)
0. eps
-

U-node (B)
4. 10-5 3.99996
10-5
0.00
v-node (B)
0.
0.
-
xx - node (B)

0.
2.6874 10-2
-
yy - node (B)
40. 39.9716
-
0.07
zz - node (B)
0. 0.
-

xy - node (B)
0. eps
-

U-node (E)
4.17193 10-5 4.17215
10-5
0.005
v-node (E)
4.17193 10-5 4.17215
10-5
0.005
xx - node (E)
20.
20.2875
1.44
yy - node (E)
20. 20.2875
1.44
zz - node (E)
0. 0.
-

xy - node (E)
-80. -79.9196
-
0.10

U-node (F)
2.82843 10-5 2.82841
10-5
- 0.001
v-node (F)
2.82843 10-5 2.82841
10-5
- 0.001
xx - node (F)
20.
20.0167
0.08
yy - node (F)
20. 20.0167
0.08
zz - node (F)
0. 0.
-

xy - node (F)
-20. -19.9993
-
0.004

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/03/008/A

---

33 Modeling P

33.1 Characteristics of modeling

Elements 3D (PENTA15 and HEXA20) even grid that modeling NR

Grid obtained by extrusion starting from a grid 2D resembling the grid below
(8 elements in the radial direction, 4+4 elements in the circumferential direction) and duplicated for
to have a complete section of the cylinder (on 360°).
F
Normally blocked face
y
E
45°
With
B
X
Face with imposed pressure
Face blocked out of Dy

Along axis Z:
1 layer of elements
Total thickness:
0.01

Limiting conditions:

normally blocked face EF
face AB blocked out of Dy

pressure on face AE
FP
basic effect on sections FP

With FP: linear pressure function of time being worth 60. to t=1s and 120. with t=2s

Names of the nodes:
With = N5349
B = N6092
C = N433

D = N441
E = N2180
F = N1632

33.2 Characteristics of the grid

A number of nodes: 8832
A number of meshs and types: 1024 PENTA15, 512 HEXA20, 1176 QUAD8 and 2048 TRIA6.

33.3 Functionalities
tested

Orders

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA
DNOR
AFFE_CHAR_MECA_F PRES_REP

GROUP_MA

EFFE_FOND
“MECHANICAL” AFFE_MODELE “3D”
ALL

DEFI_MATERIAU ELAS

CALC_NO “EPSI_NOEU_DEPL”

“SIGM_NOEU_DEPL”

33.4 Remarks

Contrary to modeling NR, one tests here a basic pressure and effect variables in function time. A linear variation of the pressure involves a linear variation of the constraints.

34 Results of modeling P

34.1 Values
tested

Identification Reference Aster % difference

U-node (A) with t=1. S
5.6 10-5 5.6000
10-5
0.00

v-node (A) with t=1. S
0.
eps
-

xx - node (A) with t=1. S
-60.
-59.5414
- 0.76

yy - node (A) with t=1. S
100. 99.6183 -
0.38

zz - node (A) with t=1. S
20. 19.9976 -
0.01

xy - node (A) with t=1. S
0. eps
-

xx - node (A) with t=2. S
-120.
-119.0829
- 0.76

yy - node (A) with t=2. S
200. 199.2366 -
0.38

zz - node (A) with t=2. S
40. 39.9952 -
0.01

xy - node (A) with t=2. S
0. eps
-

U-node (B) with t=1. S
3.4 10-5 3.4000

10-5
0.00
v-node (B) with t=1. S
0.
eps
-
xx - node (B) with t=1. S
0.
2.6761 10-2
-
yy - node (B) with t=1. S
40. 39.9740 -
0.06
zz - node (B) with t=1. S
20. 19.9973 -
0.01

xy - node (B) with t=1. S
0. eps
-
xx - node (B) with t=2. S
0.
5.3523 10-2
-
yy - node (B) with t=2. S
80. 79.9480 -
0.06
zz - node (B) with t=2. S
40. 39.9946 -
0.01

xy - node (B) with t=2. S
0. eps
-

xx - node (E) with t=1. S
20.
20.3287
1.64
yy - node (E) with t=1. S
20. 20.3287 1.64

zz - node (E) with t=1. S
20. 20.1739 0.87

xy - node (E) with t=1. S
-80. -79.9775 -
0.03
xx - node (E) with t=2. S
40.
40.6575
1.64
yy - node (E) with t=2. S
40. 40.6575 1.64
zz - node (E) with t=2. S
40. 40.3479 0.87

xy - node (E) with t=2. S
-160. -159.9550 -
0.03

xx - node (F) with t=1. S
20.
20.0176
0.09
yy - node (F) with t=1. S
20. 20.0176 0.09
zz - node (F) with t=1. S
20. 20.0072 0.04

xy - node (F) with t=1. S
-20. 20.0027 0.01
xx - node (F) with t=2. S
20.
40.0351
0.09
yy - node (F) with t=2. S
20. 40.0351 0.09
zz - node (F) with t=2. S
0. 40.0144 0.04

xy - node (F) with t=2. S
-20. 40.0054 0.01

---

35 Summary of the results

Summary of the errors max in %

3D
Localization MOD A MOD B MOD C MOD D MOD L MOD M MOD NR MOD P
elem pe6, h8
pe15, h20
te4 te10 py5 py13
pe15, h20 pe15, h20
geom

45° 45° 45° 45° 45° 45° 360° 360°
Nb

1922 2115 1115 1395 342 1703 8832 8832
No
Dépl. With,
E 0.08
0.09
0.17
0.04

0.21
0.00
0.00
0.00
B, F
0.10
0.07
0.30
0.04
0.16
0.00
0.00
0.00
xx A,
E 4.59
0.39
10.45
4.41
11.74
0.11
1.64
1.64
B, F
5.24
0.07
7.78
0.95
5.24
0.11
0.09
0.09
yy
WITH, E
5.70
0.92
9.46
1.80
57.57
0.81
1.64
1.64
B, F
1.89

0.01
2.46
0.49
4.75
0.08
0.09
0.09
zz
WITH, E
Good
Good
Good
Good
Good
Good
0.87
0.87

B, F
Good
Good
Good
Good
Good
Good
0.04
0.04
xy
WITH, E
0.15
0.26
2.89
0.27
3.46
0.07
0.03
0.03
B, F
0.90
0.06
0.81
0.28
4.95

0.09
0.01
0.01

C_plan
Localization
MOD E
MOD F
MOD G
MOD O
Type of elements

tria3, quad4
tria6, quad8
quad9
tria6, quad8
Modelled geometry

45° 45° 45°
360°
A number of nodes

961
591
441
384
Displacements A,
E
0.07
0.09
0.00
0.01
B, F
0.09
0.07
0.00
0.00
Constraints
4.65
0.39
0.27
1.44
xx
WITH, E

B, F
5.19
0.06
0.02
0.08
Constraints
WITH, E
5.68
0.90
0.16
1.44
yy
B, F
1.40
0.04
0.05
0.08
Constraints
WITH, E
Good
Good
Good
Good
zz
B, F
Good
Good
Good
Good
Constraints
WITH, E
0.16
0.23
0.20
0.10
xy
B, F
1.23
0.07
0.09
0.00

Axis

Localization
MOD H
MOD I
MOD J
Type of elements

tria3, quad4
tria6, quad8
quad9
A number of nodes

113
175
205
Displacements A,
E
0.01
0.00
0.00
B, F
0.01
0.00
0.00
Constraints
5.66
0.17
0.17
xx
WITH, E
B, F
Good
Good
Good
Constraints
WITH, E
Good
Good
Good
yy
B, F
Good
Good
Good

Constraints
WITH, E
1.29
0.09
0.09
zz
B, F
1.00
0.07
0.02
Constraints
WITH, E
Good
Good
Good
xy
B, F
Good
Good
Good

· The results are more precise with elements of order 2.
· The problem is adapted more to an axisymmetric modeling. The results are better.
· The grids remain insufficient for the elements 3D of order 1: constraints and deformations modelings A, C, E and L (especially for modeling L in PYRAM5).
· The pyramids give results similar to the other elements 3D, with equivalent grid.
· Modelings NR and P with basic effect and pressure constant or variables give of good results.

SSLV07 - Stretching of a parallelepiped
under its own weight

Summary:
This static test 3D makes it possible to validate the following functionalities:
· loading in actual weight (gravity or internal force) and in uniform pressure,
· calculation of the potential energy of the structure,
· estimator of error in residue (modeling B).
It includes/understands 3 modelings. Its interest lies in the description of the effect of the Poisson's ratio (of contraction).

1
Problem of reference
1.1 Geometry

Z
B
With
D
y
E
L
B
C
X

has
Height:

L = 3 m
Width:

has = 1 m
Thickness:

B = 1 m
Co-ordinates of the points (in meters):
With
B
C
D
E
X
0.
0.
0.5
0.5
0.
y
0.
0.
0.
0.
0.
Z
3.
0.
0.
3.
1.5

1.2
Material properties

E = 2 1011 MPa
= 0.3
= 7.800 kg/m3

1.3
Boundary conditions and loadings

Not a: (U = v = W = 0, X = y = Z = 0)
Actual weight following axis Z
Uniform constraint with traction for the higher face: Z = gL = + 229.554. Pa

1.4 Conditions
initial
Without object for the static analysis.
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SSLV07 Stretching of a parallelepiped under its own weight
Date:
21/01/98
Author (S):
X. DESROCHES
Key:
V3.04.007-D Page:
3/10

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card SSLV07/89 of the guide VPCS which presents method of calculation in the following way:

Displacements:
G X Z
G y Z
G z2 G
G L2
U
= -
v
= -
W
=
+
(x2 + y2) -
E
E
2nd
2nd
2nd

Constraints:

=

=
=
=
=
=
zz
G Z
xx
yy
xy
yz
zx
0
Z
U
With
Of
D
L/2
E
L
B
C
It

X
W
wB
B'

2.2 Results of reference

Displacement of the points B, C, D and E.
Constraints zz of A and E.

2.3 Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
S.P. TIMOSHENKO. Theory of elasticity. Paris. Polytechnic bookshop. CH. Béranger,

p.279 with 282 (1961).
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

Code_Aster ®
Version
4.0
Titrate:
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Key:
V3.04.007-D Page:
4/10

3 Modeling
With
3.1
Characteristics of modeling

3D

Z
B
With
D
y
L
C
X
has
Cutting:
3 in height
2 in width and thickness
meshs hexa20
Limiting conditions:
on axis AB
DDL_IMPO: (GROUP_NO: ABsansA DX=0., DY=0.)
in A and D
(NODE: WITH DX=0., DY=0., DZ=0.), (NODE: D DY=0.)
Names of the nodes:
Not A = N59
Not B = N53

Not C = N12
Not D = N18
Not E = N56
3.2
Characteristics of the grid
A number of nodes: 111
A number of meshs and types: 12 HEXA20
Files:
Aster: yes
IDEAS: not
ALI-BABA: not
3.3 Functionalities
tested
Orders
Keys
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
GRAVITY
FORCE_FACE
GROUP_MA
CALC_CHAM_ELEM
OPTION
“SIGM_ELNO_DEPL”
[U4.61.01]
“EPOT_ELEM_DEPL”
POST_ELEM
ENER_POT
[U4.61.04]
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

Code_Aster ®
Version
4.0
Titrate:

4
Results of modeling A

4.1 Values
tested

Localization
Type of value
Reference
Aster
% difference
(m)
Not B
UB
0.
< 1014
-
VB
0.
< 1014
-
WB
1.721655 106
1.7217 106
< 0.1
Not C
CPU
0.
= 1014
-
VC
0.
< 1014
-
WC
1.707308 106
1.7073 106

< 0.1
Not D
UD
1.721655 107
1.7216 107
< 0.1
VD
0.
< 1014
-
WD
1.434713 108
1.4324 108
0.2
Not E
EU
0.
< 1014
VE
0.
< 1014
WE
1.291241 106
1.2913 106
< 0.1
(Pa)
Not A

2.29554 105
2.2956 105
< 0.1
zz
Not E

1.14777 105
1.14777 105
< 0.1
zz

4.2 Remarks

Modeling in HEXA20 is completely acceptable for this coarse grid.

4.3

Contents of the file results

Displacements and constraints. Potential energy by element.

4.4 Parameters
of execution
Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
4.26 seconds

---

5 Modeling
B

5.1
Characteristics of modeling
3D

Cutting:
12 in height
8 in width and thickness
meshs HEXA8
Limiting conditions:
on axis AB
DDL_IMPO: (GROUP_NO: ABsansA DX=0., DY=0.)
in A and D
(NODE: WITH DX=0., DY=0., DZ=0.), (NODE: D DY=0.)
Names of the nodes:
Not A = N533
Not B = N521

Not C = N989
Not D = N1001
Not E = N527

5.2
Characteristics of the grid

A number of nodes: 1053
A number of meshs and types: 768 HEXA8

5.3 Functionalities
tested

Orders
Keys

AFFE_MODELE
"MECHANICAL"
"3D"
ALL
[U4.22.01]
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FORCE_INTERNE
GRAVITY
AFFE_CHAR_MECA_F
FORCE_FACE
GROUP_MA
MECA_STATIQUE
OPTION
"SIGM_ELNO_DEPL"
[U4.31.01]
"EPOT_ELEM_DEPL"
CALC_ELEM
OPTION
"ERRE_ELGA_NORE"
[U4.61.02]

5.4 Remarks

This modeling makes it possible to test the estimator of error in residue in 3D.

6
Results of modeling B
6.1 Values
tested
Localization
Type of value
Reference
Aster
% difference
(m)
Not B
UB
0.
< 1015
-
VB
0.
< 1015
-
WB
1.721655 106
1.7217 106
< 0.1
Not C
CPU
0.
3.7081 109
-
VC
0.
< 1015
-
WC
1.707308 106

1.7095 106
0.13
Not D
UD
1.721655 107
1.6846 107
2.2
VD
0.
< 1015
-
WD
1.434713 108
1.2118 108
15.5
Not E
EU
0.
< 1015
-
VE
0.
< 1015
-
WE
1.291241 106
1.2917 106
< 0.1
(Pa)
Not A

2.29554 105
2.1739 105
5.3
zz
HEX12
relative error
1.15
1.148
0.17
HEX600
relative error
1.30

1.301
0.07

6.2 Remarks

The grid remains insufficient for a modeling in HEXA8. The total relative error is weak (3%) but 20% exceed on certain meshs.

6.3
Contents of the file results

Displacements and constraints. Relative and absolute errors total by the estimator in residue. Errors by element. Potential energy by element.

6.4 Parameters
of execution

Version:
3.02.11
Machine:
CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
36.42 seconds

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---

7 Modeling
C

7.1
Characteristics of modeling

3D

Cutting:
12 in height
8 in width and thickness
meshs hexa8

Limiting conditions:
on axis AB
DDL_IMPO: (GROUP_NO: ABsansA DX=0., DY=0.)
in A and D
(NODE: WITH DX=0., DY=0., DZ=0.), (NODE: D DY=0.)

Names of the nodes:
Not A = N533
Not B = N521
Not C = N989
Not D = N1001
Not E = N527

7.2
Characteristics of the grid

A number of nodes: 1053
A number of meshs and types: 768 HEXA8

7.3 Functionalities
tested

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO

[U4.25.01]
AFFE_CHAR_MECA_F
FORCE_INTERNE
FORCE_FACE
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
OPTION
“SIGM_ELNO_DEPL”
[U4.61.01]

7.4 Remarks

This modeling makes it possible to test key word FORCE_INTERNE in AFFE_CHAR_MECA_F.

8
Results of modeling C

8.1 Values
tested

Locali-

Type of value
Reference
ASTER
% difference
sation
(m)
Not B
UB
0.
< 1015
-
VB
0.
< 1015
-
WB
1.721655 106
1.7217 106
< 0.1
Not C
CPU
0.
3.7081 109
-
VC
0.
< 1015
-
WC
1.707308 106
1.7095 106
+0.13
Not D
UD
1.721655 107
1.6846 107
2.15
VD
0.
< 1015
-
WD
1.434713 108

1.2118 108
15.5
Not E
EU
0.
< 1015
-
VE
0.
< 1015
-
WE
1.291241 106
1.2917 106
< 0.1
(Pa)
Not A

2.29554 105
2.1739 105
5.3
zz

8.2 Remarks

The grid remains insufficient for a modeling in HEXA8.

8.3

Contents of the file results

Displacements and constraints.

8.4 Parameters

of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
11.61 seconds

4.0
Titrate:
SSLV07 Stretching of a parallelepiped under its own weight
Date:
21/01/98
Author (S):
X. DESROCHES
Key:
V3.04.007-D Page:
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9
Summary of the results
Type of value
Reference
Aster
Aster
(m)
Hexa20
Hexa8
(A)
(B)
UB
0.
VB
0.
WB
1.721655 106
< 0.1%
< 0.1%
CPU
0.
X
VC
0.
WC
1.707308 106
< 0.1%
0.1%
UD
1.721655 107
< 0.1%
-2.2%
VD

0.
WD
1.434713 108
-0.2%
-15.5%
EU
0.
VE
0.
WE
1.291241 106
< 0.1%
< 0.1%
(Pa)
With
2.29554 105
< 0.1%
-5.3%
zz
E
1.14777 105
< 0.1%
< 0.1%
zz
Modeling:
With (HEXA20 cutting: 3 in Z, 2 in X and Y)
B (HEXA8 cutting: 12 in Z, 8 in X and Y)
Modeling in HEXA8 would require a grid much finer.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.100
SSLV100 - Hollow roll in plane deformations

Summary:
This test makes it possible to validate the elements of plane deformation on the following functionalities:
· pressure distributed,
· matrix of rigidity,
· imposed displacements:
- by
ddl,
-
by face of element.
It includes/understands 4 modelings.
The 3 first correspond to elements of the different type (linear and quadratic).
The last validates the displacements imposed by face (blocking of the normal component).

---

1 Problem of reference

1.1 Geometry

y
R
E
F

C

45°
D
P
With
B
Z
X
Internal ray
= 0.1 m has
External ray
B = 0.2 m
Co-ordinates of the points:
With
B
C
D
E
F
X
0.100
0.200
0.1 cos (22.5)
0.2 cos (22.5)
2/2
2
y
0.
0.
0.1 sin (22.5)
0.2 sin (22.5)
2/2
2
Z
0
0.
0.
0.
0.
0.

1.2

Properties of materials

E = 2.105 Mpa
= 0.3

1.3
Boundary conditions and loadings

Internal pressure: P = 60. MPa

---

2 Reference solution

2.1 Method of calculation used for the reference solution

Analytical

2

has

=

zz

2 *P b2 - a2*

2

2

has

B

=

1-

rr

P b2 - a2 R

2

2

2

has
B

= *P*
1+

b2 - *a2*
R

2
=
R
0
P
a2

b2
U
=
(1+ 1- 2 +
R
) (
)
R
E *b2* - *a2*

R

2
One obtains:
-5
5
-
for *R* = 0 1
.
U = 5.72 10
for *R* = 0.2
U = 3.64 10
R
R
= 60.

-
= 0.
rr
rr
= 100.
= 40.
= 12.
= 12.
zz
zz
= 0.
= 0.
R
R
Passage in the system of Cartesian axes:

=
cos2
+
sin2
-
xx
rr

2 *R* sin cos

=
sin2
+
cos2
+
yy
rr

2 *R* sin cos

=
sin cos -
sin cos - 2
cos2
-
2
xy
rr

R (
sin)
with:
·
= 0° at points A and B,
·
= 22.5° at the points C and D,
·
= 45° at the points E and F.

2.2
Results of reference

Displacements (U, v) and forced (*xx*, *yy*
, *zz*
, *xy*
) at the points A, B, C, D, E, F.

2.3 References
bibliographical

[1]
Y.C. FUNG. Fundations of solid mechanics. Prentice-hall, Inc. Englewood Cliffs. NJ. 1965
p. 243 to 245.

---

3 Modeling
With

3.1
Characteristics of modeling: D-plan (QUAD4 + TRIA3)

F
Normally blocked face
y
D
Face with imposed pressure
E
C
45°
X
With
B
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO: (GROUP_NO: bordAB
DY: 0.)
side EF
FACE_IMPO: (GROUP_MA: faceEF
DNOR: 0.)
pressure on face AE
PRES_REP: (GROUP_MA: faceAE
NEAR: 60.)
Names of the nodes:
With = N23
B = N1
C = N391
D = N369
E = N451
F = 751

3.2

Characteristics of the grid

A number of nodes: 759
A number of meshs and types: 704 TRIA3, 352 QUAD4

3.3 Functionalities
tested

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA

DNOR
PRES_REP
GROUP_MA
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]
POST_RELEVE
CHAM_GD
“EXTRACTION”
[U4.74.03]

---

4 Results of modeling A

4.1 Values tested

Place
Size
Reference
Aster
% difference

tolerance
With
U
5.72 105
5.7155 105
0.08
102
v
0.
eps
-
xx
-60.
56.3770
6.04
yy
100.
96.3917
3.61
zz
12.
12.0044
0.04
xy
0.
0.9563
-
C
U
5.28459 105
5.2832 105
0.03
102
v
2.18895 105
2.1777 105
0.51
xx
36.56854
33.5312
8.31
yy
76.56854

76.9335
0.48
zz
12.
13.0207
8.51
xy
56.56854
53.7445
4.99
E
U
4.04465 105
4.0400 105
0.11
102
v
4.04465 105
4.0400 105
0.11
xx
20.
23.4926
17.46
yy
20.
25.4141
27.07
zz
12.
14.6720
22.27
xy
-80.
78.3081
2.11
B
U
3.640 105
3.6405 105
0.01
102
v

0.
eps
-
xx
0.
0.4064
-
yy
40.
39.8759
0.31
zz
12.
11.8408
1.33
xy
0.
0.4447
-
D
U
3.36292 105
3.3603 105
0.08
102
v
1.39297 105
1.3945 105
0.11
xx
5.85786
5.2229
10.84
yy
34.14214
33.8961
0.72
zz
12.
11.7357
2.20
xy
14.14214

14.1755
0.24
F
U
2.57387 105
2.5710 105
0.11
102
v
2.57387 105
2.5710 105
0.11
xx
20.
19.1238
4.38
yy
20.
19.6156
1.92
zz
12.
11.6218
3.15
xy
-20.
20.1797
0.90

4.2 Remarks

The increase in the error, when one passes from AB to CD then EF, is ascribable with the grid (density in elements QUAD4 lower than that in TRIA3).

4.3 Parameters of execution

Version: 3.03.32
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.54 seconds

5 Modeling B

5.1
Characteristics of modeling: D-plan (QUAD8 + TRIA6)

y
B
D
Face blocked in dx
F
With
Normally blocked face
C
Face with imposed pressure
E
45°
X

Limiting conditions:
side AB
DDL_IMPO: (GROUP_NO: bordAB
DY: 0.)
side EF
FACE_IMPO: (GROUP_MA: faceEF
DNOR: 0.)
pressure on AE
PRES_REP: (GROUP_MA: faceAE
NEAR: 60.)

Names of the nodes:
With = N2
B = N48

C = N401
D = N424
E = N606
F = N494

5.2

Characteristics of the grid

A number of nodes: 729
A number of meshs and types: 192 TRIA6, 96 QUAD8

5.3 Functionalities
tested

Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]
POST_RELEVE
CHAM_GD
“EXTRACTION”
[U4.74.03]

Titrate:
SSLV100 Hollow roll in plane deformations
Date:
24/08/99
Author (S):
X. DESROCHES
Key:
V3.04.100-D Page:
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6
Results of modeling B
6.1 Values
tested

Place
Size
Reference
Aster
% difference
tolerance
With
U
0.
eps
-
102
v
5.72 105
5.7155 105
0.04
xx
100.
99.7100
0.29
yy
-60.
59.7725
0.38
zz
12.
11.9813
0.16
xy
0.

0.2643
-
C
U
2.18895 105
2.1881 105
0.04
102
v
5.28459 105
5.2826 105
0.04
xx
76.56854
76.7005
0.17
yy
36.56854
36.4500
0.32
zz
12.
12.0751
0.63
xy
56.56854
56.2844
0.50
E
U
4.04465 105
4.0432 105
0.04
102
v
4.04465 105
4.0432 105
0.04
xx
20.
20.0083
4.104
yy

20.
19.9988
6.105
zz
12.
12.0021
2.104
xy
80.
79.8176
0.23
B
U
0.
eps
-
102
v
3.640 105
3.6390 105
0.03
xx
40.
39.9924
0.02
yy
0.
0.001338
-
zz
12.
11.9973
0.02
xy
0.
0.04083
-
D
U
1.39297 105
1.3926 105
0.03
102

v
3.36292 105
3.3619 105
0.03
xx
34.14214
34.1361
0.02
yy
5.85786
5.8948
0.63
zz
12.
12.0093
0.08
xy
14.14214
14.1596
0.12
F
U
2.57387 105
2.5731 105
0.03
102
v
2.57387 105
2.5731 105
0.03
xx
20.
20.0000
3.106
yy
20.
19.9996
2.105
zz
12.
11.9999
7.106
xy

20.
19.9975
1.104

6.2 Remarks

The evolution of the error induced by the grid according to AB, CD or EF, is clearly attenuated by report/ratio
with modeling A.

6.3 Parameters
of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
6.11 seconds

7 Modeling
C

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

7.1 Characteristics of modeling: D-plan (QUAD9)

F
Normally blocked face
y
D
E
C
45°
X
With
B
Face with imposed pressure
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO: (GROUP_NO: bordAB DY: 0.)
side EF
FACE_IMPO: (GROUP_MA: faceEF DNOR: 0.)
pressure on AE
PRES_REP: (GROUP_MA: faceAE NEAR: 60.)
Names of the nodes:
With = N1
B = N47
C = N351
D = N374
E = N569
F = N423

7.2 Characteristics of the grid

A number of nodes: 725

A number of meshs and types: 168 QUAD9

7.3 Functionalities
tested
Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS
[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]
POST_RELEVE
CHAM_GD
“EXTRACTION”
[U4.74.03]

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

Code_Aster ®
Version
3
Titrate:
SSLV100 Hollow roll in plane deformations
Date:
24/08/99
Author (S):
X. DESROCHES
Key:

8
Results of modeling C
8.1 Values
tested
Place
Size
Reference
Aster
% difference
tolerance
With
U
5.72 105
5.7173 105
0.05
102
v
0.
eps
-
xx
-60.
56.8334
0.27
yy
100.
99.84
0.16
zz
12.
12.0023
0.02
xy
0.
0.00272
-
C
U
5.28459 105
5.2821 105
0.05

102
v
2.18895 105
2.1879 105
0.05
xx
36.56854
36.45
0.32
yy
76.56854
76.46
0.14
zz
12.
12.003
0.02
xy
56.56854
56.45
0.2
E
U
4.04465 105
4.0427 105
0.05
102
v
4.04465 105
4.0427 105
0.05
xx
20.
19.996
2. 104
yy
20.
20.011
5.5 104
zz
12.
12.002
2. 104

xy
-80.
79.837
0.2
B
U
3.640 105
3.6386 105
0.04
102
v
0.
eps
-
xx
0.
2.7 103
-
yy
40.
40.0011
4. 104
zz
12.
11.9995
4. 104
xy
0.
4.8 104
-
D
U
3.36292 105
3.3617 105
0.04
102
v
1.39297 105
1.3924 105
0.04
xx
5.85786
5.8557

0.03
yy
34.14214
34.143
2.5 105
zz
12.
11.9996
3. 105
xy
14.14214
14.1435
1. 104
F
U
2.57387 105
2.5729 105
0.04
102
v
2.57387 105
2.5729 105
0.04
xx
20.
19.999
3. 105
yy
20.
20.0002
1. 105
zz
12.
11.9999
9. 106
xy
-20.
20.0025
0.01

8.2 Remarks

The evolution of the error induced by the grid according to AB, CD or EF, is clearly attenuated by report/ ratio
with modeling A.

8.3 Parameters
of execution
Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5.67 seconds
9 Modeling
D

9.1
Characteristics of modeling: D-plan (QUAD4 + TRIA3)
F
Normally blocked face
y
E
D
G
Face with displacement
normal imposed
C
H
45°
X
With

B
Face blocked out of Dy
Limiting conditions:
side AB
DDL_IMPO: (GROUP_NO: bordAB DY: 0.)
side EF
FACE_IMPO: (GROUP_MA: faceEF DNOR: 0.)
on AE
normal displacement imposed on 5.72 E-5m
FACE_IMPO: (GROUP_MA: faceAE DNOR: -5.72 E-5)
Names of the nodes:
With = N23
B = N1
C = N391
D = N369
E = N451
F = N751
H = N92
G = N447

9.2
Characteristics of the grid

A number of nodes: 759
A number of meshs and types: 704 TRIA3, 352 QUAD4

9.3 Functionalities
tested
Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
FACE_IMPO
GROUP_MA
DNOR
PRES_REP
GROUP_MA
AFFE_MODELE
“MECHANICAL”
“D_PLAN”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS

[U4.23.01]
CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
[U4.61.01]
POST_RELEVE
CHAM_GD
“EXTRACTION”
[U4.74.03]
CALC_NO
“REAC_NODA”
[U4.61.03]

10
Results of modeling D

10.1 Values
tested

Localization
Size
Reference
Aster
% difference
C
Fx
0.1360
0.14069
3.45

Fy
0.056

0.05827
4.06
H
Fx
0.14686
0.13608
7.34
Fy
0.0108
0.0100
7.04
G
Fx
0.1138
0.114
0.19
Fy
0.093
0.0936
0.61

10.2 Remarks

One checks that the nodal forces of reaction are null in all the nodes, except on the nodes of line AE, EF and AB.

10.3 Parameters of execution

Version: 2.03.04
Machine: CRAY C90
System:
UNICOS 6.0
Obstruction memory:
6 megawords
Time CPU To use:
10.17 seconds

11
Summary of the results
D_plan
modeling
Summary of the errors
With
B
C
max in %
Displacements
WITH, B
0.08
0.04
0.05
C, D
0.51
0.04
0.05
E, F
0.11
0.04
0.05
Constraints
WITH, B
6.04
0.29
0.27

C, D
10.84
0.17
0.32
xx
E, F
17.46
4.104
2.104

Constraints
WITH, B
3.61
0.38
0.16

C, D
0.72
0.63
0.14
yy
E, F
27.07
2.105
5.5.104
Constraints
WITH, B
1.33
0.16
0.02

C, D
8.51
0.63
0.02
zz
E, F
22.27
2.104
2.104
Constraints
WITH, B
-
-
-

C, D
4.99
0.50
0.2
xy
E, F
2.11
0.23

0.2
These 3 modelings appreciably have the same number of nodes; results obtained with
elements of order 1 (modeling A in Tria3 and Quad4) are definitely less precise, in particular on internal wall.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.104

SSLV104 - Beam in rotation

Summary:

This test makes it possible to validate the linear elastic design of a slim beam subjected to a rotation of one of its
ends. Three modelings are tested: elements 3D (HEXA20) and elements of COQUE_3D (QUAD9 and TRIA7). That tests the inertias of rotation, without taking account of the elementary terms of stiffening centrifuge (cf [V3.04.105]).

The reference solution is analytical (1D). The results coincide perfectly with the reference solution.

1
Problem of reference

1.1 Geometry

Directed slim beam carried in space by the axis of directing vector (1, 1, 1).

0.5 m
Z
0.02 m
Y
Embedded face
X

Square section of surface: 4.0 104 m2
Length of the beam: 0.5 m

1.2
Material properties

E = 2. 1011 Pa
= 0
= 7800 kg/m3
A_CIS = 0.8333 (factor of correction of transverse shearing equal to 5/6 for a theory of the type
Thin Reissner hull)

1.3
Boundary conditions and loadings

Free beam fixed in rotation around an axis perpendicular to its greater dimension and
passing by the center of the embedded face.
Component of the vector rotation: (1, 0, 1).
Number of revolutions: = 3000 rd/s.
The important value number of revolutions does not have anything physics.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

In the local reference mark of the beam:

2 *Ux*
+ 2x = 0 *with U* () =

0
0
2
X
X
E
Ux (*L*) = (*L*) =

0
X
xx

By integrating the preceding differential equation one obtains, in the reference mark of the beam:

2
x3
U (*X*) =
X L2 -
U = *U2* =
X
0
2nd
y

3

Displacements of all points of the beam are thus written in the total reference mark:

2
R 3
U
=
2 -
X (*X*, *Y*, *Z*)
R L
2 3rd

3
2
R 3
U
=
2 -
y (*X*, *Y*, *Z*)
R L
2 3rd
3
2
R 3
U
=
2 -
Z (*X*, *Y*, *Z*)
R L
2 3rd
3
front
R
EC. =
X 2 + *Y* 2 + *Z* 2

2.2
Results of reference

Values of three displacements in the center of the section furthest away from the axis of rotation.

---

3 Modeling

With
3.1
Characteristics of modeling
Elements 3D (HEXA20)
Regulated grid including:
4 elements on the section

50 elements over the length

200 elements on the whole
0.5 m
Z
0.02 m
Y
Embedded face
X
3.2
Characteristics of the grid
A number of nodes: 1521
A number of meshs and types: 200 HEXA20
3.3 Functionalities
tested
Orders
Keys
AFFE_MODELE
AFFE
PHENOMENON
“MECHANICAL”
[U4.22.01]
MODELING
“3D”
AFFE_CHAR_MECA
DDL_IMPO
DX, DY, DZ
[U4.25.01]
ROTATION
CALC_MATR_ELEM
OPTION

"RIGI_MECA"
[U4.41.01]
CALC_VECT_ELEM
OPTION
"CHAR_MECA"
[U4.41.02]
RESO_LDLT
MATR_FACT
[U4.51.02]
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/98/040 - Ind A

4
Results of modeling A

4.1 Values tested

Identification
Reference
Aster
% difference
DX in L
8.44 103
8.44 103
0.05
DY in L
8.44 103
8.44 103
0.04
DZ in L
8.44 103

8.44 103
0.04

4.2 Parameters of execution

Version: 4.00.02
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
6 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

Elements of hull MEC3QU9H

0.02
Grid including:
2 elements according to the dispatcher

4 elements according to the length
8
elements
with
total
0.5 m
Z
y
X
Embedded face

5.2
Characteristics of the grid

A number of nodes: 45
A number of meshs and types: 8 QUAD9

5.3 Functionalities
tested

Orders
Keys
AFFE_MODELE
AFFE
PHENOMENON

"MECHANICAL"
[U4.22.01]
MODELING
"3D"
AFFE_CHAR_MECA
DDL_IMPO
DX, DY, DZ
[U4.25.01]
ROTATION
CALC_MATR_ELEM
OPTION
"RIGI_MECA"
[U4.41.01]
CALC_VECT_ELEM
OPTION
"CHAR_MECA"
[U4.41.02]
RESO_LDLT
MATR_FACT
[U4.51.02]

6 Results of modeling B

6.1 Values tested

Identification	Reference	Aster	% difference
DX in L	8.44 103	8.44 E3	0.04
DY in L	8.44 103	8.44 E3	0.04
DZ in L	8.44 103	8.44 E3	0.04

6.2 Parameters of execution

Version: 4.00.14

Machine: CRAY C90
Obstruction memory:
16 MW
Time CPU To use:
4.3 seconds

---

7 Modeling
C
7.1
Characteristics of modeling
Elements of hull MEC3TR7H
0.02
Grid including:
4 elements according to the dispatcher

8 elements according to the length
64
elements
with
total
0.5 m
Z
y
X
Embedded face
7.2
Characteristics of the grid

A number of nodes: 217
A number of meshs and types: 64 TRIA7

7.3 Functionalities
tested
Orders
Keys

AFFE_MODELE
AFFE
PHENOMENON
“MECHANICAL”
[U4.22.01]
MODELING
“3D”
AFFE_CHAR_MECA
DDL_IMPO
DX, DY, DZ
[U4.25.01]
ROTATION
CALC_MATR_ELEM
OPTION
“RIGI_MECA”
[U4.41.01]
CALC_VECT_ELEM
OPTION
“CHAR_MECA”
[U4.41.02]
RESO_LDLT
MATR_FACT
[U4.51.02]

8
Results of modeling C

8.1 Values
tested
Identification
Reference
Aster
% difference

DX in L
8.44 103
8.44 E3
0.08
DY in L
8.44 103

8.44 E3
0.02
DZ in L
8.44 103
8.44 E3
0.03

8.2 Parameters
of execution

Version: 4.00.14
Machine: CRAY C90
Obstruction memory:
16 MW
Time CPU To use:
7.6 seconds

9
Summary of the results

The coincidence of the results with the analytical solution makes it possible to validate the loading due to the forces
of inertia of rotation.

Modeling COQUE_3D with MEC3QU9H gives the solution with very few elements.

One will refer to test SSLV105 [V3.04.105] to evaluate the effect of the stiffening centrifuges for
the element 3D, HEXA20.

Handbook of Validation

V3.04 booklet: Linear statics of the voluminal structures

Document: V3.04.105

SSLV105 - Stiffening centrifuges of a beam
in rotation

Summary:

Test of Mechanics of the structures in linear static analysis.

The geometry is that of a slim beam subjected to a rotation around one of its ends. Only one modeling: elements 3D (HEXA20). One tests here the inertias of rotation (like test SSLV104) with taking into account of the centrifugal stiffening.

The reference solution (analytical) takes into account the term of additional rigidity due to rotation. results are identical to the reference solution.

---

1 Problem of reference

1.1 Geometry

The structure is made up of a directed slim beam carried in space by the axis of vector
director (1, 1, 1).
0.5 m
Z
Y
0.02 m
X
Embedded face
Square section of surface: 4.0 104 m2
Length of the beam: 0.5 m

1.2
Material properties

E = 2. 1011 Pa
= 0
= 7800 kg/m3

1.3
Boundary conditions and loadings

Free beam fixed in rotation around an axis perpendicular to its greater dimension and
passing by the center of the embedded face.
Co-ordinates of the vector rotation: (1, 0, 1).
Number of revolutions: = 3000 rd/s.
The important value number of revolutions does not have anything physics.

2
Reference solution

2.1
Method of calculation used for the reference solution

In local reference mark of the beam: the equation relating to *Ux* displacement (without neglecting

lengthening) is:
2Ux
+ 2 *X* + *U* = 0
2
(
X)
X
E
With the boundary conditions *U* () =
X 0
0
Ux (*L*) = (*L*) = 0
X
xx

2

One poses: =
E
By integrating the preceding differential equation one obtains, in the reference mark of the beam:
(
sin *X*)
U (*X*) = cos (
- *X*
U = *U* =
X
y

2
0
L)
The displacement of any points of the beam is thus written in the total reference mark:
1 sin *R*

U
=

-
X (*X*, *Y*, *Z*)
( )
3 cos

(
R

L)
1 sin *R*

U
=

-
y (*X*, *Y*, *Z*)
( )
3 cos

(
R
L)
1 sin *R*

U
=

-
Z (*X*, *Y*, *Z*)
( )
3 cos

(
R
L)
with *R*
=
X2 + *Y* 2 + *Z2*

2.2
Results of reference

Values of three displacements in the center of the section furthest away from the axis of rotation.

2.3
Uncertainty on the solution

Without object (analytical solution).

---

3 Modeling With

3.1 Characteristics of modeling

Elements 3D (HEXA20)

Regulated grid including:
4 elements on the section
50
elements
on

length
200
elements
with
total
0.5 m
Z
Y
0.02 m
X
Embedded face

3.2 Characteristics of the grid

A number of nodes: 1521
A number of meshs and types: 200 HEXA20

3.3 Functionalities tested

Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
ROTATION
CALC_MATR_ELEM

---

4 Results of modeling A

4.1 Values tested

Identification	**Reference**	**Aster**	**% difference**
DX in L	8.75 103	8.75 103	0
DY in L	8.75 103	8.75 103	0
DZ in L	8.75 103	8.75 103	0

4.2 Parameters of execution

Version: 3.5.27
Machine: CRAY C90
Obstruction memory:

8 MW
Time CPU To use:
7 seconds

---

5 Summary of the results

Correct operation of option RIGI_ROTA. To note the increase in axial displacement by report/ratio with the case without stiffening (SSLV104 [V3.04.104]).

Organization (S): EDF/AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.109

SSLV109 - Full cylinder in nonuniform pressure
mode 1

Summary:

This test validates all the elements of Fourier (triangles and quadrangles of degrees 1 and 2) in elasticity.
functionalities are as follows:

· variable pressure in space,
· imposed displacements,
· matrices of rigidity Fourier mode 1,
· forced with the nodes Fourier mode 1,
· recombination of Fourier on displacements and constraints (modeling A),
· transverse isotropic material (modeling F).

The test has a quadratic analytical solution in displacements.

The interest of the test lies in:

· the comparison between solution calculated and analytical solution on the various finite elements,
· the comparison between the results and Code PERMAS on elements TRIA6 (modeling A).

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

L = 12
With
C
p = R
Z
R = 1
R
B
D

The modelled field is ACDB (plane = 0).

1.2
Material properties

E = 72 N/m2

= 0.3

1.3

Boundary conditions and loadings

ur ()
With
= uz ()
With
= uq ()
With
= 0
uz (A)
B
= 0

R
p = p
cos
R

with p = 1. and R = 1 applied in Z = 12

1.4 Conditions
initial

Without object for the static analysis.

2
Reference solution

2.1
Method of calculation used for the reference solution

M
p
2

U
, ,
=

,
cos with
,
=
+
2
R (R Z
)
(ur Z)
(ur Z)
Z
R
2EI
2ER
p
U
, ,
=

,
cos with
,
= -

Z (R Z
)
v (R Z)
v (R Z)
rz
2EI

M
p
2

U
2
(R, Z,)
=
(wr, Z) (- sin) with (wr, Z) =
Z -
R
2EI
2ER

p
All the constraints are null except zz (R, Z) = - R.
R

The data were selected in such way that (
u.a.) = (
U 0, L) = 1.

Displacements are thus written here:

(
z2
R 2
R Z
z2
R 2
U R, Z) =
+
v (R, Z) = -
(
W R, Z) =
-

144
480
72
144
480

and:

zz (R, Z) = - R

2.2
Results of reference

U, v, W, zz
in
R = 0. , 0.5, 1.
Z = 0. , 6. , 12.

U, U, U
R
Z

in R = 0. , Z = 6. , 12. , = 45°

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
PERMAS-HS. Axisymmetric Continued with arbitrary loads. Stuttgart 1985. INTES publication n°224 pp 42 - 49.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLV109 - Full cylinder in pressure nonuniform mode 1

Date:
23/09/02
Author (S):

3 Modeling With

3.1 Characteristics of modeling

Number of the nodes:
With = N1
B = N3
C = N13

D = N15
E = N7
F = N8
G = N9

blocked node
With
E
C
face
blocked
F
y (Z)
in Z
B
G
D
X (R)

Limiting conditions:

DDL_IMPO:
(NODE: WITH DX = 0.
DY = 0.
DZ = 0.)

face AB
(GROUP_NO: AB DY = 0.)

Pressure on the face CD: PRES_REP (GROUP_MA: Boils NEAR: p)

p being defined by AFFE_CHAR_MECA_F by p (X) = X

3.2
Characteristics of the grid

A number of nodes: 15

A number of meshs and types: 4 TRIA6, 1SEG3 on segment CD

3.3 Functionalities
tested

Orders

AFFE_MODELE
MECHANICS
“AXIS_FOURIER”
ALL

DEFI_FONCTION
NOM_PARA
“X”

AFFE_CHAR_MECA_F
DDL_IMPO
NODE

PRES_REP
GROUP_MA

CALC_MATR_ELEM
“RIGI_MECA”
MODE_FOURIER

CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”

MODE_FOURIER

COMB_CHAM_NO
COMB_FOURIER

COMB_CHAM_ELEM
COMB_FOURIER

3.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM (by defect, it is regarded as being worth 0).

4
Results of modeling A

4.1 Values tested

Node Size
Reference
Aster *%*
difference

B
U
2.0833 10-3 2.0835
10-3 9.10-3
v
0.
DDL_IMPO

W
-2.0833 10-3
-2.0834 10-3 3.10-3

zz
-1. -1.000001
6.10-4

E
U 0.25
0.250001
5.10-4
v
0.
-4.10-6

W
0.25
0.250000
2.10-4

zz
0.
-1.10-4

F
U 0.250521
0.250522
4.10-4
v
-0.04166 -0.041668 3.10-3
W
0.0249479
0.0249479
-6.10-3

zz
-0.5 -0.50005 1.10-2

G
U 0.252083
0.252084
3.10-4
v
-0.083333
-0.083333 -7.10-3
W
0.247917 0.247916
1.10-4

zz
-1. -1.
9.10-3

C
U 1. 1.0006
6.10-3
v
0.
-5.10-5

W
1.
1.00006
6.10-3

zz
0.
-1.1 10-3

D
U 1.00208
1.00215
7.10-3
v
-0.16666 -0.166691 1.5 10-2
W
0.99791 0.997981

1.9 10-2

zz
-1. -0.999 0.1

4.2 Remarks

The analytical solution is found with a precision < 0.02% for displacements and < 0.1% for the constraints.

With a numerical formula of integration at 6 points of GAUSS (instead of 3) to calculate the stiffness, one would find the relation at 1010 close (like PERMAS).
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

---

5 Modeling B

5.1 Characteristics of modeling

Number of the nodes:
With = N1
B = N3
C = N13

D = N15
E = N7
F = N8
G = N9

blocked node
C
With
E
y (Z)
face
blocked
F
in Z
B
G
D
X (R)

Limiting conditions:

DDL_IMPO:
(NODE: WITH DX = 0.
DY = 0.
DZ = 0.)
face AB
(GROUP_NO: AB DY = 0.)

Pressure on the face CD: PRES_REP (GROUP_MA: Boils NEAR: p)

p being defined by AFFE_CHAR_MECA_F by p (X) = X

5.2
Characteristics of the grid

A number of nodes: 15

A number of meshs and types: 2 QUAD8, 1 SEG3 on segment CD

5.3 Functionalities
tested

Orders

AFFE_MODELE
MECHANICS
“AXIS_FOURIER”
ALL

DEFI_FONCTION
NOM_PARA
“X”

AFFE_CHAR_MECA_F
DDL_IMPO
NODE

PRES_REP
GROUP_MA

CALC_MATR_ELEM
“RIGI_MECA”
MODE_FOURIER

CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
MODE_FOURIER

5.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM (by defect, it is regarded as being worth 0).

6
Results of modeling B

6.1 Values tested

Node Size Reference
***Aster** %*
difference

B
U
2.0833 10-3 2.0833
10-3 10.10-11
v
0.
DDL_IMPO

W
-2.0833 10-3
-2.0833 10-3
10.10-11

zz
-1. -1 10.10-11

E
U 0.25
0.25
10.10-11
v
0.
-3.9 10-14

W

0.25
0.25
10.10-11

zz
0.
-4.10-12

F
U 0.250521
0.250521
10.10-11
v
-0.04166 -0.04166 10.10-11
W
0.0249479
0.0249479
10.10-11

zz
-0.5 -0.5 10.10-11

G
U 0.252083
0.252083
10.10-11
v
-0.08333 -0.08333 10.10-11
W
0.247917 0.247917
10.10-11

zz
-1. -1. 10.10-10

C
U 1. 1. 10.1011
v
0.
-4.3.10-14

W
1.

1
10.10-11

zz
0.
6.10-12

D
U 1.00208
1.00208
10.10-11
v
-0.16666 -0.16666 10.10-11
W
0.99791 0.99791
10.10-11

zz
-1. -1. 10.10-11

6.2 Remarks

The analytical solution is found with 10 or 11 significant figures.

---

7 Modeling
C

7.1
Characteristics of modeling

Number of the nodes:
With = N1
B = N3
C = N13

D = N15
E = N7
F = N8
G = N9

blocked node
With
E
C
face
y (Z)
blocked
F
in Z
B
G
D
X (R)

Limiting conditions:

DDL_IMPO:
(NODE: WITH DX = 0.
DY = 0.
DZ = 0.)
face AB
(GROUP_NO: AB DY = 0.)

Pressure on the face CD: PRES_REP (GROUP_MA: Boils NEAR: p) *p being defined by AFFE_CHAR_MECA_F by p (X) = X*

7.2 Characteristics of the grid

A number of nodes: 15

A number of meshs and types: 2 QUAD9, 1 SEG3 on segment CD

7.3 Functionalities tested

Orders

AFFE_MODELE
MECHANICS
“AXIS_FOURIER”
ALL

DEFI_FONCTION
NOM_PARA
“X”

AFFE_CHAR_MECA_F
DDL_IMPO
NODE

PRES_REP
GROUP_MA

CALC_MATR_ELEM
“RIGI_MECA”
MODE_FOURIER

CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
MODE_FOURIER

7.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM (by defect, it is regarded as being worth 0).

8
Results of modeling C

8.1 Values
tested

Node Size
Reference
Aster *%*
difference

B
U
2.0833 10-3 2.0833
10-3 10.10-11
v
0.
DDL_IMPO

W

-2.0833 10-3
-2.0833 10-3
10.10-11

zz
-1. -1 10.10-10

E
U 0.25 0.25 10.1011
v
0.
-3.9 10-14

W
0.25
0.25
10.10-11

zz
0.
-4.10-12

F
U 0.250521
0.250521
10.10-11
v
-0.04166
-0.04166
10.10-11
W
0.0249479
0.0249479
10.10-11

zz
-0.5 -0.5 10.10-11

G
U 0.252083
0.252083
10.10-11
v

-0.08333
-0.08333
10.10-11
W
0.247917
0.247917
10.10-11

zz
-1. -1. 10.10-11

C
U 1.
1.
10.10-11
v
0.
-4.3.10-14

W
1.
1.
10.10-11

zz
0.
6.10-12

D
U 1.00208
1.00208
10.10-11
v
-0.16666
-0.16666
10.10-11
W
0.99791
0.99791
10.10-11

zz
-1. -1. 10.10-11

8.2 Remarks

The analytical solution is found with 10 or 11 significant figures.

---

9 Modeling
D

9.1
Characteristics of modeling

Number of the nodes:
With = N1
B = N1129
C = N1369

D = N2169
E = N141
F = N705
G = N1269

blocked node

With
E
C
face
y (Z)
blocked
F
in Z
B
G
D
X (R)

Limiting conditions:

DDL_IMPO:
(NODE: WITH DX = 0.
DY = 0.
DZ = 0.)
face AB
(GROUP_NO: AB DY = 0.)

Pressure on the face CD: PRES_REP (GROUP_MA: Boils NEAR: p)

p being defined by AFFE_CHAR_MECA_F by p (X) = X

9.2
Characteristics of the grid

A number of nodes: 2169

A number of meshs and types: 1920 QUAD4, 8 SEG2 on segment CD

9.3 Functionalities
tested

Orders

AFFE_MODELE
MECHANICS

"AXIS_FOURIER"
ALL

DEFI_FONCTION
NOM_PARA
"X"

AFFE_CHAR_MECA_F
DDL_IMPO
NODE

PRES_REP
GROUP_MA

CALC_MATR_ELEM
"RIGI_MECA"
MODE_FOURIER

CALC_CHAM_ELEM
"SIGM_ELNO_DEPL"
MODE_FOURIER

9.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM (by defect, it is regarded as being worth 0).

11/16

10 Results of modeling D

10.1 Values tested

Node Size
Reference
Aster %
difference

B
U
2.0833 10-3 2.0919
10-3
0.41
v
0.
DDL_IMPO

W
- 2.0833 10-3
- 2.0674 10-3
0.76

zz
-1. -1.00974
0.97

E
U 0.25 0.2498 0.07
v
0.
-2.7.10-10

W
0.25
0.2498 0.07

zz
0. 0.0090
0.90

F
U 0.250521
0.250347
0.07
v
-0.04166
-0.04164
0.07
W
0.0249479
0.0249317 0.06

zz
-0.5 -0.51005
2.01

G
U 0.252083
0.251911
0.07
v
-0.083333
-0.083273
0.07
W
0.247917
0.247752 0.07

zz
-1. -1.0103
1.03

C
U 1.
0.99927
0.07
v
0.
-2.3.10-7

W
1.
0.99928 0.07

zz
0. 0.0088

D
U 1.00208
1.001357
0.07
v
-0.16666
-0.16653
0.08
W
0.99791
0.997208 0.06

zz
-1. -1.0027
0.27

10.2 Remarks

To obtain a precision of about 1% on the constraints, it is necessary to model structure very finely (8 elements radially and 240 axially).

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---

11 Modeling *E*

11.1 Characteristics of modeling

Number of the nodes:
With = N1
B = N2421

E = N121
F = N1331
G = N2541

blocked node
With
E
y (Z)
face
blocked
F
in Z
B
G
X (R)

Limiting conditions:

DDL_IMPO:
(NODE: WITH DX = 0.
DY = 0.
DZ = 0.)
face AB
(GROUP_NO: AB DY = 0.)

Pressure on face EG: PRES_REP (GROUP_MA: Boils NEAR: p)

p being defined by AFFE_CHAR_MECA_F by p (X) = X

11.2 Characteristics of the grid

A number of nodes: 2541

A number of meshs and types: 4800 TRIA3, 20 SEG2 on segment EG

11.3 Functionalities
tested

Orders

AFFE_MODELE
MECHANICS
“AXIS_FOURIER”
ALL

DEFI_FONCTION
NOM_PARA
“X”

AFFE_CHAR_MECA_F
DDL_IMPO
NODE

PRES_REP
GROUP_MA

CALC_MATR_ELEM
“RIGI_MECA”

MODE_FOURIER

CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
MODE_FOURIER

11.4 Remarks

To decrease the number of nodes, one modelled the structure for y 6.
The precision on the results is nevertheless less than for elements QUAD4.

---

12 Results of modeling E

12.1 Values
tested

Node Size
Reference
Aster %
difference

B
U

2.0833 10-3 2.0228
10-3
2.90
v
0.
DDL_IMPO

W
-2.0833 10-3
-2.1143 10-3
1.49

zz
-1. -1.0078
0.78

E
U 0.25 0.24949 0.20
v
0.
-2.4 10-5

W
0.25
0.24950 0.20

zz
0.
-5.3 10-2

F
U 0.250521
0.25003 0.19
v
-0.04166 -0.04161
0.13
W
0.249479 0.24900 0.19

zz
-0.5 -0.49738
0.52

G

U 0.252083
0.251605
0.19
v
-0.083333 -0.083157
0.21
W
0.247917 0.247449 0.19

zz
-1. -0.9814
1.86

12.2 Remarks

The precision on displacements is lower than 3%, that on the constraints lower than 2%.

On this example, the TRIA3 converge definitely less quickly than the QUAD4 towards the solution exact.

---

13 Modeling
F

13.1 Characteristics of modeling

Number of the nodes:
With = N1
B = N3
C = N13

D = N15
E = N7
G = N9

blocked node
With
N4
E
N12
C

y (Z)
face
blocked N2
N14
in Z
B
G
N12
D
X (R)

Limiting conditions:

DDL_IMPO:
(NODE: WITH DX = 0.
DY = 0.
DZ = 0.)
face AB
(GROUP_NO: AB DY = 0.)

Pressure on the face CD: PRES_REP (GROUP_MA: Boils NEAR: p)

p being defined by AFFE_CHAR_MECA_F by p (X) = X

13.2 Characteristics of the grid

A number of nodes: 15

A number of meshs and types: 2 QUAD8, 1SEG3 on segment CD

13.3 Functionalities tested

Orders

AFFE_MODELE
MECHANICS
“AXIS_FOURIER”
ALL

DEFI_MATERIAU
ELAS_ORTH

DEFI_FONCTION
NOM_PARA
“X”

AFFE_CHAR_MECA_F
DDL_IMPO
NODE

PRES_REP
GROUP_MA

CALC_MATR_ELEM
“RIGI_MECA”
MODE_FOURIER

CALC_CHAM_ELEM
“SIGM_ELNO_DEPL”
MODE_FOURIER

13.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM (by defect, it is regarded as being worth 0).
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V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

---

14 Results of modeling F

14.1 Values
tested

Node Size
Reference
Aster %
difference

N2
U 2.6041666
2.6041666
1.10-9
W
-2.6041666 -2.6041666
1.10-9
With
zz

0.
-1.10-13

B
zz
-1. -1. 3.10-10

N4
U 0.0625 0.0625 4.1010
W
0.0625
0.0625
4.10-10
E U
0.25
0.25
3.10-10
W
0.25
0.25
3.10-10

zz
0.
-1. 10-14

G v
-0.083333 -0.083333
2.10-10

zz
-1. -1. 2.10-11
N10 U
0.5625 0.5625 2.10-10
W
0.5625 0.5625 2.10-10
N12 v
-0.125 -0.125 1.10-10
C U
1. 1. 1.10-10
W
1. 1. 1.10-10

zz

0.
7.10-14

N14 v
-0.083333 -0.083333 9.10-11
D v
-0.166666 -0.166666 9.10-11

zz
-1. -1. 1.10-11

---

15 Summary of the results

The elements of order 2 give the analytical solution.

The elements of order 1 converge slowly towards the solution and require very fine grids.
Times calculations remain however reasonable.

Titrate:
SSLV110 - Elliptic crack in an infinite medium

Date:
15/02/06
Author (S):
E. GALENNE, X. DESROCHES Key
:
V3.04.110-C Page:
1/14

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.110

SSLV110 - Elliptic crack in an infinite medium

Summary:

It is about a test in statics for a three-dimensional problem. This test makes it possible to calculate the rate of refund
of energy total and local on the bottom of crack by the method.

The rays of the crowns of integration are variable along the crack, and the rate of refund of energy room is calculated according to 2 different methods (LEGENDRE and LAGRANGE).

The interest of the test is the validation of the method in 3D and the following points:

- *comparison between the results and an analytical solution,*
- *stability of the results according to the crowns of integration,*
- *comparison between 2 methods different for calculation from G local,*
- *2 cases of equivalent loadings (pressure distributed and voluminal loading).*

This test contains 4 different modelings.

The 3rd modeling tests the derivative of G compared to the parameters material and loading.

1
Problem of reference

1.1 Geometry

It is about an elliptic crack plunged in a presumedly infinite medium. Only one eighth is modelled *of a parallelepiped:*

y
P
Z
X
120 mm
6 mm
m
0
1250 m
25 mm
725 mm

0: melts of elliptic crack

1.2 Properties
materials

E= 210.000.MPa

= 0.3

1.3
Boundary conditions and loadings

Symmetry compared to the 3 principal plans:

Ux = 0. in the plan X = 0.

UY = 0. in the plan Y = 0.

UZ = 0. in the plan Z = 0. out of the crack

The conditions of loadings are is:

P = 1 MPa in the plan Z = 1250 mm (modelings A and B)

that is to say:

FZ = 8.104 N/mm3 on all the elements of volume (loading are equivalent to the precedent)
(modelings C and D).
Handbook of Validation

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is an analytical solution resulting from SIH [bib1] and [bib2].

It is noted that the angle indicates here the parametric angle of the point M (angle compared to axis OX of
projected M on the circle of radius b) and not the polar co-ordinate of this point.

1/4
1/2
K
1
b2

b2
I
=
2
sin +

2
cos
with K = 1

B
E (K)
a2

has

2

/2
1/2
E (K) = (1 - k2 2
sin) D
0

Here: = 25 mm B = 6 mm have, therefore K = 0,9707728

The values of the elliptic integrals E (K) are tabulées in [bib3], according to asin (K) which is worth here 76,11°. One finds then: E (K) = 1,0672.
1 4

B ²

From where the factor of intensity of the constraints in MPa.mm: K () =
0680
,
4
sin ² +
cos ²

I

² has

1

(- ²)
Then, starting from the formula of Irwin (plane deformation): G () =
K I () 2
E

The total rate of refund of Gref energy is calculated by integration of G (): Gref = 5,76.10-3 J/mm.

Derived from G (modeling C):
For the derivative of G compared to the Young modulus E, one can write:

G

G
G =
(with =
,
302 4) thus
= -
E
E

E

In addition, while varying the Fz loading, one finds:

2
G
G = F
with =
9
,
2276 thus
= F

2

Z
Z
F
Z

2.2 Bibliography

[1]
G.C. SIH: Mathematical Theories of Brittle Fractures - FRACTURE, flight II - Academic Press - 1968
[2]
M.K. KASSIN and G.C. SIH: Three-dimensional stress distribution around year elliptical ace under arbitrary loadings J. Appl. Mech., 88, 601-611, 1966.
[3]
H. TADA, P.PARIS, G. IRWIN: The Stress Analysis of Cracks Handbook - Third Edition - International ASM - 2000

---

3 Modeling
With

3.1
Characteristics of modeling

With = N01099 (S = 0.)
B = N01259 (S = 26.68)
C = N01179 (S = 17.8; =/4)

C1
C2
C3
With
C
Z
Y
B
X

Loading: Unit pressure distributed on the face of the block opposed to the plan of the lip:

P = 1.MPa in the plan Z = 1250.mm.

3.2
Characteristics of the grid

A number of nodes: 1716
A number of meshs and types: 304 PENTA15 and 123 HEXA20

3.3 Functionalities
tested

Orders

DEFI_FOND_FISS LEVRE_SUP
GROUP_MA ALL

CALC_THETA FOND_3D

THETA_3D

CALC_G_THETA_T RESULT
TOUT_ORDRE

NUME_ORDRE

LIST_ORDRE

CALC_G_LOCAL_T
“THETA_LEGENDRE”
DEGREE = 7

“G_LEGENDRE”

R_INF_FO/R_SUP_FO

AFFE_CHAR_MECA FORCE_FACE

3.4 Remarks

The degree of the polynomials of LEGENDRE used to calculate G (S) is 7 (maximum value Aster).

For the 3 crowns of integration, rays R_INF and R_SUP vary linearly along the bottom of fissure.

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4
Results of modeling A

4.1 Values tested

The values tested are:

- *the total rate of refund of energy G,*
- *the rate of refund of energy room G in all the nodes of the bottom of crack.*

The grid includes/understands only one of the lips of the crack, it is thus necessary to use key word "SYME_CHAR" automatically to multiply by 2 in calculation Aster the rate of refund of energy calculated by virtual extension of the single lip.

In the same way, G total calculated here corresponds to the quarter of G of reference defined previously, only one eighth of parallelepiped being represented.

Identification Reference
Aster *%*
difference

G Crown C1
1.44 10-3 1.410
10-3
-2.1
G Crown C2
1.44 10-3 1.451
10-3
0.8
G Crown C3
1.44 10-3 1.424
10-3
-1.1

G (A) crowns C1 7.171
10-5
6.829 10-5
-4.8
G (A) crowns C2 7.171
10-5
7.239 10-5
0.95
G (A) crowns C3 7.171
10-5
6.864 10-5
-4.3

G (B) crowns C1 1.721
10-5
1.48 10-5
-13.8
G (B) crowns C2 1.721
10-5
1.57 10-5
-8.7
G (B) crowns C3 1.721
10-5
1.90 10-5

-6.9

G (C) crown C1 5.215
10-5
4.992 10-5
-4.3
G (C) crown C2 5.215
10-5
5.124 10-5
-1.7
G (C) crown C3 5.215
10-5
5.013 10-5
-3.9

4.2 Notice

The results are rather stable between the crowns safe at the point B where the variation of G (S) is more large and results far away from the reference solution. One can explain this variation by the grid of poor quality.

---

5 Modeling
B

5.1
Characteristics of modeling

With = N01099 (S = 0.)
B = N01259 (S = 26.68)
C = N01179 (S = 17.8)

C1
C2
C3
With
C
Z
Y
B
X

Loading: *Unit pressure distributed on the face of the block opposed to the plan of the lip:*

P = 1 MPa in the plan Z = 1250 Misters.

5.2
Characteristics of the grid

A number of nodes: 1716
A number of meshs and types: 304 PENTA15 and 123 HEXA20

5.3 Functionalities
tested

Orders

DEFI_FOND_FISS LEVRE_SUP
GROUP_MA

CALC_THETA FOND_3D

THETA_3D

CALC_G_THETA_T

CALC_G_LOCAL_T “THETA_LAGRANGE”

“G_LEGENDRE”
DEGREE = 4

R_INF_FO/R_SUP_FO

AFFE_CHAR_MECA FORCE_FACE

5.4 Remarks

“THETA_LAGRANGE”: the field is discretized starting from the functions of forms of the nodes of the bottom
of crack, but G (S) is always discretized starting from the polynomials of LEGENDRE.

The degree of the polynomials of LEGENDRE used to calculate G (S) is 4 [R7.02.01].

For the 3 crowns of integration, rays R_INF and R_SUP vary linearly along the bottom of fissure.

6
Results of modeling B

6.1 Values tested

The values tested are:

- *the total rate of refund of energy G,*
- *the rate of refund of energy room G in all the nodes of the bottom of crack.*

The grid includes/understands only one of the lips of the crack, it is thus necessary to use key word "SYME_CHAR" automatically to multiply by 2 in calculation Aster the rate of refund of energy calculated by virtual extension of the single lip.

In the same way, G total calculated here corresponds to the quarter of G of reference defined previously, only one eighth of parallelepiped being represented.

Identification Reference
Aster %
difference

G Crown C1
1.44 10-3 1.410
10-3
-2.1
G Crown C2
1.44 10-3 1.451

10-3
0.8
G Crown C3
1.44 10-3 1.424
10-3
-1.1

G (A) crowns C1 7.171
10-5 7.120
10-5 -0.7
G (A) crowns C2 7.171
10-5 7.452
10-5 3.9
G (A) crowns C3 7.171
10-5 7.431
10-5 3.6

G (B) crowns C1 1.721
10-5 1.608
10-5 -6.6
G (B) crowns C2 1.721
10-5 1.662
10-5 -3.4
G (B) crowns C3 1.721
10-5 1.706
10-5 -0.9

G (C) crown C1 5.215
10-5 4.978
10-5 -4.5
G (C) crown C2 5.215
10-5 5.096
10-5 -2.3
G (C) crown C3 5.215
10-5 5.014
10-5 -3.9

6.2 Notice

The results are better than in modeling A at the point B, but the disparity between crowns remains strong.

---

7 Modeling
C

7.1
Characteristics of modeling

With = N01099 (S = 0.)
B = N01259 (S = 26.68)
C = N01179 (S = 17.8)

C1
C2
C3
With
C
Z
Y

B
X

Loading: Voluminal force FZ equivalent to a unit pressure on the face of the block opposed to plan of the lip:

FORCE_INTERNE: FZ = 8.104 N/mm3 on all the elements of volume.

7.2
Characteristics of the grid

A number of nodes: 1716
A number of meshs and types: 304 PENTA15 and 123 HEXA20

7.3 Functionalities
tested

Orders

DEFI_FOND_FISS LEVRE_SUP
GROUP_MA

CALC_THETA FOND_3D

THETA_3D

CALC_G_THETA_T SENSITIVITY

CALC_G_LOCAL_T
"THETA_LEGENDRE"
DEGREE = 7

"G_LEGENDRE"

R_INF_FO/R_SUP_FO

AFFE_CHAR_MECA FORCE_INTERNE

7.4 Remarks

The degree of the polynomials of LEGENDRE used to calculate G (S) is 7 (maximum value Aster).

For the 3 crowns of integration, rays R_INF and R_SUP vary linearly along the bottom of fissure.

8
Results of modeling C

8.1 Values tested

The values tested are:

.
the total rate of refund of energy G,

·
the rate of refund of energy room G in all the nodes of the bottom of crack,
·
the derivative of G compared to E and to the loading in voluminal force Fz.

The grid includes/understands only one of the lips of the crack, it is thus necessary to use key word "SYME_CHAR"
automatically to multiply by 2 in calculation Aster the rate of refund of energy calculated
by virtual extension of the single lip.

In the same way, G total calculated here corresponds to the quarter of G of reference defined previously, only one
eighth of parallelepiped being represented.

Identification Reference
Aster %
difference

G Crown C1
1.44 10-3 1.437
10-3
-0.2
G Crown C2
1.44 10-3 1.479
10-3
2.7
G Crown C3
1.44 10-3 1.450
10-3
0.7

G (A) crowns C1 7.171
10-5 6.962
10-5 -2.9
G (A) crowns C2 7.171
10-5 7.379
10-5 +2.9
G (A) crowns C3 7.171

10-5 6.997
10-5 -2.4

G (B) crowns C1 1.721
10-5 1.509
10-5 -12.2
G (B) crowns C2 1.721
10-5 1.598
10-5 -7.1
G (B) crowns C3 1.721
10-5 1.629
10-5 -5.2

G (C) crown C1 5.215
10-5 5.085
10-5 -2.5
G (C) crown C2 5.215
10-5 5.219
10-5 0.1
G (C) crown C3 5.215
10-5 5.107
10-5 -2.1

DG/dE crowns C1
-6.8610 10-9 -6.842
10-9
-0.2
DG/dE crowns C2
-6.8610 10-9 -7.041
10-9
2.7
DG/dE crowns C3
-6.8610 10-9 -6.907
10-9
0.7

DG/dFz crowns C1 3.599 3.592
-0.1
DG/dFz crowns C2 3.599 3.697
2.7
DG/dFz crowns C3 3.599 3.629
0.9

8.2 Notice

The results are rather stable between the crowns. One always notes worse results with node B.
The errors on the derivative of G are comparable with those on G.

---

9 Modeling
D

9.1
Characteristics of modeling

With = N01099 (S = 0.)
B = N01259 (S = 26.68)

C = N01179 (S = 17.8)

C1
C2
C3
With
C
Z
Y
B
X

Loading: Voluminal force Fz equivalent to a unit pressure distributed on the face of the block opposed to the plan of the lip:

FORCE_INTERNE: FZ = 8.104 N/mm3 on all the elements of volume.

9.2
Characteristics of the grid

A number of nodes: 1716
A number of meshs and types: 304 PENTA15 and 123 HEXA20

9.3 Functionalities
tested

Orders

DEFI_FOND_FISS LEVRE_SUP
GROUP_MA
CALC_THETA FOND_3D

THETA_3D

CALC_G_THETA_T

CALC_G_LOCAL_T "THETA_LAGRANGE"

“G_LEGENDRE”
DEGREE = 7

R_INF_FO/R_SUP_FO

AFFE_CHAR_MECA FORCE_INTERNE

9.4 Remarks

“THETA_LAGRANGE”: the field is discretized starting from the functions of forms of the nodes of the bottom
of crack, but G (S) is always discretized starting from the polynomials of LEGENDRE.

The degree of the polynomials of LEGENDRE used to calculate G (S) is 7.

For the 3 crowns of integration, rays R_INF and R_SUP are supposed to vary linearly on
bottom of crack.

---

10 Results of modeling D

10.1 Values tested

The values tested are:

- ***the total rate of refund of energy G,***
- ***the rate of refund of energy room G in all the nodes of the bottom of crack.***

The grid includes/understands only one of the lips of the crack, it is thus necessary to use key word "SYME_CHAR" automatically to multiply by 2 in calculation Aster the rate of refund of energy calculated by virtual extension of the single lip.

In the same way, G total calculated here corresponds to the quarter of G of reference defined previously, only one eighth of parallelepiped being represented.

Identification Reference Aster % difference

G Crown C1 1.44 10-3 1.437 10-3 -0.2
G Crown C2 1.44 10-3 1.479 10-3 2.7
G Crown C3 1.44 10-3 1.450 10-3 0.7

G (A) crowns C1 7.171

10-5 7.259
10-5 1.2
G (A) crowns C2 7.171
10-5 7.597
10-5 5.9
G (A) crowns C3 7.171
10-5 7.575
10-5 5.7

G (B) crowns C1 1.721
10-5 1.636
10-5 -4.9
G (B) crowns C2 1.721
10-5 1.992
10-5 -1.7
G (B) crowns C3 1.721
10-5 1.734
10-5 0.7

G (C) crown C1 5.215
10-5 5.071
10-5 -2.7
G (C) crown C2 5.215
10-5 5.192
10-5 0.4
G (C) crown C3 5.215
10-5 5.108
10-5 -2.1

10.2 Notice

The results are better than in modeling C at the point B.

---

11 Summary of the results

Calculation of G local:

- *2 methods (LEGENDRE and LAGRANGE) give the same results appreciably (less than 5% of error compared to the analytical solution) except at the point B (not end ellipse on the large axis) where the Lagrange method is most precise,*
- *loading case: the values obtained with the voluminal loading are slightly higher than those obtained with imposed constraints (including for the values of G). The differences are tiny and due to numerical integrations different on the term from volume and the term of edge.*

Calculation of derived from G:

- *the errors on the derivative of G are weak and comparable with those on G.*

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X. DESROCHES

Organization (S): EDF/IMA/MMN

Document: V3.04.111

SSLV111 - Estimator of error on a plate perforated in linear elasticity

Summary:

This test validates and compares the 2 versions of the estimator of error of Zhu-Zienkiewicz (version 1 of 1987, noted ZZ1, and version 2 of 1992, noted ZZ2) applied to the system of linear elasticity, in statics.

It comprises 5 modelings in plane constraints, corresponding each one to a type of finite element (TRIA3, QUAD4, TRIA6, QUAD8, QUAD9).

The analytical solution is known and makes it possible to compare the errors estimated with the exact error.

The interest of the test resides:

* *in the comparison enters the constraints smoothed with ZZ1 (continuous total smoothing) and ZZ2 (smoothing room with patchs of elements),*
* *in the comparison of the estimators between them,*
* *in the qualitative and quantitative analysis of the results (relative errors total and local).*

The test highlights the good behavior of ZZ2 on all the types of elements and the bad results of ZZ1 on quadratic elements when the solution does not present a strong singularity, which is the case.

---

1 Problem of reference

1.1 Geometry

y
= 1.0
= 1.0
B
C
X
With
D
E
has
( )
y
B
C
With
R
X
E
D
1.0
3.0
(H)

1.2 Material properties

E = 1.000 MPa
= 0.3.

1.3 Boundary conditions and loadings

On AB, *U*
=
X
0
On ED, *U* =
y
0
F

= (*X* = 4)
X
xx
.
On CD tractions *F* = (*X* = 4)
y
xy

.
F =
=
X
xy (*y*
4).
On BC tractions *F* =
=
y
yy (*y*

4)

.
According to the analytical solution [2].

---

2 Reference solution

2.1 Method of calculation used for the reference solution

One considers a portion of an infinite plate with a circular central hole, subjected to a loading
&
&
unit one-way in the direction *OX* = 1 *E E*
X
X.
The analytical solution of this problem is [bib1]:
2
4

has 3
3 *A*
= 1-
cos +
xx
cos (
4)
cos (
4)

r2

2

+ 2 *r4*
2
4

has
= -
1 cos (
3 *A*
2
-
yy
) cos (
4)
cos (
4)
r2

2

- 2 *r4*
2
4

has
= -
1 sin (
3 *A*
2
+
xy
) sin (
4)
sin (
4)
r2

2

+ 2 *r4*
where:

.
A is the ray of the hole,
.
(*R*,) polar co-ordinates.

2.2

Uncertainty on the solution

Analytical solution.

2.3 References
bibliographical

[1]
Zhu-Zienkiewicz: The superconvergent patch recovery and a posteriori error estimates -
1 leaves: the technical recovery (Int. J. for Num. Methods in Engineering vol. 33, p. 1355
(May 1992)).

---

3 Modeling
With

3.1
Characteristics of modeling

3.2
Characteristics of the grid

A number of nodes: 357.
A number of meshs and types: 640 TRIA3.

3.3 Functionalities
tested

Orders
Keys
MECA_STATIQUE
OPTION

"SIEF_ELGA_DEPL"
[U4.31.01]
CALC_ELEM
OPTION
"ERRE_ELEM_NOZ1"
[U4.61.02]
OPTION
"ERRE_ELEM_NOZ2"
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

---

4 Results of modeling A

4.1 Values tested

Identification	Reference	Aster	% difference	tolerance
To *xx* ZZ1	3.	2.823	5.91	0.1
xx ZZ2	3.	2.884	3.85	0.1

yy ZZ1
0.
0.261
-
0.3
yy ZZ2
0.
0.207
-
0.3
xy ZZ1
0.
7.4 103
-
0.1
xy ZZ2
0.
6.1 102
-
0.1
P *xx* ZZ1
1.15625
1.152
0.37
0.1
xx ZZ2
1.15625
1.145
0.98
0.1
yy ZZ1
0.15625
0.150
3.81
0.1
yy ZZ2
0.15625
0.145
7.00
0.1
xy ZZ1
0.125
0.117

6.11
0.1
xy ZZ2
0.125
0.124
0.68
0.1
Net M1 *eabs* ZZ1
1.33 104
1.103
eabs ZZ2
8.13 105
1.103
erel ZZ1
6.63%
0.1
erel ZZ2
4.05%
0.1
eabs ZZ1
0.445 102
0.424 102
4.76
eabs ZZ2
0.445 102
0.451 102
+1.31
erel ZZ1
3.44%
3.28%
erel ZZ2
3.44%
3.49%
ZZ1
0.952
ZZ2
1.013

4.2 Remarks

= estimated error is an indication of effectivity of the estimator.
exact error

Contents of the files results:

· absolute errors and relative total by the 2 methods,
· maximum and minimal values of the constraints and the errors,

· lists of the meshs where the relative error is higher than 10%.

4.3 Parameters
of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
19.0 seconds

---

5 Modeling B

5.1 Characteristics of modeling

5.2 Characteristics of the grid

A number of nodes: 357.
A number of meshs and types: 320 QUAD4.

5.3 Functionalities tested

Orders
Keys
MECA_STATIQUE
OPTION
“SIEF_ELGA_DEPL”
[U4.31.01]

---

6 Results of modeling B

6.1 Values tested

Identification	**Reference**	**Aster**	**% difference**	**tolerance**
To *xx* ZZ1	3.	3.017	0.57	0.1
xx ZZ2	3.	2.971	- 0.95	0.1
yy ZZ1	0.			

0.17
-
0.3
yy ZZ2
0.
0.136
-
0.3
xy ZZ1
0.
2.8 103
-
0.1
xy ZZ2
0.
1.04 102
-
0.1
P *xx* ZZ1
1.15625
1.168
0.98
0.1
xx ZZ2
1.15625
1.153
0.26
0.1
yy ZZ1
0.15625
0.158
1.28
0.1
yy ZZ2
0.15625
0.152
2.83
0.1
xy ZZ1
0.125
0.121
2.99
0.1

xy ZZ2
0.125
0.124
0.94
0.1
Net M1 *eabs* ZZ1
1.57 104
1.103
eabs ZZ2
2.40 104
1.103
erel ZZ1
5.79%
0.1
erel ZZ2
8.83%
0.1
eabs ZZ1
0.320 102
0.294 102
8.1
eabs ZZ2
0.320 102
0.307 102
4.2
erel ZZ1
2.48%
2.28%
erel ZZ2
2.48%
2.37%
ZZ1
0.919
ZZ2
0.958

6.2 Remarks

= estimated error is an indication of effectivity of the estimator.
exact error

Contents of the files results:

· absolute errors and relative total by the 2 methods,
· maximum and minimal values of the constraints and the errors,
· lists of the meshs where the relative error is higher than 10%.

6.3 Parameters

of execution
Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
13.4 seconds

---

7 Modeling
C

7.1
Characteristics of modeling

7.2
Characteristics of the grid

A number of nodes: 357.
A number of meshs and types: 160 TRIA6.

7.3 Functionalities
tested

Orders
Keys
MECA_STATIQUE
OPTION
“SIEF_ELGA_DEPL”
[U4.31.01]
CALC_ELEM
OPTION

"ERRE_ELEM_NOZ1"
[U4.61.02]
OPTION
"ERRE_ELEM_NOZ2"
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

8
Results of modeling C
8.1 Values
tested
Identification
Reference
Aster
% difference
tolerance
To *xx* ZZ1
3.
2.975
0.83
0.1
xx ZZ2
3.
2.957
1.43
0.1
yy ZZ1
0.
6.86 102
-

0.3
yy ZZ2
0.
7.52 102
-
0.3
xy ZZ1
0.
3.12 102
-
0.3
xy ZZ2
0.
0.155
-
0.3
P *xx* ZZ1
1.15625
1.166
0.85
0.1
xx ZZ2
1.15625
1.153
0.25
0.1
yy ZZ1
0.15625
0.167
6.92
0.1
yy ZZ2
0.15625
0.153
1.87
0.1
xy ZZ1
0.125
0.127
1.52
0.1
xy ZZ2
0.125

0.124
0.58
0.1
Net M1 *eabs* ZZ1
1.81 104
1.103
eabs ZZ2
2.92 104
1.103
erel ZZ1
4.69%
0.1
erel ZZ2
7.56%
0.1
eabs ZZ1
0.152 102
0.123 102
19
eabs ZZ2
0.152 102
0.167 102
+9.9
erel ZZ1
1.17%
0.95%
erel ZZ2
1.17%
1.29%
ZZ1
0.810
ZZ2
1.099

8.2 Remarks

= estimated error is an indication of effectivity of the estimator.
exact error

Contents of the files results:

· absolute errors and relative total by the 2 methods,
· maximum and minimal values of the constraints and the errors,
· lists of the meshs where the relative error is higher than 10%.

8.3 Parameters
of execution

Version: 3.02.11

Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
10.4 seconds
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

---

9 Modeling
D

9.1
Characteristics of modeling

9.2
Characteristics of the grid

A number of nodes: 277.
A number of meshs and types: 80 QUAD8.

9.3 Functionalities
tested

Orders
Keys
MECA_STATIQUE
OPTION
“SIEF_ELGA_DEPL”
[U4.31.01]
CALC_ELEM
OPTION
“ERRE_ELEM_NOZ1”
[U4.61.02]

10 Results of modeling D

10.1 Values tested

Identification	Reference	Aster	% difference	tolerance
To *xx* ZZ1	3.	3.063	2.11	0.1
xx ZZ2	3.	3.037	1.24	0.1
yy ZZ1	0.	0.101	-	0.3
yy ZZ2	0.	2.47 102	-	0.3
xy ZZ1	0.			

5.8 103
-
0.3
xy ZZ2
0.
2.41 102
-
0.3
P *xx* ZZ1
1.15625
1.170
1.19
0.1
xx ZZ2
1.15625
1.153
0.29
0.1
yy ZZ1
0.15625
0.162
3.54
0.1
yy ZZ2
0.15625
0.153
1.87
0.1
xy ZZ1
0.125
0.124
1.09
0.1
xy ZZ2
0.125
0.124
0.84
0.1
Net M1 *eabs* ZZ1
6.1 105
1.103
eabs ZZ2
2.1 104

1.103
erel ZZ1
1.45%
0.1
erel ZZ2
5.01%
0.1
eabs ZZ1
9.01 104
2.90 104
+67.9 (!)
eabs ZZ2
9.01 104
8.88 104
1.5
erel ZZ1
0.697%
0.22%
erel ZZ2
0.697%
0.687%
ZZ1
0.321
ZZ2
0.985

10.2 Remarks

= estimated error is an indication of effectivity of the estimator
exact error

Contents of the files results:

· absolute errors and relative total by the 2 methods,
· maximum and minimal values of the constraints and the errors,
· lists of the meshs where the relative error is higher than 10%.

10.3 Parameters
of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.6 seconds
Handbook of Validation

---

11 Modeling E

11.1 Characteristics of modeling

11.2 Characteristics of the grid

A number of nodes: 357.
A number of meshs and types: 80 QUAD9.

11.3 Functionalities tested

Orders		Keys	
MECA_STATIQUE	OPTION	"SIEF_ELGA_DEPL"	[U4.31.01]
CALC_ELEM	OPTION	"ERRE_ELEM_NOZ1"	[U4.61.02]
	OPTION	"ERRE_ELEM_NOZ2"	

12
Results of modeling E
12.1 Values
tested
Identification
Reference
Aster
% difference
tolerance
To *xx* ZZ1
3.
3.070
2.33
0.1
xx ZZ2
3.
3.004
0.14
0.1
yy ZZ1
0.
0.113
-
0.3
yy ZZ2
0.
0.04
-
0.3
xy ZZ1
0.
1.4 103
-
0.1
xy ZZ2

0.
1.89 102
-
0.1
P *xx* ZZ1
1.15625
1.170
1.19
0.1
xx ZZ2
1.15625
1.152
0.33
0.1
yy ZZ1
0.15625
0.162
3.44
0.1
yy ZZ2
0.15625
0.153
2.11
0.1
xy ZZ1
0.125
0.124
1.06
0.1
xy ZZ2
0.125
0.124
0.94
0.1
Net M1 *eabs* ZZ1
6.1 105
1.103
eabs ZZ2
2.1 104
1.103
erel ZZ1
1.45%
0.1

erel ZZ2
5.01%
0.1
eabs ZZ1
8.99 104
2.75 104
+69.4 (!)
eabs ZZ2
8.99 104
8.55 104
4.9
erel ZZ1
0.695%
0.21%
erel ZZ2
0.695%
0.66%
ZZ1
0.306
ZZ2
0.951

12.2 Remarks

= estimated error is an indication of effectivity of the estimator
exact error

Contents of the files results:

· absolute errors and relative total by the 2 methods,
· maximum and minimal values of the constraints and the errors,
· lists of the meshs where the relative error is higher than 10%.

12.3 Parameters
of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
8.8 seconds

13
Summary of the results
TRIA3
QUAD4
TRIA6
QUAD8
QUAD9
E
exact
3.44%
2.48%
1.17%
0.697%
0.695%
rel
ZZ1
3.28%
2.28%
0.95%
0.22%
0.21%
ZZ2
3.49%
2.37%
1.29%
0.687%
0.66%

ZZ1
0.952
0.919
0.810

0.321
0.306
ZZ2
1.013
0.958
1.099
0.985
0.951
The constraints with the nodes, as a whole, are approximated better with ZZ2, especially for the elements
ex
*
of order 2. If one makes tighten *H* towards 0, the rates of convergence with H of
- are higher by
method ZZ2 for all the types of elements to those of method ZZ1 (* is the smoothed constraint).
Estimator ZZ1 is not reliable for the elements of order 2, the nodal constraints remain correct. One can
to check in this particular case that 0 when *H* 0, which shows that continuous total smoothing proves
insufficient to estimate the error in the case of a solution without singularities (case of this test).
ZZ2 is on the other hand reliable and asymptotically exact (1 when *H* 0).

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Titrate:
SSLV112 - Calculation of G local by a Lagrangian method
Date:
17/02/02
Author (S):
***G. DEBRUYNE**, C. Key DURAND*
:
V3.04.112-B Page:
1/8

Organization (S): EDF/AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.112

SSLV112 - Calculation of G by the method Lagrangian for a circular crack

Summary

It is about a test in statics for a three-dimensional problem. This test allows the calculation of the rate of refund of
energy room by the Lagrangian method of propagation for an initial crack quasi-circular plunged in a presumedly infinite medium. One transforms it into circular crack of more important ray.

The interest of the test is to study the validity of the calculation of the rate of refund of energy room

after extension of
fissure. It is also to be able to calculate the rate of refund of energy starting from a grid fixed on one fissure variable geometry (in elasticity). Methods of calculation of G_LOCAL, THETA_LAGRANGE and of
THETA_LEGENDRE are used.

The test includes/understands two modelings.

1
Problem of reference

1.1 Geometry

Z
= 1.
G
H
I
F
O
B
E
Y
With
C

X
D

Large initial axis: OA = 35 mm

Small initial axis: OB = 33.95 mm

SupX = Face OEGH

SupY = Face OCIH

Supfissz: Face ABEDC

mailpress: Face IFGH

1.2
Material properties

Young modulus: E = 2.105 MPa

Poisson's ratio: = 0.3

1.3
Boundary conditions and loadings

Face OEGH: ux = 0

Face OCIH: uy = 0

Face ABEDC: uz = 0

Face IFGH: uniform constraint of traction Z = 1 MPa

2
Reference solution

2.1
Method of calculation used for the reference solution

has

For a circular crack of ray has in an infinite medium, the rate of refund of energy G is equal to
:

(1- 2)
G =
4 2
has

E

Numerical application:

Initially, the crack is not strictly circular (OA = 35 mm, OB = 33.95 mm).

One transforms it into circular crack of ray has = 42 mm without touching with the grid, (it is the goal of
this method) but while forming on the modules of the field theta in each node of the bottom. One has then
NR
in any point G =
-
2.433 10 4
.

.
mm

2.2 Results of reference

Values of G local in bottom of crack.

The solutions given in the "handbook" of SIH give the value of KI divided by by report/ratio with the traditional definition [bib1].

2.3 References bibliographical

[1]
Solution of Sneddon (1946) in G.C. SIH: Handbook of stress-intensity factors Institute of Fracture and Solid Mechanics - Lehigh University Bethlehem, Pennsylvannie

---

3 Modeling a: method THETA_LAGRANGE

3.1 Characteristics of modeling

Z
Y
X

3.2
Characteristics of the grid

A number of nodes: 1754

A number of meshs and types: 304 PENTA 15 and 131 HEXA 20

3.3 Functionalities
tested

Orders

MECHANICAL AFFE_MODELE
3D
ALL

CALC_MATR_ELEM OPTION
"RIGI_MECA_LAGR"

CALC_G_LOCAL_T "THETA_LAGRANGE"

PROPAGATION: 1

DEGREE: 4

3.4 Notice

The initial crack is not circular (OA = 35 mm, OB = 33.95 mm) but the transformation Lagrangian makes it circular thanks to the field theta of module different from 1 in each node from melts of crack (OA = OB = 42 mm in the final configuration).

.

The degree of the polynomials of LEGENDRE used to calculate G (S) is 4.

4
Results of modeling A

4.1 Values
tested

The number between brackets indicates the nth position of the node on the bottom

Identification Reference
Aster %
difference
G local Node A (1)
1.2165 10-4 1.2406
10-4
1.98
G local Node (5)
1.2165 10-4 1.1268
10-4
7.96
G local Node (10)
1.2165 10-4 1.1406
10-4
6.65
G local Node (15)

1.2165 10-4 1.1892
10-4
2.30
G local Node (20)
1.2165 10-4 1.2013
10-4
1.26
G local Node (25)
1.2165 10-4 1.1825
10-4
2.88
G local Node B (33)
1.2165 10-4 1.3042
10-4
7.21

4.2 Notice

In calculation Aster, G local corresponds to the virtual extension of only one lip of the crack
Gréf
NR
(half-crown), the value obtained is thus to compare with
= 12165
.

2
mm

5
Modeling b: method THETA_LEGENDRE

5.1
Characteristics of modeling

Z
Y
X

5.2
Characteristics of the grid

A number of nodes: 1754

A number of meshs and types: 304 PENTA 15 and 131 HEXA 20

5.3 Functionalities
tested

Orders

MECHANICAL AFFE_MODELE
3D
ALL
CALC_MATR_ELEM OPTION
"RIGI_MECA_LAGR"

CALC_THETA THETA_3D

CALC_G_LOCAL_T "THETA_LEGENDRE"

PROPAGATION: 1

DEGREE: 4

5.4 Notice

The initial crack is not circular (OA = 35 mm, OB = 33.95 mm) but the transformation Lagrangian makes it circular thanks to the field theta of module different from 1 in each node from melts of crack (OA = OB = 42 mm in the final configuration).

.

The degree of the polynomials of LEGENDRE used to calculate G (S) is 4.

6
Results of modeling B

6.1 Values tested

The number between brackets indicates the nth position of the node on the bottom

Identification	***Reference***	***Aster***	*% **difference***
G local Node A (1)	*1.2165 10-4*	*1.1455 10-4*	*6.20*
G local Node (5)	*1.2165 10-4*	*1.1258 10-4*	*8.06*
G local Node (10)	*1.2165 10-4*	*1.1476 10-4*	*6.00*
G local Node (15)	*1.2165 10-4*	*1.1797 10-4*	*3.12*
G local Node (20)	*1.2165 10-4*	*1.1974 10-4*	*1.60*
G local Node (25)	*1.2165 10-4*	*1.1960 10-4*	*1.71*
G local Node B (33)	*1.2165 10-4*	*1.1929 10-4*	*1.98*

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

7
Summaries of the results

Calculation of G local:

.
2 methods (THETA_LEGENDRE and THETA_LAGRANGE) give the same ones appreciably results (8% of error to the maximum compared to the analytical solution),
.
the precision of the results is average because the extension of the crack is approximately 1.2, which is close to the maximum of extension reasonable for this method for a crack 3D,
.
method LEGENDRE is less expensive in time CPU.

Organization (S): EDF/IMA/MMN
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
V3.04.113 document
SSLV113 - Estimator of error on a cylinder
hollow Bi-materials

Summary:

This test validates the estimator of error in pure residue, applied to linear elasticity 2D, in statics. One is considered
hollow roll made up of two materials and subjected to internal and external pressures.
2 modelings are axisymmetric, on quadrangles with 8 nodes.
The interest of the test lies in the comparison between the exact and calculated constraints, on the one hand, the error
estimated and the exact error, in addition. This test also makes it possible to show the validity of the estimator in residue
on a structure bimatériau, contrary to the estimator of Zhu-Zienkiewicz which is not applicable on
structures presenting of discontinuities in the stress field (here with the interface material).

1
Problem of reference

1.1 Geometry

Z
With
D
C
1
chechmate. 1

chechmate. 2
p
Q
With
E
B
0.
1.
3/2
2.
R

1.2
Material properties

chechmate. 1:
E = 2.
= 0 3
.
chechmate. 2:
E = 1.
= 0 3
.

1.3
Boundary conditions and loadings

On AB, UZ = 0.
on cd., UZ = 0.91333 = A.
Pressure interns on AD, p = 1.
External pressure on BC, Q = 2.

2
Reference solution
2.1
Method of calculation used for the reference solution

μ
I
E
=
I
(
2 1 +)

I
E
=
I
(1-
2) (1+)
has
= - 0.98097
B
= - 1.11741
1
1
calculated numerical data

has
= - 1.34405
B
= -
2
2
0.30048 starting from the equations of Navier
For the material "I", one a:
B
U
= R has
I
+
R
I
R
U

= A
Z

I
B
=
2
+
+ 2
-
rr
I (ia
) A µi ia

r2

I
B
= 2 + + 2
+
I (
I
has
) A µi ia

r2

= 2
+
+
zz
I ia (I 2 µi) A

2.2
Uncertainty on the solution
Analytical solution.

---

3 Modeling
With

3.1
Characteristics of modeling

M1
M2
M3
M4
With
E
B

3.2
Characteristics of the grid

A number of nodes: 23.
A number of meshs and types: 4 QUAD8.

3.3 Functionalities
tested

Orders
Keys
CALC_ELEM
OPTION
“SIRE_ELNO_DEPL”
[U4.61.02]
OPTION
“ERRE_ELGA_NORE”

---

4 Results of modeling A

4.1 Values tested

Identification	Reference	Aster	% difference	tolerance
With	1.00003	1.06833	6.83	7.0
rr				
	4.43821	4.46731	0.66	2.0
	0.19518	0.16596	14.9	15.0
zz				
E	2.37%	5.0		
rel				

E chechmate. 1
1.95508
1.97893
1.22
2.0
rr

3.48316
3.49330
0.29
2.0

0.19518
0.18498
5.22
6.0
zz
E
1.05%
5.0
rel
E chechmate. 2
1.95508
1.98398
1.48
2.0
rr

2.16049
2.13394
1.23
2.0

0.32135
0.32204
0.22
2.0
zz
E
0.152%
5.0
rel
B
1.99999

2.00095
0.048
2.0
rr

2.11555
2.11595
0.012
2.0

0.32135
0.32174
0.12
2.0
zz
E
0.057%
5.0
rel

4.2 Remarks

Grid being coarse (4 elements according to Gold), certain constraints close to the axis of axisymetry are badly approximated. The jump of and zz to the interface of 2 materials are on the other hand well detected.

4.3 Parameters
of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
4.7 seconds

4.4 Remarks

Relative error considered total = 1.40%.

---

5 Modeling
B

5.1
Characteristics of modeling

M1
M10
M20
M11
With
E
B

5.2
Characteristics of the grid

A number of nodes:
A number of meshs and types: 20 QUAD8.

5.3 Functionalities
tested

Orders
Keys
CALC_ELEM
OPTION
"SIRE_ELNO_DEPL"
[U4.61.02]
OPTION
"ERRE_ELGA_NORE"

SSLV113 Estimator of error on a hollow roll Bi-materials
Date:

26/01/98
Author (S):
X. DESROCHES
Key:
V3.04.113-A Page:
7/8

6
Results of modeling B

6.1 Values
tested

Identification
Reference
Aster
% difference
tolerance
With
1.00003
1.00351
0.35
0.5
rr

4.43821
4.43970
0.034
0.05

0.19518
0.19369
0.76
0.8
zz
E
0.57%
0.6
rel
E chechmate. 1
1.95508
1.95583
0.039
0.05
rr

3.48316

3.48347
0.009
0.01

0.19518
0.19486
0.16
0.2
zz
E
0.14%
0.2
rel
E chechmate. 2
1.95508
1.96166
0.34
0.5
rr

2.16049
2.15403
0.299
0.5

0.32135
0.32138
0.009
0.01
zz
E
0.027%
0.03
rel
B
1.99999
2.00003
0.002
0.01
rr

2.11555
2.11558
0.001

0.01

0.32135
0.32135
0.002
0.01
zz
E
0.0084%
0.01
rel

6.2 Parameters of execution

Version: 3.02.11
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 megawords
Time CPU To use:
5.3 seconds

6.3 Notice

Relative error considered total = 0.24%.

---

7 Summary of the results

The estimator of error in residue “ERRE_ELGA_NORE' gives good results on the problems in bi-materials.

Note:

The estimator of error of Zhu-Zienkiewicz does not give correct results. Indeed, with
the interface it detects a strong error because it carries out a continuous smoothing of the constraints whereas it
exist a jump for *zz* and.

Organization (S): EDF/IMA/MMN

Handbook of Validation

V3.04 booklet: Linear statics of the voluminal structures

Document: V3.04.114

SSLV114 - Movements of solid body 2D and 3D

Summary:

This test validates (in 2D and 3D) key word LIAISON_SOLIDE of order AFFE_CHAR_MECA [U4.25.01].
This key word is used to rigidify an expressing whole of nodes by linear relations that displacements "rigidified" nodes are dependent between them by the equation:
(
U *M*) = (
U
)
With + ()
WITH **AMNDT.**
This equation is valid only in small displacements.
The test problem the 2D and the 3D as well as the particular cases:
· geometrically confused nodes (2D and 3D),
· aligned nodes (in 3D).
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

1
Problem of reference
1.1 Geometry
Problem 2D
3D problem
y
Z
J
D
C
M
1
O

2 E1, E2, E3
I
F
NR
Q1, Q2, Q3
K
With
B
L
1
2
3
y
G
1
P
H
X

1.2

Material properties

E = 0
= 0

The finite elements present in this problem are only used to define the ddls carried by the nodes. Their rigidity must be null.

1.3

Boundary conditions and loadings

In this problem, one defines “solid” groups of nodes:

· in 2D:
-
WITH, B, C, D
-
E1, E2, E3

· in 3D:
-
F, G, H, I, J, K, L, M
-
O, NR, P
-
Q1, Q2, Q3

For each one of these groups of nodes, one imposes partial displacements so that them “solid” move while respecting:

2 .

translation: (
T
)
With = (
T *E*)
1 =
in 2D:

3 .
rotation: ()
WITH = (*E*)
1 =

0 0
. 1

2 .

translation: (
T *F*)

= (
T *NR*) = (
T *Q*)
1 = 3
.

4.
in 3D:

0.

001
rotation: (*F*) = (*NR*) = (*Q*) 1= 0.

002

0.

Selected displacements forced to lead to required displacements "solid" are:

2D

DX (A) = 2.
DX (E1) = 2.
DY (A) = 3.
DY (E1) = 3.
DY (B) = 3.001
(+DRZ (E1) = 0.001 for modeling B)

3D

DX (F, NR, Q1) = 2.
DY (F, NR, Q1) = 3.
DZ (F, NR, Q1) = 4.
DY (J, O) = 2.002
DY (J, O) = 2.999
DX (I) = 1.997
+ DRZ (NR) = 0.003
for modeling B
DRX (Q1) = 0.001
DRY (Q1) = 0.002
DRZ (Q1) = 0.003

2 Reference solution

2.1 Method of calculation used for the reference solution

The movement of the "solids" being imposed, the reference solution (in displacement) is it imposed movement.

The reference solution is thus exact (in small rotations).

2.2
Results of reference

1.

999
2 .
In 2D:
U (*C*) =

;
(
U.E. 2) =
3.

001
3 .
1999
.

1998
.

2

.
In 3D:
U (*L*) = 3.

002
;
(
U *P*) = 3 001
.

;
(
U *Q*)
3 = 3
.

3.

999

4.
000

4.
2.3
Uncertainty on the solution
Exact solution.
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

---

3 Modeling
With
3.1
Characteristics of modeling
The finite elements affected on the meshs of the grid are those of modelings D_PLAN and 3D.
ddls carried by the nodes is thus:
DX, DY in 2D,
DX, DY, DZ in 3D
3.2
Characteristics of the grid
A number of nodes: 21
A number of meshs and types: 1 QUAD4, 1 HEXA8, 8 SEG2
3.3 Functionalities
tested
Orders
Keys
AFFE_CHAR_MECA
LIAISON_SOLIDE
[U4.25.01]

4
Results of modeling A
4.1 Values
tested
Identification
Reference
Aster
% difference

DX (C)
1.999
1.999
² 1012
DY (C)
3.001
3.001
² 1012
2D DX (E2)
2.000
2.000
² 1012
DY (E2)
3.000
3.000
² 1012
DX (L)
1.999
1.999
² 1012
3D DY (L)
3.002
3.002
² 1012
DZ (L)
3.999
3.999
² 1012
DX (P)
1.998
1.998
² 1012
DY (P)
3.001
3.001

² 1012
DZ (P)
4.000
4.000
² 1012
DX (Q3)
2.000
2.000
² 1012
DY (Q3)
3.000
3.000
² 1012
DZ (Q3)
4.000
4.000
² 1012

4.2 Parameters
of execution

Version: 3.04
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
5 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

The finite elements affected on the meshs of the grid are those of modelings D_PLAN, COQUE_C_PLAN, 3D and POU_D_E.

· the nodes 2D carry the ddls DX, DY
(+ DRZ for B and E1),
· the nodes 3D carry ddls DX, DY, DZ
(+DRX, DRY, DRZ for I, NR and Q1).

5.2
Characteristics of the grid

A number of nodes: 21
A number of meshs and types: 1 QUAD4, 1 HEXA8, 10 SEG2

5.3 Functionalities
tested

Orders	**Keys**	
AFFE_CHAR_MECA	LIAISON_SOLIDE	[U4.25.01]

6
Results of modeling B

6.1 Values
tested

Identification	**Reference**	**Aster**	**% difference**
DX (C)	1.999	1.999	² 1012
DY (C)	3.001	3.001	² 1012
2D DX (E2)	2.000	2.000	² 1012
DY (E2)	3.000	3.000	² 1012

DX (L)
1.999
1.999
^{2} 1012
3D DY (L)
3.002
3.002
^{2} 1012
DZ (L)
3.999
3.999
^{2} 1012
DX (P)
1.998
1.998
^{2} 1012
DY (P)
3.001
3.001
^{2} 1012
DZ (P)
4.000
4.000
^{2} 1012
DX (Q3)
2.000
2.000
^{2} 1012
DY (Q3)
3.000
3.000
^{2} 1012
DZ (Q3)
4.000
4.000
^{2} 1012

6.2 Parameters of execution

Version: 3.04
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:

8 MW
Time CPU To use:
5 seconds

---

7 Summary of the results

The results are excellent (² 1012).

Organization (S): EDF/AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
Document: V3.04.115

SSLV115 - Concrete element prestressed in
compression and gravity

Summary:

This test allows a simple checking of calculations of gravity for the concrete elements with cables of prestressed, in linear mechanics of the structures static.

The concrete element is voluminal, and the elements of cable of prestressing are elements of bar.

Only one modeling is used: it makes it possible to test the application of gravity on elements of bar, for two directions of gravity.

The values tested are the resultants of the reactions on the supports, equal to the total weight of modeling.

1
Problem of reference

1.1 Geometry

A right-angled parallelepiped modelling the concrete, and a line included in this volume modelling it cable of prestressed:

1101

2101

Z

B
1102

2102

0.6

1001
2001

y

2

1002
X

2002

2

All dimensions are in meters. The surface of the cross sections of the cable is worth A=0.00015m ²

The cable is parallel to axis X. Its intersection with the plan (Oyz) is defined by the item (1. , 0.3).

1.2
Material properties

E = 2.1 1011 Pa for the cable, and E=3.1010 Pa for the concrete.
Rho=2104 kg/m3 for the cable, and the concrete, Rho=3 kg/m3 (nonphysical values intended for to make dominating the weight of the cable)

1.3
Boundary conditions and loadings

DY=0 as in point 1001, DZ=0 for all the nodes of the face z=0, and DX=0 for all the nodes of face x=0.

1 only loading is applied: gravity, with g=10m/s ², successively in direction Z
then X.
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
SSLV115 - Concrete element prestressed in compression and gravity
Date:
23/09/02
Author (S):
***J. Mr. PROIX**, P. BADEL*
Key: V3.04.115-A Page: 3/4

2
Reference solution

2.1
Method of calculation used for the reference solution

· Analytical Solution:

The resultant of the efforts (equal to the total weight) is worth:

-
*weight of the concrete: Pb=V*Rhob*g*
-
*weight of the cable: Pc=A*L*Rhoc*g*

in the direction where gravity is applied.

2.2
Results of reference

· Résultante from the efforts: R=132N

2.3
Uncertainty on the solution

Analytical solution.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/02/001/A

---

3 Modeling With

3.1 Characteristics of modeling

The volume of concrete is modelled by only one element. The cable of prestressing is modelled by 4 elements BARS.

3.2 Characteristics of the grid

4 meshs SEG2, a mesh HEAX8

3.3 Functionalities tested

Orders

AFFE_CARA_ELEM
BAR
DEFI_CABLE_BP

AFFE_CHAR_MECA
GRAVITY

CALC_NO
REAC_NODA
STAT_NON_LINE

COMP_INCR
RELATION
ELAS
POST_RELEVE_T
OPERATION
RESULTANT

4
Results of modeling A

4.1 Values tested

Loading case	***Identification***	***Reference***	***Aster***	*%* ***difference***
gravity according to Z	*Rz*	*132*	*132*	*0*
gravity according to X	*X-ray*	*132*	*132*	*0*

5
Summary of the results

This test, very simple, makes it possible simultaneously to check the correct operation of gravity in elements of bar of prestressing, which is checked by the perfect coincidence of the results with analytical solution. It was introduced following the discovery D `an anomaly on gravity into bars, and makes it possible to validate the correction.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.120

SSLV120 - Stretching of a parallelepiped orthotropic under its own weight

Summary:

This test of mechanics of the structures allows the evaluation of displacements and the constraints of one parallelepiped becoming deformed under its own weight. The material is elastic linear orthotropic. modeling is three-dimensional. The model is similar to test VPCS SSLV07 (but in this case the material is isotropic) and with test SSLV121 (in this case the material is isotropic transverse).

The variations of the results obtained by Aster range between 0,00 and 0,5% of the calculated reference analytically.

1
Problem of reference

1.1 Geometry

Z
X
.
B
With
D
y
E
L
B
X
C
has
Height: L = 3 m
Width: has = 1 m
Thickness: B = 1 m
Co-ordinates of the points (in meters):
With
B
C
D
E
X
X
0.
0.
0.5
0.5
0.
0.
y
0.
0.
0.
0.
0.
0.5
Z
3.
0.
0.
3.

1.5
3.
1.2
Material properties
YOUNG moduli in directions X, y and Z:
E_L = 5. 1011 Pa, E_T = 5. 1011 Pa, E_N = 2. 1011 Pa.
Poisson's ratios in the xy plans, xz and yz:
_LT = 0.1, _LN = 0.3, _TN = 0.1.
Moduli of rigidity in the xy plans, xz and yz:
G_LT = 7.69231 1010 Pa, G_LN = 7.69231 1010 Pa,
G_TN = 7.69231 1010 Pa.
Density: = 7800 kg/m3.
1.3
Boundary conditions and loadings
Not a: (U = v = W = 0, X = y = Z = 0)
Actual weight following axis Z
Uniform constraint with traction for the higher face:
Z = gL = + 229.554. Pa

2
Reference solution
2.1
Method of calculation used for the reference solution
The reference solution results from that given in card SSLV07/89 of guide VPCS (in considering in more one orthotropic elastic matrix). The analytical expression of the solution is following:
Displacements:
_ xz G X Z

_ yz G y Z
G z2 G
G L2
U = -
v = -
W = -
+
(_xzx2 +_yzy2) -
E_ Z
E_ Z
2E_ Z
2E_ Z
2E_ Z
Constraints:
=
=
=
=
=
=
zz
G Z
xx yy xy yz zx 0
Z
X U
.
With
Of
D
L/2
E
L
B
C
X
It
W wB
B'

2.2

Results of reference

Displacement of the points B, C, D, E and X.
Constraints zz of A and E

2.3

Uncertainty on the solution
Exact analytical results.
2.4 References
bibliographical
[1]
TIMOSHENKO (S.P) Theory of elasticity - Paris - Polytechnic Bookshop CH. Béranger,
p.279 with 282 (1961)
[2]
S.W. TSAI, H.T. HAHN - Composite introduction to materials. Technomic Publishing Company
(1980).
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

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3 Modeling
With
3.1
Characteristics of modeling
3D meshs hexa20
Z
B
With
D
y
L
C
X
has
Cutting:
3 in height
2 in width and thickness

Limiting conditions:
on axis AB
DDL_IMPO: (GROUP_NO: ABsansA DX=0., DY=0.)
in A and D
(NODE: WITH DX=0., DY=0., DZ=0.)
(NODE: D DY=0.)
Names of the nodes:
With = N59
B = N53
C = N12
D = N18
E = N56
X = N70

3.2
Characteristics of the grid

A number of nodes: 111
A number of meshs and types: 12 HEXA20

3.3 Functionalities
tested
Orders
Keys

AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
GRAVITY
FORCE_FACE
GROUP_MA
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS_ORTH
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

Code_Aster ®
Version
4.0
Titrate:

4 Results of modeling A

4.1 Values tested

Identification	Reference	Aster	% difference
UB	0.	1022	-
VB	0.	1022	-
WB	1.721655106	1.721674106	0.01
CPU	0.	= 1014	-
VC	0.	= 1019	-
WC	1.707308 106	1.707326 106	0.01
UD	1.721655 107	1.721652 107	

0.01
VD
0.
= 1023
-
WD
1.434713 108
1.432400 108
0.2
EU
0.
= 1022
VE
0.
= 1022
WE
1.291241 106
1.291260 106
0.01
(Pa)
zz (A)
2.29554 105
2.2956 105
< 0.01
zz (E)
1.14777 105
1.14777 105
< 0.01
zz (X)
2.29554 105
2.29549 105
< 0.01
UX
0.
1020
-
VX
5.738850 108
5.738740 108
0.01
WX
4.782375 109
4.759220 109

0.5

4.2 Remarks

Modeling in HEXA20 is completely acceptable for this coarse grid.

4.3 Parameters
of execution

Version: 3.04.00
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:
8 MW
Time CPU To use:
4.99 seconds

5
Summary of the results

The results concerning displacements and the constraints are very close to the solution analytical with adopted modeling (< 0.2% for displacements, < 0.5% for the constraints).
The elastic coefficients in the 3 directions of orthotropism were selected so as to obtain them same values of displacements at the points B, C, D and E that those calculated for a material isotropic (test SSLV007) or isotropic transverse (test SSLV121). Numerically, these values are very close relations of those of these tests at the points considered (of about a 10-6) the difference resulting from method of construction of the matrices of rigidity in the various cases. As in point X, these values differ but correspond well to the reference solution.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.121

SSLV121 - Stretching of an isotropic parallelepiped transverse under its own weight

Summary:

This test of mechanics of the structures allows the evaluation of displacements and the constraints of one parallelepiped becoming deformed under its own weight. The material is elastic linear isotropic transverse.

modeling is three-dimensional. The model is similar to test VPCS SSLV07 (but in this case the material is isotropic) and with test SSLV120 (in this case the material is orthotropic.).

The variations of the results obtained by Aster range between 0,00 and 0,2% of the calculated reference analytically.

1

Problem of reference

1.1 Geometry

Z
X
.
B
With
D
y
E
L
B
X
C
has
Height: L = 3 m
Width: has = 1 m
Thickness: B = 1 m
Co-ordinates of the points (in meters):
With
B
C
D
E
X
X
0.
0.
0.5
0.5
0.
0.
y
0.
0.
0.
0.
0.
0.5
Z
3.
0.
0.

3.
1.5
3.
1.2
Material properties
YOUNG moduli in the xy plan and direction Z:
E_L = 5. 1011 Pa, E_N = 2. 1011 Pa.
Poisson's ratios relating to the xy plan and direction Z:
_LT = 0.1, _LN = 0.3.
Modulus of rigidity relating to direction Z:
G_LN = 7.69231 1010 Pa.
Density: = 7800 kg/m3.
1.3
Boundary conditions and loadings
Not a: (U = v = W = 0, X = y = Z = 0)
Actual weight following axis Z
Uniform constraint with traction for the higher face:
Z = gL = + 229.554. Pa
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SSLV121 Stretching of a transverse isotropic parallelepiped
Date:
26/01/98
Author (S):
G. DEBRUYNE
Key:
V3.04.121-C Page:
3/6
2
Reference solution
2.1
Method of calculation used for the reference solution
The reference solution results from that given in card SSLV07/89 of guide VPCS (in considering in more one transverse isotropic elastic matrix). The analytical expression of the solution is as follows:
Displacements:
_ Z G X Z

_ Z G y Z
G z2 G
G L2
U = -
v = -
W = -
+
(_zx2 +_zy2) -
E_ Z
E_ Z
2E_ Z
2E_ Z
2E_ Z
Constraints:
=
=
=
=
=
=
zz
G Z
xx yy xy yz zx 0
Z
X U
.
With
Of
D
L/2
E
L
B
C
X
It
W wB
B'

2.2

Results of reference

Displacement of the points B, C, D, E and X.
Constraints zz of A and E

2.3

Uncertainty on the solution

Exact analytical results.

2.4 References bibliographical

[1]
TIMOSHENKO (S.P) Theory of elasticity - Paris - Polytechnic Bookshop CH. Béranger, p.279 with 282 (1961)

[2]
S.W. TSAI, H.T. HAHN - Composite introduction to materials. Technomic Publishing Company (1980).

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HI-75/96/017 - Ind A

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3 Modeling

With

3.1 Characteristics of modeling

3D
Z
B
With
D
y
L
X
C
has
Cutting:
3 in height
2 in width and thickness
meshs hexa20
Limiting conditions:
on axis AB
DDL_IMPO: (GROUP_NO: ABsansA DX=0., DY=0.)
in A and D
(NODE: WITH DX=0., DY=0., DZ=0.)
(NODE: D DY=0.)
Names of the nodes:
With = N59
B = N53
C = N12
D = N18
E = N56
X = N70

3.2
Characteristics of the grid
A number of nodes: 111
A number of meshs and types: 12 HEXA20
3.3 Functionalities
tested
Orders
Keys
AFFE_CHAR_MECA
DDL_IMPO
GROUP_NO
[U4.25.01]
GRAVITY
FORCE_FACE
GROUP_MA
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“MECHANICAL”
“3D”
ALL
[U4.22.01]
DEFI_MATERIAU
ELAS_ISTR_FO

4
Results of modeling A

4.1 Values
tested
Identification
Reference
Aster
% difference
UB
0.
1022
-
VB
0.
1022
-
WB
1.721655106
1.721672106
0.01
CPU
0.
= 1014
-
VC
0.
= 1019
-
WC
1.707308 106
1.707325 106
0.01
UD
1.721655 107
1.721649 107
0.01
VD
0.
= 1023
-
WD
1.434713 108
1.432587 108
0.2
EU

0.
= 1022
VE
0.
= 1023
WE
1.291241 106
1.291259 106
0.01
(Pa)
zz (A)
2.29554 105
2.2956 105
< 0.01
zz (E)
1.14777 105
1.14777 105
< 0.01
zz (X)
2.29554 105
2.29549 105
< 0.01
UX
0.
1020
-
VX
1.721655 107
1.721649 107
-
WX
1.434712 108
1.432587 108
0.15
4.2 Remarks
Modeling in HEXA20 is completely acceptable for this coarse grid.
4.3 Parameters
of execution
Version: 3.04.00
Machine: CRAY C90
System:
UNICOS 8.0
Obstruction memory:

8 MW
Time CPU To use:
4.25 seconds

5

Summary of the results

The results concerning displacements and the constraints are very close to the solution analytical with adopted modeling (< 0.2% for displacements, < 0.5% for the constraints).
The fact that there is only one component of the constraints (zz) in the problem only allows to test 2 elastic coefficients (E_Z and NU_Z).
Although these coefficients are constant, they were introduced in the form of functions to test functionality ELAS_GITR_FO.
The elastic coefficients in plan XY and direction Z were selected so as to obtain them same values of displacements at the points B, C, D and E that those calculated for a material isotropic (test SSLV07) or orthotropic (test SSLV120). Numerically, these values are very close those of these tests at the points considered (of about a 10-6) the difference resulting from the mode of construction of the matrices of stiffness in the various cases. As in point X, these values differ but correspond well to the reference solution.

Date:
23/09/03
Author (S):
Key ***S. MICHEL-PONNELLE***
:
V3.04.130-C Page:
1/14

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.130

SSLV130 - Hollow roll into incompressible

Summary:

This test makes it possible to validate the quasi-incompressible elements in statics for a three-dimensional problem,
axisymmetric or two-dimensional (plane deformations). One considers a hollow roll subjected to a pressure
intern. The material has a Poisson's ratio equal to 0.4999 and one uses the elements quasi
incompressible (modeling INCO). In all the cases of modeling, one carries out the test or not while

imposing
the condition of perfect incompressibility (DDL_IMPO and GONF=0)

Four modelings are carried out for this problem. Modelings A and B make it possible to test quasi-incompressible modeling 3D (3D_INCO), on the one hand with HEXA20 (A) and on the other hand with
TETRA10 (B). Modelings C and D are studies 2D being based on mixed grids QUAD8 and TRIA6. Modeling C is the study in plane deformations (D_PLAN_INCO), modeling D is a study axisymmetric (AXIS_INCO).

This test is similar to test SSLV100.

The numerical results are satisfactory for all modelings. The fact of imposing explicitly condition of incompressibility influences only very little the results.

1
Problem of reference

1.1 Geometry
y
R
E
F

C
45°
D
P
With
B
Z
X
Internal ray
= 0.1 m has
External ray
B = 0.2 m

Co-ordinates of the points

WITH B
E
F
C
D
X 0.1.0.2.0.1*cos (45) 0.2*cos (45) 0.1*cos (22.5) 0.2*cos (22.5)
y
0 0.0.1*sin (45)
0.1*sin (45)
0.1*sin (22.5) 0.1*sin (22.5)
Z
0 0
0
0
0
0

1.2
Properties of material

E = 2.105 MPa
= 0.4999

1.3
Boundary conditions and loadings

Pressure interns P = 60 MPa.

2
Reference solution

2.1
Method of calculation

The general solution in displacement is as follows:

2
Pa

2
B
U =
1
(+)
R
1
(- 2) R +

E (2

B - 2
has)

R

U = U = 0

Z
In deformations:

2
Pa

2
B
=
1
(+)
rr
1
(- 2) -

E (2
B - 2
has)

2
R

2
Pa

2
B

=
1
(+

) 1
(- 2) +

E (2
B - 2
has)

2
R

=

= 0
R
zz

In constraints:

2
has

2
B
= P
rr
2
2 1 -
2

B - has
R

2
2

has

B
= P
1+

2
2
2
B - has

R

2
has
= 2 P
zz
2
B - 2

has
= 0

R

One obtains for a perfectly incompressible cylinder (= 0.5):

in R = 0 1
. : U = 6. 105
in R = 0 2
. :
= 3. 105
R
ur
= 6
-. 10-4
= 1
- 5
. 10-4
rr
rr

= 6. 10-4

= 1 5
. 10-4

= 60
- .
= 0.
rr
rr

= 100.

= 40.

= 20.
= 20.
zz
zz

The passage in the Cartesian system is done using the following relations:

= cos2 +
2
xx
rr
sin - 2 sin cos
R

= sin2 +
2
yy
rr
cos + 2 sin cos
R

= sin cos -
2
2
xy
rr
sin cos - 2
R (cos - sin)

2.2
Sizes and results of reference

One compares with the values of reference:

- *displacements (U, v) at points A and F,*
- *the strains (xx, yy, xy) and the stresses (xx, yy, zz, xy) at points A and F,*
- *equivalent strains and stresses equivalent to point A.*

Lastly, to test the passage of the sizes of the points of Gauss to the nodes for the nodes mediums, one also tests the nonnull strains and stresses in a node medium of the structure.

2.3 References
bibliographical

[1]
Y.C. FUNG: Foundations of solid mechanics. Prenctice-hall, Inc. Englewood Cliffs. NJ. 1965, p. 243-245
[2]
[V3.04.100] Hollow roll in plane deformations

3 Modeling
With

3.1
Characteristics of modeling

Grid with incompressible elements 3D of type HEXA20 only

y
B

Face blocked in dx
F
With
Normally blocked face
E
Face with imposed pressure
45°
X

Along axis Z:

.
total thickness E = 0.01
.
2 layers of elements

For the needs for examination in a node medium, one defines the node NOEUMI = A + (0. 0. e/4) where
the strains and the stresses are the same ones as in A.

Limiting conditions:

DDL_IMPO =
GROUP_NO = ' FACSUP'

DZ =
0.
GROUP_NO
= ' FACINF'

DZ =
0.

faces AEFD (z=0 and Z = 0.01)

GROUP_NO = ' FACEAB' DX =
0.

face AB
FACE_IMPO = GROUP_MA = ' FACEEF'
DNOR =
0.

face EF
PRES_REP = GROUP_MA = ' FACEAE'
CLOSE =
60.

face AE

3.2
Characteristics of the grid

A number of nodes: 1501 nodes
A number of meshs: 240 HEXA20

3.3 Functionalities
tested

Orders

DEFI_GROUP CREA_GROUP_NO

CRIT_NOEUD
"SUMMIT"
AFFE_MODELE MODELING "3D_INCO"
GROUP_MA
DEFI_MATERIAU ELAS

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
FACE_IMPO
GROUP_MA

PRES_REP
GROUP_MA

STAT_NON_LINE COMP_INCR
RELATION ELAS
NEWTON
REAC_ITER
1

3.4
Sizes tested and results

For A and F, one notes the result obtained

.
first column without imposing GONF = 0
.
second column while imposing GONF = 0

Identification
Reference
Aster
% difference
With U
0. 3.29
10-22 -1.39
10-21
- -
v
6. 10-5
5.9998 10-5
5.9995 10-5 -0.003 -0.008

xx
100. 99.92
99.92
-0.078
-0.078
yy
-60. -59.91
-59.91
-0.155
-0.155
zz
20. 19.98
19.99
-0.076
-0.056
xy
0. -8.48
10-3 -8.48
10-3
- -
xx
6. 10-4
5.9948 10-4
5.9945 10-4 -0.086 -0.091
yy
-6. 10-4
-5.9915 10-5
-5.9918 10-4 -0.141 -0.136
xy
0. -6.36
10-8 -6.36
10-8
- -
INVA_2
6.9282 10-4
6.9211 10-4
6.9211 10-4 -0.102
-0.102
PRIN_1
-6. 10-4
-5.9936 10-4
-5.9939 10-4 -0.107
-0.102

PRIN_2
0. 9.38
10-16
-1.3394 10-15
- -
PRIN_3
6. 10-4 5.9942
10-4
5.9939 10-4 -0.097
-0.102
VMIS
138.5641 138.1433 138.1433 -0.304
-0.304
TRESCA
160. 159.5142
159.5142
-0.304
-0.304
PRIN_1
-60. -59.7571
-59.7571
-0.405
-0.405
PRIN_2
20. 19.9961
20.0001
-0.019
0.0007
PRIN_3
100. 99.7571
99.7571
-0.243
-0.243
VMIS_SG
138.5641 138.1433 138.1433 -0.304
-0.304

7.2

Identification
Reference
Aster
% difference
F U
-2.1213 10-5 -2.1216
10-5 -2.1212 10-5
0.014 -0.006
v
+2.1213 10-5 2.1216
10-5 2.1212
10-5
0.014 -0.006
xx
20. 20.01
20.01
-0.104 0.04
yy
20. 19.99
19.99
-0.035 -0.035
zz
20. 19.999
19.999
-0.027 -0.007
xy
20. 20.02
20.02
0.087 0.087

xx
0. 1.01
10-7 7.11
10-8
- -
yy
0. -1.08
10-8 -4.07
10-8
- -
xy
1.5 10-4 1.5012
10-4 1.5012
10-4
0.08 0.08

Checking of the passage to the node for the nodes mediums (only for the result obtained without to impose GONF = 0) - value on node NOEUMI:

Identification
Reference
Aster
% difference
xx
100. 99.92
-0.076
yy
-60. -59.92 -0.127
zz
20. 19.996
-0.076
xx
6. 10-4 5.9942
10-4 -0.019
yy
-6. 10-4 -5.9936
10-4 -0.107

3.5 Remarks

One obtains very good results since for all the examined sizes, the difference between solution obtained with the code and the analytical solution is lower than 0.2%. It is seen that the

variation enters
the solutions obtained by imposing or not the condition tr = 0 is unimportant.

---

4 Modeling
B

4.1
Characteristics of modeling

Grid with incompressible elements 3D of type TETRA10 only

F
Normally blocked face
y
D
E
C

45°

With
B
X
Face with imposed pressure

Face blocked out of Dy

AB is on axis OX (contrary to modeling A).

Cutting:

6 equidistant nodes on segments AB, CD and EF,
5 equidistant nodes on arcs ACE and BDF.
Along axis Z:
.
total thickness E = 0.01
.
2 layers of elements

For the needs for examination, one defines the node NOEUMI = A + (0. 0. e/4) where deformations and the constraints are the same ones as in A.

Limiting conditions:

DDL_IMPO =
GROUP_NO = ' FACSUP'
DZ =
0.
GROUP_NO
= ' FACINF'

DZ =
0.

faces AEFD (z=0 and Z = 0.01)

GROUP_NO = ' FACEAB' DY =
0.

face AB
FACE_IMPO = GROUP_MA = ' FACEEF'
DNOR =
0.

face EF
PRES_REP = GROUP_MA = ' FACEAE'
CLOSE =
60.

face AE

4.2
Characteristics of the grid

A number of nodes: 703
A number of meshs: 356 TETRA10

4.3 Functionalities tested

Orders

DEFI_GROUP CREA_GROUP_NO
CRIT_NOEUD
"SUMMIT"
AFFE_MODELE MODELING "3D_INCO"
GROUP_MA
DEFI_MATERIAU ELAS

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA

PRES_REP
GROUP_MA

STAT_NON_LINE COMP_INCR
RELATION
ELAS
NEWTON

REAC_ITER
1

4.4
Sizes tested and results

For the points A and F, one notes the result obtained without imposing GONF = 0 (column 1) and while imposing
GONF = 0 (column 2)

Identification
Reference
Aster
% difference
With U
6. 10-5 6.011
10-5 6.011
10-5 0.19
0.18
v
0. 2.65
10-23 -3.06
10-22 - -
xx
-60. -59.51
-61.1452
-0.82
1.90
yy
100. 100.95
101.345
0.95
1.34
zz
20. 20.42
19.813
2.08
0.93
xy
0. -2.104
-2.60
- -
xx
-6. 10-4 -6.02

10-4 -6.02
10-4 0.36
0.36
yy
+6. 10-4 6.01
10-4 6.01
10-4 0.20
0.19
xy
0. -1.58
10
-5 -1.58
10-5 - -
INVA_2
6.9282 10-4
6.9509 10-4
6.9509 10-4
0.328 0.328
PRIN_1
-6. 10-4
-6.0241 10-4
-6.0244 10-4
0.401 0.406
PRIN_2
0. -2.85
10-6
-2.86 10-6
- -
PRIN_3
6. 10-4 6.0153
10-4
6.0150 10-4
0.255 0.250
VMIS
138.5641 137.4852
137.4852
-0.779 -0.779
TRESCA
160. 158.7541 158.7543 -0.779 -0.779
PRIN_1
-60. -58.6561 -58.6560 -2.240 -2.240
PRIN_2
20. 20.4167 20.4209 2.083 2.104

PRIN_3
100. 100.0980 100.0980 0.098 0.098
VMIS_SG
138.5641 137.4852
137.4852
-0.779 -0.779

Identification
Reference
Aster
% difference
F U
2.1213 10-5 2.1210
10-5
2.1206 10-5 -0.02 -0.04
v
2.1213 10-5 2.1210
10-5
2.1206 10-5 -0.02 -0.04
xx
20. 20.13 20.12 0.627 0.60
yy
20. 19.96 19.98
-0.209 -0.11
zz
20. 20.025 20.035
0.127 0.17
xy
-20. -19.98 -19.97 0.105 -0.13
xx
0. 6.85
10-7 6.55
10-7
- -
yy
0. -5.68
10-5 -5.98
10-7
- -
xy
2.1213 10-5 2.1210
10-5

2.1206 10-5 -0.02 -0.04

Checking of the passage to the node for the nodes mediums (only for the result obtained without to impose GONF = 0) - value on node NOEUMI:

Identification
Reference
Aster
% difference
xx
-60. 58.988
-1.687
yy
100. 100.501
0.501
zz
20. 20.685
3.424
xx
-6. 10-4 -5.97503
10-4 -0.416
yy
6. 10-4 5.98584

10-4 -0.236

4.5 Remarks

The results obtained here are a little worse than in the case of modeling A, but discretization is coarser since there are approximately 2 times less nodes in this case-test. results are satisfactory all the same since the variations are lower than 0.2% for displacements, lower than 0.5% for the deformations and lower than 1% for the constraints. One note again that there is no significant improvement of the result when one imposes explicitly tr = 0.

---

5 Modeling C

5.1 Characteristics of modeling

Grid with incompressible elements 2D of type QUAD8 and TRIA6

y
B
Face blocked in dx
F
With

Normally blocked face
E
Face with imposed pressure
45°
X

Limiting conditions:

DDL_IMPO =
GROUP_NO = ' GRNM11'
DX =
0.

side AB
FACE_IMPO = GROUP_MA = ' GRMA12'
DNOR =
0.
dimensioned EF
PRES_REP = GROUP_MA = ' GRMA13'
CLOSE =
60.
face AE

Name of the nodes:

With = N2, B = N361, C = N121, D = N584, E = N155, F = N503

5.2
Characteristics of the grid

A number of nodes: 591
A number of meshs: 200 TRIA6, 50 QUAD8.

5.3 Functionalities
tested

Orders

DEFI_GROUP CREA_GROUP_NO CRIT_NOEUD
“SUMMIT”

AFFE_MODELE MODELING
“D_PLAN_INCO”
GROUP_MA
DEFI_MATERIAU ELAS

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
FACE_IMPO
GROUP_MA

PRES_REP
GROUP_MA

STAT_NON_LINE COMP_INCR
RELATION ELAS
NEWTON
REAC_ITER
1

5.4
Sizes tested and results

For the points A and F, one notes the result obtained without imposing GONF = 0 (column 1) and while

imposing
GONF = 0 (column 2).

Identification
Reference
Aster
% difference
With U
0. 1.59
10-21
9.53 10-22
- -
v
6. 105
5.9935 10-5
5.9932 10-5 -0.108
-0.113
xx
100. 99.93 99.93
-0.071
-0.071
yy
-60. -59.72 -59.72
-0.464
-0.464
zz
20. 20.09 20.10
0.470
0.490
xy
0. 0.224
0.224
- -
xx
6. 104
5.987 10-4
5.987 10-4 -0.212
-0.217
yy
6. 104
-5.986 10-4
-5.986 10-4 -0.237
-0.232

xy
0. 1.68
10-6
1.68 10-6
- -
INVA_2
6.9282 10-4
6.9127 10-4
6.9127 10-4 -0.224
-0.224
PRIN_1
-6. 10-4
-5.9858 10-4 -5.9861 10-4 -0.237
-0.232
PRIN_2
0. 0.0
0.0
- -
PRIN_3
6. 10-4 5.9873
10-4
5.9870 10-4 -0.212
-0.217
VMIS
138.5641 138.1093 138.1093 -0.328
-0.328
TRESCA
160. 159.4749
159.4749
-0.328
-0.328
PRIN_1
-60. -59.6335
-59.6335
-0.611
-0.611
PRIN_2
20. 20.0940
20.0980
0.470
0.490
PRIN_3
100. 99.8414

99.8414
-0.159
-0.159
VMIS_SG
138.5641 138.1093 138.1093 -0.328
-0.328

Identification
Reference
Aster
% difference
F U
2.1213 105
-2.1195 10-5 -2.1191 10-5
-0.086
-0.106
v
+2.1213 105
2.1195 10-5
2.1191 10-5
-0.086
-0.106
xx
20. 20.03
20.03
0.153
0.153
yy
20. 19.97
19.97
-0.134
-0.134
zz
20. 19.99
19.997
-0.036
-0.016
xy
20. 20.01
20.01
0.051
0.051
xx

0. 2.84
10-7
2.54 10-7
-
-
yy
0. -1.46
10-7
-1.76 10-7
-
-
xy
1.5 10-4 1.5007
1.5007 0.044
0.044

5.5 Remarks

As for modeling 3D, the results obtained are completely satisfactory.

---

6 Modeling
D

6.1
Characteristics of modeling

Incompressible elements axi (TRIA6 + QUAD8)

Center cylinder
Node blocked out of Dy
y
E
F
0.01m
C
D
With
B
X
Face with imposed pressure

For the needs for examination, one defines the nodes:

.
NOEUMIA = A + (0. 0.01/4) where the strains and stresses are the same one as in A
.
NOEUMIB = B + (0. 0.01/4) where the strains and stresses are the same one as out of B

Limiting conditions:

DDL_IMPO =
GROUP_NO = ' FACSUP'
DY =
0.

y=0.1
GROUP_NO
= ' FACINF'

DY =
0.

y=0

PRES_REP = GROUP_MA = ' FACEAE'
CLOSE =
60.

face AE

6.2
Characteristics of the grid

A number of nodes: 175.
A number of meshs and types: 20 QUAD8, 40 TRIA6.

6.3 Functionalities
tested

Orders

DEFI_GROUP CREA_GROUP_NO
CRIT_NOEUD
“SUMMIT”
AFFE_MODELE MODELING
“AXIS_INCO”
GROUP_MA
DEFI_MATERIAU ELAS

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FACE_IMPO
GROUP_MA

PRES_REP
GROUP_MA

STAT_NON_LINE COMP_INCR
RELATION
ELAS
NEWTON
REAC_ITER
1

6.4
Sizes tested and results

For A and F, one notes the results obtained without imposing GONF = 0 (column 1) and while imposing GONF = 0 (column 2).

Identification
Reference
Aster
% difference
With U
6. 105
6.0000 10-5 5.9996
10-5
-0.002 -0.007
v
0. 9.93
10-24 -8.93
10-23
- -
xx
-60. -59.91
-59.91

-0.150 -0.150
yy
20. 19.99
19.997 -0.036 -0.016
zz
100. 99.91
99.91
-0.086 -0.086
xy
0. 3.73
10-9
3.73 10-9
- -
xx
6. 104
-5.99 10-4 -5.99
10-4
-0.180 -0.123
yy
0. -1.69
10-15 -1.69
10-15
- -
xy
0.
2.80 10-14 2.80
10-14
- -
INVA_2
6.9282 10-4
6.9201 10-4
6.9201 10-4
-0.117 -0.117
PRIN_1
-6. 10-4
-5.9923 10-4
-5.9926 10-4
-0.128 -0.123
PRIN_2
0. 6.45
10-16
6.40 10-16
- -

PRIN_3
6. 10-4 5.9937
10-4
5.9934 10-4
-0.105 -0.110
VMIS
138.5641 138.4116
138.4116
-0.110 -0.110
TRESCA
160. 159.8239 159.8239 -0.110 -0.110
PRIN_1
-60. -59.9101 -59.9101 -0.150 -0.150
PRIN_2
20. 19.9928 19.9968 -0.036 -0.016
PRIN_3
100. 99.9138 99.9138 -0.086 -0.086
VMIS_SG
138.5641
138. 4116
138. 4116
-0.110 -0.110

Identification
Reference
Aster
% difference
F U
3 10-5 3.0004
10-5
2.9998 10-5
0.014 -0.006
v
0. -4.96
10-22
-5.69 10-22
- -
xx
0. 2.59
10-2
2.58 10-2
- -
yy

20. 19.997 20.001 -0.014 0.006
zz
40. 39.99 39.99
-0.025 -0.025
xy
0. -4.87
10-3
-4.87 10-3
- -
xx
-1.5 10-4 -1.498
10-4 -1.498
10-4
-0.129 -0.109
yy
0. -3.20
10-8 -3.20
10-8
- -
xy
0.
-3.65 10-8
-3.66 10-8
- -

Checking of the passage to the node for the nodes mediums (only for the result obtained without to impose GONF = 0)

NOEUMIA

Identification
Reference
Aster
% difference
xx
-60. -59.91 -0.150
yy
20. 19.99
-0.036
zz
100. 99.91
-0.086
xx

-6. 10-4
-5.9923 10-4 -0.128
zz
6. 10-4
5.9937 10-4 -0.105

NOEUMIB

Identification
Reference
Aster
% difference
xx
0. -1.39
10-2
-
yy
20. 19.9999
-0.002
zz
40. 39.9993
-0.002
xx

-1.5 10-4 -1.4988
10-4 -0.078
zz
1.5 10-4 1.4999
10-4 -0.008

6.5 Remarks

The precision obtained is very good.

7
Summary of the results

With a Poisson's ratio very close to 0.5, one finds the results of the solution analytical incompressible with a weak difference. It is noticed that it is not necessary to impose explicitly the condition of incompressibility tr = 0 to obtain good results since the results are quasi-identical that one activates or not, condition GONF=0 with DDL_IMPO.

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.131

SSLV131 - Orthotropism in an unspecified reference mark

Summary

This case test validates modelings relating to linear elasticity which implement materials orthotropic whose properties are known in a reference mark defined by the user different from the total reference mark.
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HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLV131 - Orthotropism in an unspecified reference mark

Date:
16/11/01
Author (S):
C. Key DURAND
:
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Count

matters

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5.0

Titrate:
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16/11/01
Author (S):

1
Problem of reference

1.1 Geometry

The total reference mark is reference mark (A, X, Y, Z). In this reference mark the co-ordinates of the nodes are:

To (0. , 0. , 0.)
B (3. , 1. , 0.)
C (2. , 3. , 0.)
D (3.1, - 1)

For the 2D, one will study the behavior of the triangle ABC whose material properties are defined in the total reference mark (A, X, y) represented on the figure; this reference mark is turned of an angle of 30° around
of Z compared to the total reference mark.

For the 3D, one will study the behavior of the tetrahedron ABCD whose material properties are defined in a local reference mark (A, X, y, Z) obtained by rotation of the total reference mark according to angles'
nautical (= 30°, = 20°, = 10°).

This reference mark is not represented on the figure.

1.2
Properties of material

The materials used are orthotropic and isotropic transverse.

One adopts the convention of terminology used in ASTER, i.e the suffixes L, T and NR means Longitudinal, Transverse and Normal.

The units will not be specified.

EL =
,
11000 AND =

,
5000 IN =

,
8000
= 0. ,
18
= 0. ,
15
= 0.11
LT
LN
TN
EL = 11000; AND = 5000; IN = 8000
= 0. ,
18
= 0. ,
15
= 0. ,
11
LT
LT
TN
G =

,
10500 G =

,
7000 G = 13000
LT
LT
TN

EL
EL
AND
(It is known that
=
X

,
=
X

,

=
X,
TL
LT
NL
LN
NT
TN
AND
IN
IN
that is to say =

0.396,

=

,
62
.
020

= 06875
.
0

TL
NL
NT

For the transverse isotropy, one keeps the same values while knowing as:

AND = EL,

=
G
and

TL
LN
EL
LT= 2 (1

+
)
LT

It is pointed out that these coefficients are defined in a local reference mark (A, L, T, NR) turned of 30° in
plan (L, T) compared to the reference mark total for the 2D and turned with the nautical angles (30°, 20°, 10°)
compared to the total reference mark for the 3D.

1.3
Boundary conditions and loadings

The boundary conditions are of Dirichlet type. One makes the assumption of a field of displacement linear in X and y so that the field of deformation is constant.

For the 2D one takes
$dX = 2x + 4y$

$Dy = 4x + 3y$

For the 3D one takes
$dX = 2x + 3y + 4z$

$Dy = 3x + 5y + 6z$

$dZ = 4x + 6y + 7z$

For the 2D, one thus will impose:

·
for node A
$dX = 0, Dy = 0$
·
for the node B
$dX = 10, Dy = 15$
·
for the node C

dX = 16, Dy = 17

and for the 3D:

.

for node A
dX = 0, Dy = 0, dZ = 0
.
for the node B
dX = 9, Dy = 14, dZ = 18
.
for the node C
dX = 13, Dy = 21, dZ = 26
.
for the node D
dX = 5, Dy = 8, dZ = 11

2
Reference solution

2.1
Method of calculation

Calculation is analytical.
One used the formal calculation programme Mathématica to carry it out.

One exposes of it the principle only for the 3D.
It is known that the field of displacement is:

dX = 2x + 3y + 4z
Dy = 3x + 5y + 6z
dZ = 4x + 6y + 7z

The field of deformations G in the total reference mark is thus constant and equal to:

2 3 4
G = 3 5 6
4 6 7

That is to say P the matrix of passage allowing to make pass a vector of the total reference mark (A, X, Y, Z) to
locate local (A, L, NR, T).

That is to say
T
***L the** tensor of deformation in the local reference mark. One a:*
.
***L** = P*
. P
G

The tensor of Hooke H L is known in the local reference mark, that is to say L the tensor of the constraints in it
locate. One a:
= H.
L
L
L

The tensor is obtained
T
G of the constraints in the total reference mark by:
= P.
G
L. P

2.2

Results of reference

They are obtained by carrying out the operations described above with Mathematica.

2.3
Uncertainties on the solution

Uncertainty is null because the solution is analytical.

2.4 References
bibliographical

For the description of the matrices of Hooke for materials isotropic transverse and orthotropic for plane modelings 3D, constraints and plane deformations, the selected reference was:
`Matrix of Hooke for orthotropic materials `. Report/ratio interns applications in Mechanics
n° 79-018 of Jean-Claude Masson CISI.

---

3 Modeling
With

3.1
Characteristics of modeling

Following modelings are implemented:

·
2D:
- axisymmetric
- constraints
plane
- deformations
plane
·
3D.

For each one of these modelings, one tests materials isotropic transverse and orthotropic.

Note:

has) The transverse isotropy is not tested for the plane constraints because this case corresponds to isotropy.
b) For the axisymmetric case the stress field depends on the point of calculation.
This point is selected at the point of integration of the triangle (i.e it is the centre of gravity of the triangle).
c) It is pointed out that the orthtropie in an unspecified reference mark is not available for modeling as a Fourier because there is then coupling of all the components of the tensor of constraints: Implementation the current makes it possible to use only the symmetrical components to leave which one can find the antisymmetric components but so that it is possible, it
is not necessary that the slips induce tensile stresses.

3.2
Characteristics of the grid

For the 2D, there is an element triangle with 3 nodes ABC.
For the 3D, there is an element tetrahedron with 4 nodes ABCD.

3.3 Functionalities
tested

Orders
Key word
DEFI_MATERIAU ELAS_ORTH

DEFI_MATERIAU ELAS_ISTR

4
Result of modeling A

4.1 Values
tested

Identification Reference
***Aster** %*
difference
Case of the transverse isotropy 3D

name of the result: Mest1

field depl

Dy (c)
21
21
0
field epsielgadepl

Epxy 3
3
0
Epxz 4
4
0
Epyz 6
6
0
field sief.elga.depl

If xx
50461,97
50461,97
0
If yy
80136,037
80136,037
0
If zz
68682,137
68682,137
0
If xy
39559,096
39559,096
0
If xz
30622,542
30622,542
0
If yz
84027,579
84027,579

0
field sigmelnodepl

If xx
50461,971
50461,971
0
field emelelga Ep
1.23652.106 1.23652.106

Field emelelnoelga Ep
1.23652.106 1.23652.106

Case of the orthotropism 3D

name of the result: Mest2

field depl

Dy (c)
21
21
0
field epsielgadepl

Epxy 3
3
0
Epxz 4
4
0
Epyz 6
6
0
field siefelgadepl

If xx
23170,539
23170,539
0
If yy
78600,676
78600,676
0
If zz
78692,318
78692,318
0
If xy
86435,100
86435,100
0
If xz
16449,622
16449,622
0
If yz
125577,226
125577,226
0
field sigmelnodepl

if xx
2370,539
2370,539
0
field enelelga Ep
1.55286.106 1.55286.106 0
field enelelnoelga Ep
1.55286.106 1.55286.106 0
Case of the transverse isotropy in

axisymmetric
name of the result: Mest3

field depl

Dy (c)
17
17
0
field epsielgadepl

Exxy 4
4
0
field siefolgadepl

If xx
42930,079
42930,079
0
If yy
52252,113
52252,113
0
If xy
37288,135
37288,135
0
field enelelga Ep
4.15741.105 4.15741.105 0

Titrate:

SSLV131 - Orthotropism in an unspecified reference mark

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Author (S):
C.** Key **DURAND
:
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field enelcluoelga Ep
4.15741.105 4.15741.105
0
Case of the orthotropism into axisymmetric

name of the result: Mest4

field depl Dy (c)
17
17
0
field epsielgadepl

Epxy 4
4
0
field siefelgadepl

If xx
19438,248
19438,248
0
If yy
75231,714
75231,714
0
If xy

53867 ?974
53867 ?974
0
field siefelgaelga Ep
4,91317-105 4,91317-105 0
field enelchroelga Ep
4.91317-105 4.91317-105 0

Case of the transverse isotropy in

plane deformations

name of the result: Mest5

field depl Dy (c)
17
17
0
field epsielgadepl Epxy
4
4
0
field siefelgadepl

If xx
31612,684
31612,684
0
If yz
40934,718
8
0
If xy
37288,135
37288,135
0
field sigmelnodepl

if xx

31612,684
31612,684
0
field enelelga Ep
2.42167.105 2.42167.105 0
field enelelnoelga Ep
2.42167.105 2.42167.105 0
Case of the orthotropism in deformations

plane
name of the result: Mest6

field depl Dy (c)
17
17
0
field epsielgadepl Epxy
4
4
0
field siefelgadepl

If xx
9931,422
9931,422
0
If yy
68733,870
68733,870
0
If xy
51262,119
51262,119
0
field sigmelnodepl

if xx

9931,422
9931,422
0
field Epenelelga Ep
3.180807.105 3.180807.105 0
field enelelnoelga
3.180807.105 3.180807.105 0
Case of the orthotropism in constraints

plane
name of the result: Mest7

field depl Dy (c)
17
17
0
field epsielgadepl Epxy
4
4
0
field siefelgadepl

If xx
7454,007
7454,007
0
field emelelga Eo
3.10347.105 3.10347.105 0
field emelelnoelga Ep
3.10347.105 3.10347.105 0

In the asymmetrical case, the values of the field of the deformations and field of the constraints are given to the point of integration of the triangle (i.e its centre of gravity) whose co-ordinates are:

X = 1.666667
Y = 1.333334
Z = 0
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5
Summary of the results

The results provided by Mathématica and Aster are identical for all modelings usable with materials isotropic transverse and orthotropic.

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HI-75/01/010/A

Code_Aster ®
Version
8.1

Titrate:
SSLV134 - Calculation of G, fissures circular in infinite medium

Date:
15/02/06
Author (S):
***E. GALENNE**, J.M. PROIX Key*
:
V3.04.134-B Page:
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Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.134

SSLV134 - Fissure circular in infinite medium

Summary

This test allows, after obtaining the field of displacement by MECA_STATIQUE, the calculation of the rate of restitution of energy room for a circular crack plunged in a presumedly infinite medium.

For the first modeling, only a half space defined by the plan of the crack is represented. Bottom of crack is then a closed curve (a circle) and is defined as such in DEFI_FOND_FISS. The rate of restitution room and total is compared with the analytical solution of reference.

Three following modelings make it possible to calculate the stress intensity factors K1 and K3, in 3D and axisymmetric, calculated by POST_K1_K2_K3.

- *Modeling B tests K1 for a grid 3D,*
- *Modeling C tests K1 for an axisymmetric grid,*
- *Modeling D tests the combination of K1 and K3 for a grid 3D.*

Lastly, modeling E makes it possible to validate the calculation of the bilinear form of G on the same problem, and modeling F to validate same calculation for G local.

1
Problem of reference

1.1 Geometry

Z
= 1.MPa
y
has
X
= 1.MPa

The crack is circular (penny shaped ace) of ray has, in the Oxy plan. So that the medium is regarded as infinite, the sizes characteristic of the solid mass are about 5 times higher with ray A.

1.2
Material properties

Young modulus: E= 2.105 MPa

Poisson's ratio: = 0.3

1.3

Boundary conditions and loadings

Lower face
: uniform constraint of traction Z = 1. MPa
Higher face
: uniform constraint of traction Z = 1. MPa

According to modeling, one also has boundary conditions of symmetry and blocking of movements of rigid body.

In the modeling D where only the quarter of the parallelepiped is represented, one uses conditions with the limits of antisymetry for the loading of torsion: they amount imposing null them tangential displacements with a face. The loading of torsion is introduced in the form of a force surface tangential (shearing distributed) applied to the lips of the crack.

Y
X
.
Upper lip: F = -
= +
X
and F

has
Y
has
Y
X
.
Lower lip: F = +
= -
X
and F

has
Y
has

2
Reference solution

2.1
Method of calculation used for the reference solution

For a circular crack of ray in an infinite medium, subjected to a uniform traction according to the normal in the plan of the lips, the rate of refund of energy room G (S) is independent of the curvilinear X-coordinate S and is worth [bib1]:

(1 - 2
)
G (S) =
4 2
has

E

then the coefficient of intensity of K1 constraint is given by the formula of Irwin:

(1 - 2
)
2 A
G (S) =
K 2 is K =

E
1
1

R

If this crack is subjected to a shearing distributed on the lips:
=
Z

has
(what is equivalent to a torsion ad infinitum), then one is in pure mode 3 and the factor of intensity of constraints corresponding is worth:
4 A
(1+)
K =
=
2
3
thus by the formula of Irwin G (S)
K
3
E
3
In the presence of the two combined modes, one will have:

(1 - 2
)
(1+)
G (S) =
K 2 +
K 2
E
1
E
3

The théta-method connects the rates of refund of energy total and local by the equation variational following:

G
() =
ref.
G (S) .m (S) ds

where m (S) is the normal at the bottom of crack and is the field speed of a virtual propagation crack.

If one chooses for the normal unit field at the bottom of crack, one obtains, since G (S) is

constant on all the bottom of crack:

G
() = G (S 2
).
has
réf

.

2.2
Results of reference

Numerical application (case with loading of traction only):

It is considered that the crack is circular of ray has = 2. m

---

For the loading considered, one obtains then:

G (S) =
11.586 J/m2

Gréf = 145.060
J/m

K3
=
1.5958E6 J/m2

Numerical application (case with loading of torsion only):

G (S) =
7.3565 J/m2

Gréf = 92.44
J/m

K1
=
1.0638E6 J/m2

2.3 Reference bibliographical

[1]
Solution of Sneddon (1946) in G.C. SIH: Handbook of stress-intensity factors Institute of Fracture and Solid Mechanics - Lehigh University Bethlehem, Pennsylvannie

3
Modeling a: Melts of crack closed, calculation of G.

3.1
Characteristics of modeling

The interest of this modeling is to represent the entirety of the bottom of crack which is a curve closed, without benefitting from symmetries of the problem.

Only the loading of traction is taken into account.

3.2
Characteristics of the grid

A number of nodes: 11114
A number of meshs and type: 2432 PENTA 15

3.3 Functionalities
tested

Orders

DEFI_FOND_FISS FOND_FERME

CALC_THETA

CALC_G_THETA_T SYME_CHAR=' SYME'

CALC_G_LOCAL_T SYME_CHAR=' SYME'

POST_K1_K2_K3 SYME_CHAR=' SYME'

3.4 Notice

One uses key word SYME_CHAR in operators CALC_G_THETA_T and CALC_G_LOCAL_T for to multiply automatically by two the rate of refund of energy calculated on only one lip of *fissure.*

In the same way in POST_K1_K2_K3, key word SYME_CHAR allows to calculate the factors of intensity
constraints and the rate of refund of energy G_IRWIN by interpolation of displacements
of a single lip of the crack. The displacement of the nodes mediums of the edges of the elements concerning the bottom of crack to the quarter of these edges would allow to improve the precision of calculation.

4
Results of modeling A

4.1 Values tested

Identification	***Reference***	***Aster***	*%* ***difference***
G total	*145.6*	*146.2*	*0.4*
G local Node A - G Lagrange	*11.586*	*11.82*	*2.0*
G local Node B - G Lagrange	*11.586*	*11.56*	*-0.2*
G local Node C - G Lagrange	*11.586*	*11.83*	*2.1*
G local Node D - G Lagrange	*11.586*	*11.81*	*1.9*
G local Node A - G Lagrange_no_no	*11.586*	*11.71*	*1.0*

G local Node B - G Lagrange_no_no
11.586
11.60
0.2
G local Node C - G Lagrange_no_no
11.586
11.72
1.2
G local Node D - G Lagrange_no_no
11.586
11.70
1.0
G (POST_K1_K2_K3 Method 3) - Node A
11.586
10.45
9.8
G (POST_K1_K2_K3 Method 3) - Node B
11.586
10.49
9.4
G (POST_K1_K2_K3 Method 3) - Node C
11.586
10.45
9.8
G (POST_K1_K2_K3 Method 3) - Node D
11.586
10.52
9.2

---

5 Modeling b: Post_K1_K2_K3 in 3D

5.1 Characteristics of modeling

This modeling makes it possible to test the calculation of K1 using POST_K1_K2_K3 (method of extrapolation of displacements on the lips of the crack). Parameter ABSC_CURV_MAXI of the operator is selected so as to retain 5 nodes on the segment of extrapolation (dmax = 0,35).

Only the loading of traction is taken into account.

5.2 Characteristics of the grid

A number of nodes: 6536
A number of meshs and type: 432 PENTA 15 and 987 HEXA 20

The nodes mediums of the edges of the elements touching the bottom of crack are moved with the quarter of these edges, to obtain a better precision.

5.3 Functionalities tested

Orders

DEFI_FOND_FISS

CALC_G_LOCAL_T

CALC_THETA THETA_3D

CALC_G_THETA_T

POST_K1_K2_K3

5.4 Notice

One represents only the quarter of the complete three-dimensional block and thus the quarter of the crack. Thus, it
is necessary to divide the theoretical value of reference of the total rate of refund by 4:
G
= 145.60/4 = 36.40 J/m
glob
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Code_Aster *®*
Version
8.1

Titrate:
SSLV134 - Calculation of G, fissures circular in infinite medium

Date:
15/02/06
Author (S):
E. GALENNE*, J.M. PROIX Key*
:
V3.04.134-B Page:
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6
Results of modeling B

6.1 Values
tested

6.1.1 Results
of
CALC_G_THETA_T and CALC_G_LOCAL_T

Identification Reference
Aster *%*
difference
G local Node 49
11.59
11.74
1,30
G local Node 1710

11.59
11.76
1,49
G local Node 77
11.59
11.73
1,22
G total
36.40
36.82
1,16

6.1.2 Results of POST_K1_K2_K3

Identification Method
Reference
***Aster** %*
difference
K1_MIN
Node 77
method 1
16.0E+05
15.9E+05
-0,04
K1_MAX
Node 77
method 1
16.0E+05
16.1E+05
0,66
G_MIN
Node 77
method 1
11.6E00
11.6E00
-0,08
G_MAX
Node 77
method 1
11.6E00
11.7E00

1,32
K1_MIN
Node 49
method 1
16.0E+05
15.9E+05
-0,03
K1_MAX
Node 49
method 1
16.0E+05
16.1E+05
0,66
G_MIN
Node 49
method 1
11.6E00
11.6E00
-0,06
G_MAX
Node 49
method 1
11.6E00
11.7E00
1,32
K1_MIN
Node 1710 method 1
16.0E+05
15.9E+05
-0,07
K1_MAX
Node 1710 method 1
16.0E+05
16.1E+05
0,61
G_MIN
Node 1710 method 1
11.6E00
11.6E00
-0,15
G_MAX
Node 1710 method 1
11.6E00

11.7E00
1,22
K1_MIN
Node 77
method 2
16.0E+05
15.3E+05
-4,02
K1_MAX
Node 77
method 2
16.0E+05
15.9E+05
-0,21
G_MIN
Node 77
method 2
11.6E00
10.7E00
-7,87
G_MAX
Node 77
method 2
11.6E00
11.5E00
-0,42
K1_MIN
Node 49
method 2
16.0E+05
15.3E+05
-4,04
K1_MAX
Node 49
method 2
16.0E+05
15.9E+05
-0,40
G_MIN
Node 49
method 2
11.6E00
10.6E00

-7,92
G_MAX
Node 49
method 2
11.6E00
11.5E00
-0,63
K1_MIN
Node 1710 method 2
16.0E+05
15.3E+05
-4,09
K1_MAX
Node 1710 method 2
16.0E+05
15.9E+05
-0,25
G_MIN
Node 1710 method 2
11.6E00
10.6E00
-8,08
G_MAX
Node 1710 method 2
11.6E00
11.5E00
-0,49
K1
Node 77
method 3
16.0E+05
15.5E+05
-2,62
G
Node 77
method 3
11.6E00
11.0E00
-5,16
K1
Node 49
method 3
16.0E+05

15.5E+05
-2,63
G
Node 49
method 3
11.6E00
11.0E00
-5,19
K1
Node 1710 method 3
16.0E+05
15.5E+05
-2,68
G
Node 1710 method 3
11.6E00
11.0E00
-5,29

Note:

Method 3 calculates a single value for each parameter (K1_MAX = K1_MIN in file result).

7
Modeling C: Post_K1_K2_K3 into axisymmetric

7.1
Characteristics of modeling

This modeling makes it possible to test the calculation of K1 using POST_K1_K2_K3 (method of extrapolation of displacements on the lips of the crack) into axisymmetric.

Only the loading of traction is retained in this modeling.

Since one is in axisymmetric modeling, the relation between the total rates of refund of energy and room is [R7.02.01]:

G
() G (S.A.
réf
).
.
=
that is to say here G
= 23.17 J/m
ref.

7.2
Characteristics of the grid

A number of nodes: 1477
A number of meshs and type: 402 QUAD 8 and 60 SORTED 6

The nodes mediums of the edges of the elements touching the bottom of crack are moved with the quarter of these edges, to obtain a better precision.

7.3 Functionalities tested

Orders

DEFI_FOND_FISS

CALC_G_LOCAL_T

CALC_THETA THETA_3D

CALC_G_THETA_T

POST_K1_K2_K3

8
Results of modeling C

8.1 Values
tested

Identification
Method
Reference
Aster
% Difference
G
CALC_G_THETA
232E01
236E01
1,662

K1_MAX
POST_K1_K2_K3 method 1
160E+04
162E+04
1,514
K1_MIN
POST_K1_K2_K3 method 1
160E+04
160E+04
0,15
G_MAX
POST_K1_K2_K3 method 1
116E01
119E01
3,05
G_MIN
POST_K1_K2_K3 method 1
116E01
116E01
0,301

K1_MAX
POST_K1_K2_K3 method 2
160E+04
160E+04
0,569
K1_MIN
POST_K1_K2_K3 method 2
160E+04
150E+04
-6,239
G_MAX
POST_K1_K2_K3 method 2
116E01
117E01
1,141
G_MIN
POST_K1_K2_K3 method 2
116E01
102E01

-12,088

---

9 Modeling D: Post_K1_K2_K3 in 3D modes 1 and 3

9.1 Characteristics of modeling

The boundary conditions following are successively applied:

- *traction: as for modeling B;*
- *torsion.*

This modeling makes it possible to test the calculation of K1 and K3 combined using POST_K1_K2_K3 (method of extrapolation of displacements on the lips of the crack).

The nodes mediums of the edges of the elements touching the bottom of crack are moved with the quarter of these edges, to obtain a better precision.

9.2 Characteristics of the grid

A number of nodes: 6536
A number of meshs and type: 432 PENTA 15 and 987 HEXA 20

The nodes mediums of the edges of the elements touching the bottom of crack are moved with the quarter of these
edges, to obtain a better precision.

9.3 Functionalities
tested

Orders

DEFI_FOND_FISS

CALC_G_LOCAL_T

CALC_THETA THETA_3D

CALC_G_THETA_T

POST_K1_K2_K3

AFFE_CHAR_MECA FORCE_FACE

9.4 Notice

The two loading cases (traction and torsion) are taken into account. It is thus necessary to cumulate the values of G
for the two loadings. Moreover, one represents only the quarter of the complete three-dimensional block and
thus the quarter of the crack, it is thus necessary to divide the theoretical value of reference of the rate of refund
total by 4.

Thus

G (S) = (11.586 + 7.356) = 18.943 J/m2

G = (145.06 + 92.44)/4 = 59.37 J/m

Only traction contributes to K1, only torsion contributes to K3.

---

10 Results of modeling D

10.1 Values tested

Identification
Method
Localization
Reference
Aster

% Difference
G_LOCAL
CALC_G_LOCAL Legendre
Node 49
1,8943E+01 1,9055E+01
0,59
G_LOCAL
CALC_G_LOCAL Legendre
Node 1710
1,8943E+01 1,9089E+01
0,772
G_LOCAL
CALC_G_LOCAL Legendre
Node 77
1,8943E+01 1,9074E+01
0,694
G
CALC_G_THETA
5,937E+01 5,9849E+01
0,567

K1_MAX
POST_K1_K1_K3 Method 1
Node 49
1,5958E+06 1,5988E+06
0,189
K1_MIN
POST_K1_K1_K3 Method 1
Node 49
1,5958E+06 1,5952E+06
-0,038
K1_MAX
POST_K1_K1_K3 Method 2
Node 49
1,5958E+06 1,5924E+06
-0,21
K1_MIN
POST_K1_K1_K3 Method 2
Node 49

1,5958E+06 1,5620E+06
-2,116
K1_MAX
POST_K1_K1_K3 Method 1
Node 1710
1,5958E+06 1,5990E+06
0,202
K1_MIN
POST_K1_K1_K3 Method 1
Node 1710
1,5958E+06 1,5953E+06
-0,029
K1_MAX
POST_K1_K1_K3 Method 2
Node 1710
1,5958E+06 1,5925E+06
-0,202
K1_MIN
POST_K1_K1_K3 Method 2
Node 1710
1,5958E+06 1,5618E+06
-2,129
K1_MAX
POST_K1_K1_K3 Method 1
Node 77
1,5958E+06 1,5982E+06
0,155
K1_MIN
POST_K1_K1_K3 Method 1
Node 77
1,5958E+06 1,5945E+06
-0,077
K1_MAX
POST_K1_K1_K3 Method 2
Node 77
1,5958E+06 1,5918E+06
-0,249
K1_MIN
POST_K1_K1_K3 Method 2
Node 77
1,5958E+06 1,5610E+06
-2,176

K3_MIN
POST_K1_K1_K3 Method 1
Node 49
1,0638E+06 1,0564E+06
-0,704
K3_MAX
POST_K1_K1_K3 Method 1
Node 49
1,0638E+06 1,0589E+06
-0,464
K3_MIN
POST_K1_K1_K3 Method 2
Node 49
1,0638E+06 9,4420E+06
-11,246
K3_MAX
POST_K1_K1_K3 Method 2
Node 49
1,0638E+06 1,0387E+06
-2,361
K3_MIN
POST_K1_K1_K3 Method 1
Node 1710
1,0638E+06 1,0564E+06
-0,703
K3_MAX
POST_K1_K1_K3 Method 1
Node 1710
1,0638E+06 1,0589E+06
-0,464
K3_MIN
POST_K1_K1_K3 Method 2
Node 1710
1,0638E+06 9,4421E+05
-11,245
K3_MAX
POST_K1_K1_K3 Method 2
Node 1710
1,0638E+06 1,0387E+06

-2,361
K3_MIN
POST_K1_K1_K3 Method 1
Node 77
1,0638E+06 1,0563E+06
-0,708
K3_MAX
POST_K1_K1_K3 Method 1
Node 77
1,0638E+06 1,0589E+06
-0,468
K3_MIN
POST_K1_K1_K3 Method 2
Node 77
1,0638E+06 9,4413E+05
-11,253
K3_MAX
POST_K1_K1_K3 Method 2
Node 77
1,0638E+06 1,0387E+06
-2,366

G_MIN
POST_K1_K1_K3 Method 1
Node 49
1,8943E+01 1,8866E+01
-0,406
G_MAX
POST_K1_K1_K3 Method 1
Node 49
1,8943E+01 1,8884E+01
-0,313
G_MIN
POST_K1_K1_K3 Method 2
Node 49
1,8943E+01 1,6896E+01
-10,804
G_MAX
POST_K1_K1_K3 Method 2

Node 49
1,8943E+01 1,8551E+01
-2,069
G_MIN
POST_K1_K1_K3 Method 1
Node 1710
1,8943E+01 1,8868E+01
-0,395
G_MAX
POST_K1_K1_K3 Method 1
Node 1710
1,8943E+01 1,8887E+01
-0,296
G_MIN
POST_K1_K1_K3 Method 2
Node 1710
1,8943E+01 1,6893E+01
-10,819
G_MAX
POST_K1_K1_K3 Method 2
Node 1710
1,8943E+01 1,8553E+01
-2,058
G_MIN
POST_K1_K1_K3 Method 1
Node 77
1,8943E+01 1,8856E+01
-0,457
G_MAX
POST_K1_K1_K3 Method 1
Node 77
1,8943E+01 1,8875E+01
-0,358
G_MIN
POST_K1_K1_K3 Method 2
Node 77
1,8943E+01 1,6882E+01
-10,881
G_MAX
POST_K1_K1_K3 Method 2
Node 77
1,8943E+01 1,8541E+01
-2,12

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---

11 Modeling E: Calculation of the bilinear form of G

11.1 Characteristics of modeling

The grid is identical to that of preceding calculations, but only the eighth of the block is retained (Oxyz quadrant)

1) Loading 1: Idem modeling B.
2) Loading 2: Face X = 10. : uniform constraint of traction Z = 1,

Face Z = 10. : uniform constraint of traction X = 1 (shearing).
3) Loading 3: Loading 1 + Loading 2.
4) Loading 4: Loading 2 Loading 1.

Four calculations are static are carried out respectively producing displacements U, v, u+v, and considering.

11.2 Characteristics of the grid

A number of nodes:
2774
A number of meshs and type: 392 HEXA20 and 216 PENTA15

11.3 Functionalities tested

Orders

DEFI_GROUP CREA_GROUP_NO

DEFI_MATERIAU ELAS

DEFI_LIST_REEL

"MECHANICAL" AFFE_MODELE
"3D"

AFFE_MATERIAU ALL

AFFE_CHAR_MECA FORCE_FACE
GROUP_MA

PRES_REP
NEAR

STAT_NON_LINE

DEFI_FOND_FISS

CALC_THETA

CALC_G_THETA_T COMP_ELAS
"CALC_G"

CALC_G_THETA_T COMP_ELAS
"CALC_G_BILI"

11.4 Notice

One represents only the eighth of the complete three-dimensional block and thus the eighth of the crack.
Thus, it is necessary to divide the theoretical value of reference of the total rate of refund by 8.

The bilinear form G (U, v) checks the following properties:

G (U, U) = G (U) (
.

form)
1

G (U + v) - G (U - v)
G (U, v) =
(
.
form)
2
.
4
from where
G (2u) - G (2
- v)
G (U - v, U + v) =
= G (U) - G (v)
(
.
form)
3
4

---

12 Results of modeling E

12.1 Values

tested

Identification Reference
Aster %
difference
G total: G (U)
1.82 10+1
1.8273 10+1
0.4
G bilinear: G (U, U)
1.82 10+1 1.8273
10+1 0.4
G total: G (v)
-
6.8612
-
G bilinear: G (v, v)
form.1
6.8612
0.
G total: G (u+v)
-
4.7526 10+1 -
G bilinear: G (u+v, u+v)
form.1
4.7526 10+1 0.
G total: G (UV)
-
2.7428
-
G bilinear: G (UV, UV)
form.1
2.7428
0.
G bilinear: G (v, U)
form.2
1.1195 10+1 0.
G bilinear: G (UV, u+v)
form.3
1.1412 10+1 0.

One indicates by U displacement corresponding to loading 1, and v corresponding displacement with loading 2. Loadings 3 and 4 correspondent with displacements (u+v) and (considering).

---

13 Modeling F: Calculation of the bilinear form of G local

13.1 Characteristics of modeling

The grid is identical to that of modeling E.

1) Loading 1: Idem modeling B.
2) Loading 2: Face X = 10. : uniform constraint of traction Z = 1,

Face Z = 10. : uniform constraint of traction X = 1 (shearing).
3) Loading 3: Loading 1 + Loading 2.
4) Loading 4: Loading 2 Loading 1.

Four calculations are static are carried out respectively producing displacements U, v, u+v, and considering.

13.2 Characteristics of the grid

A number of nodes:
2774
A number of meshs and type: 392 HEXA20 and 216 PENTA15

13.3 Functionalities tested

Orders

DEFI_GROUP CREA_GROUP_NO

DEFI_MATERIAU ELAS

DEFI_LIST_REEL

"MECHANICAL" AFFE_MODELE
"3D"

AFFE_MATERIAU ALL

AFFE_CHAR_MECA FORCE_FACE
GROUP_MA

PRES_REP
NEAR

STAT_NON_LINE

DEFI_FOND_FISS

CALC_G_LOCAL_T COMP_ELAS
"CALC_G"

CALC_G_LOCAL_T COMP_ELAS
"G_BILINEAIRE"

13.4 Notice

One represents only the eighth of the complete three-dimensional block and thus the eighth of the crack. Thus, it is necessary to divide the theoretical value of reference of the total rate of refund by 8.

The bilinear form G (U, v) checks the following properties:

G (U, U) = G (U) (

.
form)
1

G (U + v) - G (U - v)
G (U, v) =
(
.
form)
2
.
4
from where
G (2u) - G (2
- v)
G (U - v, U + v) =
= G (U) - G (v)
(
.
form)
3
4

---

14 Results of modeling F

14.1 Values tested

Node Smoothing R_inf R_sup
Identification
Reference Code_Aster % variation
N2667 Lag-Lag
0.1
1.0
G local: G (U)
5.79
5.746
0.748
N2667 Lag-Lag
0.1
1.0
G bilinear: G (U, U)
5.79
5.746
0.748
N2667 Lag-Lag
0.1
1.0
G max: G (U, U)
-
1.4946E+01
-
N2667 Leg-Leg
0.5
1.5
G local: G (v)
-
2.1737
-
N2667 Leg-Leg
0.5
1.5
G bilinear: G (v, v)
-
2.1737
-
N2773 Leg-Leg
0.5

1.5
G max: G (v, v)
-
6.0334
-
N2667 Lag-Lag
0.2
2.0
G total: G (u+v)
-
1.5150E+01
-
N2667 Lag-Lag 0.2
2.0 G bilinear
: G (u+v,
- 1.5150E+01 -
u+v)
N2667 Lag-Lag
0.2
2.0
G max: G (u+v, u+v)
-
3.8910E+01
-

[Figure 14.1-a] below shows the values of G local in bottom of crack obtained from bilinear form of G. It is the first loading which is applied (simple traction), it requests it first mode of opening of the crack. The fields as G are discretized according to the method of Lagrange. The rays inferior and superior delimiting the crown in which fields decrease linearly are respectively equal to 0.1 mm and 1mm. The value of reference is equal to 5.79 J/m2, cf modeling A.
6,00E+00
5,00E+00
4,00E+00
I
Re
has
G_BILI_LOCAL
3,00E+00
biline
G_REF
2,00E+00
G_

1,00E+00
0,00E+00
00
00
00
00
00
00
00
00
00
00
00
+
-
01
-
01
-
01
-
01
-
01
+
+
+
+
+
+
+
+
+
+
00E
96E
93E
89E
85E
81E
18th
37E
57E

77E
96E
16th
36E
55E
75E
94E
0,
1,
3,
5,
7,
9,
1,
1,
1,
1,
1,
2,
2,
2,
2,
2,
Curvilinear X-coordinate

Appear 14.1-a: G bilinear local according to the curvilinear X-coordinate

One indicates by U displacement corresponding to loading 1, and v corresponding displacement with loading 2. Loading 3 corresponds to displacement (u+v).

---

15 Summaries of the results

Objective triple of this test is reached:

.

It is a question of validating the definition of the closed funds of crack and installations consequent calculation of G local. One checks in particular the independence of G local with respect to the angle for an axisymmetric crack and a loading. One notes a variation of less than 2% on the whole of the bottom of crack by two methods "LAGRANCE" and "LAGRANGE_NO_NO".

.

Moreover, this test makes it possible to validate the order POST_K1_K2_K3 which makes it possible to calculate them stress intensity factors by exploiting the jump of displacements on the lips of fissure. This method, less precise than G_THETA, makes it possible to obtain here (with a grid adapted: nodes mediums of the edges touching the bottom of crack moved with the quarter of these edges) of the values of K1 and K3 to less than 1% of the reference (for the method of extrapolation number 1). With the method of extrapolation number 2, the variation can go up to 8%. Precision of the method of extrapolation number 3, tested in modeling B, lies between those of the two preceding methods. Method 3 is however interesting because it provides a single value of the stress intensity factors and not not a maximum value and a minimal value.

.

Lastly, one validates the calculation of the bilinear form of G.

:
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Organization (S): EDF-R & D /AMA

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V3.04.135 document

SSLV135 Damage by tiredness under
alternate biaxial loading

Summary:

One presents a test here having an analytical reference [bib1]. The geometry treated here is a cube without defect
with which one carries out a linear elastic mechanical calculation followed calculation of the plan of shearing criticizes in
each point of Gauss and in each node.

Each of four modelings tests a criterion:

.
modeling a: criterion MATAKE;
.
modeling b: criterion DANG_VAN_MODI_AC;

·

modeling C: criterion DOMM_MAXI;

·

modeling D: criterion DANG_VAN_MODI_AV,

·

modeling E: criterion FATEMI_SOCIE.

The first two criteria are said "to plan of critical shearing", they are adapted to the loadings periodicals. The last two criteria can be qualified criteria "in plan of critical damage", they can be used when the loading is not periodical.

1
Problem of reference

1.1 Geometry
has
Face 1
has = 10
has =
m
10 m
Face 1
(above)
P1
P2
P
P5

P6
Face 4
(on the right-hand side)
Face 5
F
(behind)
Face 3
F
(side ga
G uche)
P3
P4
Face 6
F
(in front of)
(Dev.
Y
X
P7
P8
F
F this 2
(below)
Z

The cube has 10 mm on side.

1.2
Material properties

Young modulus: E = 200000 MPa

Poisson's ratio: = 0.3
Ultimate constraint: =
0
.
850 MPa
U
Curve of Wöhler (alternate traction and compression controlled in constraint):

Half amplitude of constraint 138.0 152.0 165.0 180.0 200.0 250.0 295.0
(MPa)
A number of cycles

1.0E+6 0.5E+
0.2E+
0.1E+
0.05E+
0.02E+
12.0E+
6
6
6
6
6
4
Half amplitude of constraint 305.0 340.0 430.0 540.0 690.0 930.0 1210.0
(MPa)
A number of cycles
10.0E+
5.0E+
2.0E+
1.0E+
5.0E+2 2.0E+2 1.0E+2
4
3
3
3
Half amplitude of constraint 1590.0 2210.0 2900.0
(MPa)
A number of cycles
50.0
20.0
10.0
Table 1.2-1: Curve of Wöhler

1.3 Boundary conditions and loadings

.
Displacements according to axis X of face 3 are blocked (DX=0.0).
.
Displacements according to the axis Y of face 2 are blocked (DY=0.0).
.
Displacements of the P3 point are blocked according to axis Z (DZ=0.0).
.
We apply an alternate biaxial loading (traction and compression) according to axes X and Y.
Fx (T) represents the alternate efforts applied to face 4 according to axis X and Fy (T) represents them
alternate efforts applied to face 1 according to axis Y.

Loading for modelings A and b:
200N
20
Fx (
Fx T)
100N
10
T
0
1s
2s
-100N
-200N
Fy (T)

Loading for modelings C and D:

1.4 Conditions initial

Without object for a static analysis.

2
Reference solution

2.1
Method of calculation used for the reference solution

In the case of an alternate biaxial loading where the pressures applied are such as: =,
X
y
with > 1 and < 0, one show [bib1] that it half amplitude of maximum shearing

2 = (

+

, where

2 and

2 represent the half amplitudes of constraints
X
y) 4
X
y
applied according to axes X and Y. Moreover, there are two critical plans in which shearing is maximum:

Y
n1
n1
n22
X
Z

L S two pl
S two p years of cis
years
has
of cis illement
maximum men
max badly

2.2
Results of reference for modelings A and B

See the references [bib2] and [R7.04.01].

Half amplitude of maximum shearing:

2 (MPa)

2 (MPa)

2 (MPa)
X
y
100 200 150

Note:

The half amplitude of maximum shearing is identical for the two critical plans.

Normal vectors in the two critical plans:

n1
N2
Component X
-1 2

1 2
Component y
1 2
1 2
Component Z 0
0

Normal maximum constraints in the fields of the normals n1 and N2:
NR
(N) = 50 MPa
max
1
and NR
(N) = 50 MPa
max
2
.

Hydrostatic pressure maximum, independent with respect to the plans of normals n1 and N2:
P =
33333
,
33
MPa.

Normal average constraints in the fields of the normals n1 and N2:
NR (N)

MPa
m
0
1 =
and NR (N)
MPa
m
0
2 =
.

Normal maximum deformations in the fields of the normals n1 and N2:
4
max (
-
n1) = 75
,
1
10 and
4
max (
-
N2) = 75
,
1
10

Normal average deformations in the fields of the normals n1 and N2:
(N) 0
m
1 =
and (N)
0
m
2 =
.

Criterion of MATAKE

(N)
I
+ NR has
(N) B, I =,
1 2

2
max
I
where has = 1 and B = 2.

Equivalent constraints within the meaning of MATAKE in the fields of the normals n1 and N2:

(N)
I
F
(N) =
N

eq
I

+ NR has
( )
I
, I =,
1 2

2
max
T
where F and T represent, respectively, the limit of endurance in alternating bending and the limit of endurance in alternate torsion. Here F T is equal to 5
,
1. Consequently we have:
(N)
MPa
eq
300
1 =
and
(N)
MPa
eq
300
2 =
.

Numbers of cycles to the rupture in the fields of the normals n1 and N2:

From the curve of Wöhler, cf [Table 1.2-1], and equivalent constraints within the meaning of MATAKE, we obtain:
Nb (N) = Nb (N) = 10946
Cr
1
Cr
2
cycles.

Damage in the fields of the normals n1 and N2:
5
ENDO (
-
n1) = ENDO (N2) = 913565
,
10 .

Criterion of Dang Van adapted to the periodic loadings:
DANG_VAN_MODI_AC

(N)
I
+ has P B, I =,
1 2
2
where has = 1 and B = 2.
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Equivalent constraints within the meaning of DANG VAN in the fields of the normals n1 and N2:

*(**N**)*
I
C
*(**N**) =*

eq
I

+ has P, I =,
1 2

2
T

where C and T represent, respectively, the limit of endurance in alternate shearing and the limit of endurance in alternate traction and compression. Here C T is equal to 5
,
1. Consequently we have:

*(**N**) = 275 MPa and (**N**) = 275 MPa.*
eq
1
eq
2

*Numbers of cycles to the rupture in the fields of the normals **n1** and **N2***
From the curve of Wöhler, cf [Table 1.2-1], and equivalent constraints within the meaning of DANG VAN, we obtain:
*Nb (**N**) = Nb (**N**) = 14903cycles.*

Cr
1
Cr
2

*Damage in the fields of the normals **n1** and **N2**:*
-5
*ENDO (**N**) = ENDO (**N**) = 709959*
,
6
10 .
1
2

2.3
Results of reference for modelings C and D

See the references [bib2] and [R7.04.01].

Half amplitude of constraint:

2 (MPa)

2 (MPa)
X
y
100 200

Criterion of MATAKE adapted to the nonperiodic loadings: DOMM_MAXI

For this criterion there are no analytical results.

Criterion of Dang Van adapted to the nonperiodic loadings: DANG_VAN_MODI_AV

For this criterion there are no analytical results.

---

3 Modeling
With

3.1
Characteristics of modeling

Modeling 3D: 125 quadratic elements of volume: HEXA8.

Grid of the cube made with GIBI 2000

Appear of the grid of the cube

Test criterion MATAKE.

3.2
Characteristics of the grid

The grid of the cube was obtained starting from the version 2000 of maillor GIBI.

A number of nodes: 216
A number of meshs: 465

3.3 Functionalities tested

Orders Options
LIRE_MAILLAGE

DEFI_GROUP CREA_GROUP_NO

CREA_GROUP_MA
DEFI_FONCTION NOM_PARA
“SIGM”
Interpol
“LOG”
DEFI_FONCTION NOM_PARA
“INST”
DEFI_MATERIAU ELAS

TIRE
CISA_PLAN_CRIT
DEFI_LIST_REEL

“MECHANICAL” AFFE_MODELE
“3D”
AFFE_MATERIAU ALL

AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
FACE_IMPO
GROUP_MA
FORCE_FACE
GROUP_MA
STAT_NON_LINE

MECA_STATIQUE

CALC_FATIGUE TYPE_CALCUL
“FATIGUE_MULTI”
OPTION

“DOMA_ELGA”

“DOMA_NOEUD”
TYPE_CHARGE
“PERIODIC”
RESULT
GROUND
CHAM_MATER
CHECHMATE
GROUP_MA
“FACE1”, “FACE2”, “FACE3”

“FACE4”, “FACE5”, “FACE6”
GROUP_NO
“FACE4”, “FACE5”, “FACE6”
GRID
CUBIC
CRITERION
“MATAKE”
METHOD
“CERCLE_EXACT”

4
Results of modeling A

4.1 Values

tested

Identification
Type of value
Reference
Aster *Variation*
(%)
Nodes: N1; N206;
(Moment: 3)
1.00000E+02
1.00000E+02
0.0
xx
Net: M60,
Not Gauss: 3
,,
(Moment: 3)
2.00000E+02
2.00000E+02
0.0
yy
,,

*(**N**) 2*
1.500000E+02
1.500000E+02
0.0
1
,,
component X of ***n1*** *7.071068E01 7.071068E01*
0.0
,,
component there of ***n1***
7.071068E01 7.071068E01
0.0
,,
component Z of ***n1***
0.0 6.123234E17
0.0
,,
NR
( )
max ***n1***

5.000000E+01 5.000000E+01
0.0
,,
*NR (**N**)*
m
1
0.0 4.235754E14
0.0
,,

( )
*max **n1***
1.750000E04 1.750000E04
0.0
,,
*(**N**)*
m
1
0.0 1.564995E19
0.0
,,
*(**N**)*
eq
1
3.000000E+02 3.000000E+02
0.0
,,
*(**N**)*
Cr
Nb
1
1.094600E+04 1.094600E+04
0.0
,,
*ENDO (**N**)*
1
9.135647E05 9.135647E05
0.0
,,

*(**N**) 2*
1.500000E+02 1.500000E+02 0.0
2

,,
*component X of **N2** 7.071068E01 7.071068E01 0.0*
,,
***N2** component there 7.071068E01 7.071068E01 0.0*
,,
*component Z of **N2***
0.0 6.123234E17
0.0
,,
NR
(
)
*max **N2***
5.000000E+01 5.000000E+01
0.0
,,
*NR (**N**)*
m
2
0.0 4.235754E14
0.0
,,

(
)
*max **N2***
1.750000E04 1.750000E04
0.0
,,
*(**N**)*
m
2
0.0 1.564995E19
0.0
,,
*(**N**)*
eq
2
3.000000E+02 3.000000E+02
0.0
Nodes: N1; N206;
*(**N**)*
Cr

Nb
2
1.094600E+04 1.094600E+04
0.0
Net: M60,
Not Gauss: 7
,,
*ENDO (**N**)*
2
9.135647E05 9.135647E05
0.0

The variations being lower than 1.0E-08 we put zero in the table above.

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Code_Aster ®
Version
8.2

Titrate:
SSLV135 Endommagement by tiredness under alternate biaxial loading Dates:
02/11/05
Author (S):
J.** Key **ANGLES
:
V3.04.135-B Page:
10/14

5 Modeling B

5.1 Characteristics of modeling

Except the criterion of tiredness tested, modeling B is identical to modeling A.
Test criterion DANG_VAN_MODI_AC.

5.2 Characteristics of the grid

Identical to modeling A.

5.3 Functionalities tested

The functionalities tested are identical to modeling A. only the option CRITERION of order CALC_FATIGUE is different:

Orders Options
CALC_FATIGUE CRITERION
“DANG_VAN_MODI_AC”

6
Results of modeling B

6.1 Values tested

Identification
Type of value
Reference
Aster *Variation*
(%)
Nodes: N1; N206;
(Moment: 3)
1.00000E+02

1.00000E+02
0.0
xx
Net: M60,
Not Gauss: 3
,,
(Moment: 3)
2.00000E+02
2.00000E+02
0.0
yy
,,

*(**N**)*
1
1.500000E+02
1.500000E+02
0.0
,,
*component X of **n1***
7.071068E01 7.071068E01
0.0
,,
*component there of **n1***
7.071068E01 7.071068E01
0.0
,,
*component Z of **n1***
0.0 6.123234E17
0.0
,,
NR
( )
*max **n1***
5.000000E+01 5.000000E+01
0.0
,,
*NR (**N**)*
m
1
0.0 4.235754E14
0.0
,,

( )
*max **n1***
1.750000E04 1.750000E04
0.0
,,
*(**N**)*
m
1
0.0 1.564995E19
0.0
,,
*(**N**)*
eq
1
2.750000E+02 2.750000E+02
0.0
,,
*(**N**)*
Cr
Nb
1
1.490300E+04 1.490300E+04
0.0
,,
*ENDO (**N**)*
1
6.709959E05 6.709959E05
0.0
,,

*(**N**)*
2
1.500000E+02 1.500000E+02 0.0
,,
*component X of **N2** 7.071068E01 7.071068E01*
0.0
,,
***N2** component there 7.071068E01 7.071068E01 0.0*
,,
*component Z of **N2***
0.0 6.123234E17
0.0

,,
NR
(
)
*max **N2***
5.000000E+01 5.000000E+01
0.0
,,
*NR (**N**)*
m
2
0.0 4.235754E14
0.0
,,

(
)
*max **N2***
1.750000E04 1.750000E04
0.0
,,
*(**N**)*
m
2
0.0 1.564995E19
0.0
,,
*(**N**)*
eq
2
2.750000E+02 2.750000E+02
0.0
Nodes: N1; N206;
*(**N**)*
Cr
Nb
2
1.490300E+04 1.490300E+04
0.0
Net: M60,
Not Gauss: 7
,,
*ENDO (**N**)*

2
6.709959E05 6.709959E05
0.0

The variations being lower than 1.0E-08 we put zero in the table above.

---

7 Modeling C

7.1 Characteristics of modeling

Except the criterion of tiredness tested and the loading, cf [§ 1.3], modeling C is identical to modeling A.
Test criterion DOMM_MAXI.

7.2 Characteristics of the grid

Identical to modeling A.

7.3 Functionalities tested

The functionalities tested are identical to modeling A except the following options: CRITERION is modified, METHOD is not used any more and PROJECTION is added:

Orders Options
CALC_FATIGUE CRITERION
“DOMM_MAXI”
POJECTION
“UN_AXE”

“DEUX_AXES”

8
Results of modeling C

8.1 Values
tested

Identification
Type of value
Reference
Aster *Variation*
(%)
Nodes: N1; N206;
(Moment: 3)
1.00000E+02
1.00000E+02
0.0
xx
Net: M60,
Not Gauss: 3
,,
(Moment: 3)
2.00000E+02
2.00000E+02
0.0
yy
,,
component X of ***N***
_ _
1
_ _ 3.746066E01
3.907311E01
,,
component there of ***N***

_ _
1
_ _ 9.271839E01
9.205049E01
,,
*component Z of **n1***
_ _ 6.123234E17
_ _
,,
*ENDO (**N**)*
1
_ _ 7.049845E05
_ _

*In the table above, components X and of **n1** have two values there because there are two vectors which correspond to the same value of damage ENDO (**N**)*
1 .

---

9 Modeling D

9.1 Characteristics of modeling

Except the criterion of tiredness tested and the loading, cf [§ 1.3], modeling D is identical to modeling A.

Test criterion DANG_VAN_MODI_AV.

9.2
Characteristics of the grid

Identical to modeling A.

9.3 Functionalities tested

The functionalities tested are identical to modeling A except the following options: CRITERION is modified, METHOD is not used any more and PROJECTION is added:

Orders Options
CALC_FATIGUE CRITERION
"DANG_VAN_MODI_AV"
POJECTION
"UN_AXE"

"DEUX_AXES"

10 Results of modeling D

10.1 Values tested

Identification
Type of value
Reference
Aster Variation
(%)
Nodes: N1; N206;
(Moment: 3)
1.00000E+02
1.00000E+02
0.0
xx
Net: M60,
Not Gauss: 3
,,
(Moment: 3)

2.00000E+02
2.00000E+02
0.0
yy
,,
component X of n1
_ _ 7.071068E01
– –
,,
component there of n1
_ _ 7.071068E01
– –
,,
component Z of n1
_ _ 6.123234E17
– –
,,
ENDO (N)
1
_ _ 1.341992E04
– –

---

11 Modeling
E

11.1 Characteristics of modeling

Except the criterion of tiredness tested and the loading, cf [§ 1.3], modeling E is identical to modeling A.
Test criterion FATEMI_SOCIE.

11.2 Characteristics of the grid

Identical to modeling A.

11.3 Functionalities tested

The functionalities tested are identical to modeling A except the following options: CRITERION is modified, METHOD and MECA_STATIQUE are not used any more and PROJECTION is added:

Orders Options
CALC_FATIGUE CRITERION
"FATEMI_SOCIE"
POJECTION
"UN_AXE"

"DEUX_AXES"

12 Results of modeling E

12.1 Values tested

Identification
Type of value
Reference
Aster Variation
(%)
Nodes: N1; N206;
(Moment: 3)
1.00000E+02
1.00000E+02
0.0
xx
Net: M60,
Not Gauss: 3
"
(Moment: 3)

2.00000E+02
2.00000E+02
0.0
yy
,,

-8.00000E-04
-8.00000E-04
0.0
xx (Moment: 3)
,,

1.15000E-03
1.15000E-03
0.0
yy (Urgent: 3)
,,

-1.50000E-04
-1.50000E-04
0.0
zz (Urgent: 3)
,,
component X of n1
_ _ ±4.383711E01
– –
,,
component there of n1
_ _ 8.987940E01
– –
,,
component Z of n1
_ _ 6.123234E17
– –
,,
ENDO (N)
1
_ _ 1.682346E01
– –

13 Summary of the results

The results obtained are in perfect agreement with the reference solution for modelings A and B. modeling C, D and E do not have reference solutions associated with the criteria.

Organization (S): EDF-R & D /AMA, DeltaCAD

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
Document: V3.04.139

SSLV139 - Buckling of a circular plate subjected to a compressive force uniformly distributed on its contour

Summary:

This test represents a calculation of stability of a circular plate subjected to a compressive force uniformly distributed on its contour. We determine the critical load leading to buckling rubber band of Euler as well as the associated modal deformation.

This test validates modeling AXIS_FOURIER for linear buckling with meshs QUAD8 and TRIA6 (circumferential mode equal to zero), and modeling AXIS with meshs QUAD8.

The critical load obtained is compared with an analytical reference solution.

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1
Problem of reference

1.1 Geometry

Z
Y
Fcr
Y
X
Z.
X
With
B

.
Thickness of the plate: H = 0.0005 m
.
Ray of the plate: R = 0.115 m

1.2
Properties of material

The properties of material constituting the plate are:

11

E =2.110 Pa

Young modulus
= 3
.
0

Poisson's ratio

1.3
Boundary conditions and loadings

Boundary conditions:
·
on the contour of the plate (not B): displacement following Y=0 and rotation around Z = 0

Loading: one applies a compressive force uniformly distributed F to external contour plate.

1.4 Conditions initial

Without object.

2

Reference solution

2.1
Method of calculation

The value of the critical load is given in [bib1] by the following expression:

68
.
14
D
Fcr =

2
R

with: D the bending stiffness of the plate (in N.m) defined by the following expression:

3
=
Eh
D

1
(
12
2
-)

This critical load is associated a circumferential mode equal to 0.

2.2
Sizes and results of reference

For the characteristics given, the critical load is worth:

Cr
F = 2668.315 N/m

2.3
Uncertainties on the solution

Analytical solution

2.4 References bibliographical

[1]
S.P. TIMOSHENKO, J.M. MANAGES: Theory of elastic stability, second edition, DUNOD (1966)
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/04/005/A

---

3 Modeling With

3.1 Characteristics of modeling

Modeling AXIS_FOURIER (QUAD8): 3 degrees of freedom per node (DX, DY, DZ)

Y
D
C
X
With
B
Z

Limiting conditions:
·
group meshs AD: DX = 0, DZ = 0
·
group meshs BC: DY = 0, DZ = 0

Characteristics of the discretization
·
Sides AB and CD: 460 elements
·
Sides AD and BC: 4 elements

3.2
Characteristics of the grid

A number of nodes: 6449
A number of meshs: 1840 (QUAD8)

3.3 Functionalities
tested

Orders

AFFE_MODELE
AFFE
MODELING = "AXIS_FOURIER"
AFFE_CHAR_MECA DDL_IMPO
GROUP_MA
FORCE_CONTOUR
FX
MACRO_ELAS_MULT
CAS_CHARGE
MODE_FOURIER = 0
CALC_MATR_ELEM
OPTION = "RIGI_MECA"

OPTION = "RIGI_GEOM"

MODE_FOURIER = 0

MODE_ITER_SIMULT

METHOD = “SORENSEN”

TYPE_RESU = “MODE_FLAMB”

CALC_FREQ
OPTION = “SMALLER”
NORM_MODE

= “TRAN NORMALIZES”

3.4
Sizes tested and results

Identification
Reference
***Aster** %*
Difference
Pressure criticizes (n=0)
8.4935 105 Pa
8.4847 105 Pa
-0.104
Displacement DY with the node D
1 9.99985
10-1 -0.001
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/04/005/A

3.5 Remarks

.

The pressure criticizes Pcr of reference, used in the command file, was obtained with
to leave the referred critical load in the paragraph [§2.2]:

F
2
P
Cr
=
= 849350.94N/m
Cr
2 H

.

The standardization of the clean mode for largest of the components of translation imply a value of reference equal to 1 for displacement DY to node D.

---

4 Modeling
B

4.1

Characteristics of modeling

Modeling AXIS (QUAD8): 2 degrees of freedom per node (DX, DY)

Y
D
C
X
With
B
Z

Limiting conditions:
·
group meshs AD: DX = 0
·
group meshs BC: DY = 0

Characteristics of the discretization
·
Sides AB and CD: 460 elements
·
Sides AD and BC: 4 elements

4.2
Characteristics of the grid

A number of nodes: 6449
A number of meshs: 1840 (QUAD8)

4.3 Functionalities
tested
·
Orders

AFFE_MODELE
AFFE
MODELING = "AXIS"
AFFE_CHAR_MECA DDL_IMPO

GROUP_MA
FORCE_CONTOUR
FX
MACRO_ELAS_MULT CAS_CHARGE

CALC_MATR_ELEM
OPTION = “RIGI_MECA”

OPTION = “RIGI_GEOM”
MODE_ITER_SIMULT

METHOD = “SORENSEN”

TYPE_RESU = “MODE_FLAMB”

CALC_FREQ
OPTION = “SMALLER”
NORM_MODE

= “TRAN NORMALIZES”

4.4
Sizes tested and results

Identification
Reference
Aster *%*
Difference
Pressure criticizes (n=0)
8.4935 105 Pa
8.4847 105 Pa
-0.104
Displacement DY with the node D
1 9.99985
10-1 -0.001

4.5 Remarks

.

The pressure criticizes Pcr of reference, used in the command file, was obtained with
to leave the referred critical load in the paragraph [§2.2]:

F
2
P
Cr
=
= 849350.94N/m
Cr
2 H

.

The standardization of the clean mode for largest of the components of translation
imply a value of reference equal to 1 for displacement DY to node D.

---

5 Modeling C

5.1 Characteristics of modeling

Modeling AXIS_FOURIER (TRIA6): 3 degrees of freedom per node (DX, DY, DZ)

Y
D
C
X
With
B
Z

Limiting conditions:

- *group meshs AD: DX = 0, DZ = 0.*
- *group meshs BC: DY = 0, DZ = 0.*

Characteristic of the discretization

- *Sides AB and CD: 690 elements*
- *Sides AD and BC: 6 elements*

5.2 Characteristics of the grid

A number of nodes: 17 964
A number of meshs: 8.280 (TRIA6)

5.3 Functionalities tested

.

Orders

AFFE_MODELE
AFFE
MODELING = "AXIS_FOURIER"
AFFE_CHAR_MECA DDL_IMPO
GROUP_MA
FORCE_CONTOUR
FX
MACRO_ELAS_MULT
CAS_CHARGE
MODE_FOURIER = 0
CALC_MATR_ELEM
OPTION = "RIGI_MECA"

OPTION = "RIGI_GEOM"

MODE_FOURIER = 0
MODE_ITER_SIMULT

METHOD = "SORENSEN"

TYPE_RESU = "MODE_FLAMB"

CALC_FREQ
OPTION = "SMALLER"
NORM_MODE

= "TRAN NORMALIZES"

5.4 Sizes tested and results

Identification
Reference
***Aster** %*
Difference

Pressure criticizes (n=0)
8.4935 105 Pa
8.6943 105 Pa
2.364
Displacement DY with the node D
1 9.99986
10-1 -0.001

5.5 Remarks

.
The pressure criticizes Pcr of reference, used in the command file, was obtained with
to leave the referred critical load in the paragraph [§2.2]:

F
2
P
Cr
=
= 849350.94N/m
Cr
2 H

.
The standardization of the clean mode for largest of the components of translation

imply a value of reference equal to 1 for displacement DY to node D.

6
Summary of the results

The results obtained are very satisfactory for meshs QUAD8 independently of modeling used (AXIS or AXIS_FOURIER): uncertainties on the critical pressure 0.104% do not exceed.

However, it will be noted that modeling AXIS_FOURIER is definitely less precise with meshs TRIA6 that with meshs QUAD8.

This test with licence to test and compare modelings AXIS and AXIS_FOURIER in buckling linear of Euler of a circular mean structure subjected to an external force of compression uniformly distributed on its contour.

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
V3.04.140 document

SSLV140 - Calculation of effective modules by one method Python

Summary:

One presents a test here having an analytical reference. The treated geometry is a whole of two cubes having different elastic properties. The goal is to find the Young modulus of the mixture made up of these two cubes along two directions.

1
Problem of reference

1.1 Geometry

P1
P2
P9
P5
P6
P11
P3
P4
P10
Y
P7
P8
P12
X
Z

Following surfaces are defined:

· *Face YZ1: containing the nodes P1, P3, P5 and P7.*
· *Face YZ2: containing the nodes P9, P10, P11 and P12.*
· *Face XY1: containing the nodes P1, P2, P9, P3, P4 and P10.*
· *Face XY2: containing the nodes P5, P6, P11, P7, P8 and P12.*
· *Face XZ1: containing the nodes P3, P4, P10, P7, P8 and P12.*

· Face XZ2: containing the nodes P1, P2, P9, P5, P6 and P11.

and following elements:

· Elément M1: containing the nodes P1, P2, P3, P4, P5, P6, P7 and P8.
· Elément m2: containing the nodes P2, P9, P4, P10, P6, P11, P8 and P12.

1.2
Material properties

Two materials are used:

· Matériau MAT1 allotted to the M1 element:

Young modulus: E1 = 200000 MPa

Poisson's ratio: 1 = 0.3

· Matériau MAT2 allotted to the element m2:

Young modulus: E2 = 100000 MPa

Poisson's ratio: 2 = 0.3

1.3
Boundary conditions and loadings

The first calculation:
It is a simple calculation of traction according to direction X:
· One imposes a linear elastic strain = 1 on surface YZ2.
xx
· Surface YZ1 does not move according to direction X.

The second calculation:
It is a simple calculation of traction according to the direction Y:
· One imposes a linear elastic strain
= 1 on surface XZ2.
yy
· Surface XZ1 does not move according to direction Y.

2
Reference solution

2.1
Method of calculation

According to the general theory of the homogenisation of composite materials [bib1], the Young moduli manpower EFF
E and EFF
E following directions X and Y of a mixture having the form given above, is
xx
yy
given by the following formulas:

1
F
F
1
2
=
+

E EFF
E
E
xx
1
2
E EFF = F E + F E

yy
1
1
2
2

F and F are the voluminal fractions of each material, in our case:
1
2

F = F = 0.5
1
2

2.2 References bibliographical

[1]
Mr. BORNET, T. BRETHEAU and P. GILORMINI: Homogenisation in mechanics of materials (T1). Hermes Science Publications - 2001.

---

3 Modeling With

3.1

Characteristics of the grid

A number of nodes: 12.
Modeling 3D: 2 quadratic elements of volume: HEXA8.

3.2 Functionalities tested

Orders
Options

CREA_CHAMP
TYPE_CHAM
“ELGA_SIEF_R”
OPERATION
“EXTR”
RESULT

NOM_CHAM
“SIEF_ELGA_DEPL”
CALC_CHAM_ELEM
MODEL

CHAM_MATER

OPTION
“COOR_ELGA”
EXTR_COMP

Python orders are inserted directly in the command file ASTER. These orders are used to write functions of postprocessing on the fields of results, like the averages, the trace of a tensor of deformations or constraints,… etc fields of results are recovered by order EXTR_COMP.

4
Results of modeling A

4.1 Values tested

The first calculation:
The Young modulus following direction X in this case is the average of the constraints:

xx

EFF
E
=< >
xx
xx

The second calculation:
The Young modulus following the direction Y in this case is the average of the constraints:
yy

EFF
E
=< >
yy
yy

Identification Reference
***Aster** %*
difference
< >
133333 134134
1.00
xx
< >
150000 150000
0.00
yy

5
Summary of the results

The results obtained are in perfect agreement with the reference solution.

:
17/06/03
Author (S):
X. DESROCHES *Key*
:
V3.04.301-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
Document: V3.04.301

SSLV301 - Cylindrical beam comforts under load
linearly distributed

Summary:

The goal of the test is to validate a load linearly distributed, starting from an analysis 2D with decomposition in
Fourier series of the load.

2 calculations here are carried out:

· a calculation with the first 2 modes (0 and 1),
· a calculation with the first 10 modes.

1
Problem of reference

1.1 Geometry

C

Length
: L
= 0.240 m
Ray
: R
= 0.006 m

1.2
Material properties

E = 2.1 X 1011 N/m2
= 0.3

1.3
Boundary conditions and loadings

· Embedded Arête AB

· Charge varying linearly according to Z on generator BC, being worth:

Q = 0 out of C and Q = 3000 N/m out of B

1.4 Conditions initial

Without object for the static analysis.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution is obtained analytically [bib1].

2.2 Results of reference

· Radial Déplacement of the point C: urc = 1.552 X 103 m
· Contraintes embedding at point b: zz (B) = 169.8 X 106 Pa

2.3 Uncertainty on the solution

Analytical solution.

2.4 Reference bibliographical

[1]
S. TIMOSHENKO: Resistance of materials, 1st part. Polytechnic bookshop
CH. Béranger, Paris, 1947

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/03/008/A

---

3 Modeling With

3.1 Characteristics of modeling

AXIS_FOURIER, T6 mesh

Cutting: 80 elements according to the length

2 elements in the thickness

Z
D
C

B
R
With

3.2
Characteristics of the grid

A number of nodes: 805
A number of meshs and types: 320 TRIA6

3.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “AXIS_FOURIER”
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

AFFE_CHAR_MECA_F FORCE_CONTOUR
GROUP_MA

COMB_FOURIER NOM_CHAM
“DEPL”

“SIGM_ELNO_DEPL”
CREA_CHAMP “EXTR”

X. DESROCHES Key
:
V3.04.301-A Page:
5/6

4
Results of modeling A

4.1 Values
tested

Values provided for = 0.

Standard localization
of
value
Reference
Aster
% difference
Calculation 1 (2 modes)

Not C
ur (m)
1.552 X 103
1.54839 X 103 0.232
Not B
zz (Pa)
169.8 X 106
168.73 X 106 0.63
Calculation 2 (10 modes)

Not C
ur (m)
1.552 X 103
1.54839 X 103 0.232
Not B
zz (Pa)
169.8 X 106

168.59 X 106 0.71

4.2 Notice

The values of the arrow of the beam and the constraint of embedding are obtained with precision with the first two modes only.

5
Summary of the results

The results resulting from calculation are in concord with the analytical solution.

Author (S):
X. DESROCHES Key
:
V3.04.303-A Page:
1/16

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
Document: V3.04.303

SSLV303 - Roll embedded under actual weight and pressure

Summary:

The goal of the test is to validate a load of gravity as well as a pressure, starting from an analysis 2D with
decomposition in Fourier series of the load.

Two modelings are adopted for this analysis; they differ from the key word used to define gravity:

· modeling a: to validate the key word GRAVITY,
· modeling b: to validate key word FORCE_INTERNE.

Gravity is calculated in mode 1, and the pressure applied is given in mode 1.

The two loading cases are combined and compared with a numerical calculation in modeling 3D (model C).

The fourth modeling (D) is built with an aim of validating key word FORCE_INTERNE defined to leave of a function.

1
Problem of reference

1.1 Geometry

Length
: L
= 0.240 m
Ray
: R
= 0.006 m

1.2
Material properties

E = 2.1 X 1011 N/m2
= 0.3
= 7800 kg/m3

1.3
Boundary conditions and loadings

· Sections AB, CD embedded
· Gravité according to R

: G = 9.81 m/s2
· Pression given by: p = Po cos, Po = 10.000 N/m2

1.4 Conditions
initial

Without object for the static analysis.

2
Reference solution

2.1
Method of calculation used for the reference solution

In the case of load of gravity alone:
The value of the field of radial displacement, according to Z, is given by:

Q 4
2
Z
L

ur =

- 3
Lz +
2
Z

12EI 2
2

Maximum displacement, in the median section, is worth:

3
PL
(
ur E) =
, P:
roll

clean

weight

384EI

In the case of load of pressure, one carries out a comparison with the results of modeling C.

2.2
Results of reference

· Déplacement in the median section, (
ur E) = 0.3566 X 106 m
· Contraintes embedding at point b: zz = 0.2496 X 106 Pa

2.3
Uncertainty on the solution

Analytical solution for gravity.

2.4 Reference
bibliographical

[1]
S. TIMOSHENKO: Resistance of materials, 1st part. Polytechnic bookshop
CH. Béranger, Paris, 1947
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/03/008/A

---

3 Modeling
With

3.1
Characteristics of modeling A

AXIS_FOURIER, T6 mesh

With
E
D
B
F
C
Z

R

Cutting:
80 elements according to the length

2 elements according to the ray

Loadings:

C1:
vertical gravity (Ug field) (G 2)
C2:
pressure (Up field) Po = 10.000 N/m2

Components of displacements: ur (radial), uz (axial), U (circumferential)

Names of the nodes:

With = N1
B = N2
C = N3
D = N4
E = N249
F = N87

3.2
Characteristics of the grid

A number of nodes: 805
A number of meshs and types: 320 TRIA6

3.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “AXIS_FOURIER”
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
GRAVITY
CALC_CHAM_ELEM OPTION
“SIGM_ELNO_DEPL”
MODE_FOURIER
AFFE_CHAR_MECA_F PRES_REP
GROUP_MA

COMB_CHAM_NO
COMB_FOURIER

COMB_CHAM_ELEM
COMB_FOURIER
MACRO_ELAS_MULT CHAR_MECA_GLOBAL
MODE_FOURIER

CAS_CHARGE
TYPE_MODE
CHAR_MECA

4
Results of modeling A

4.1 Values
tested

Values provided for = 0.

Standard localization
of
value
Reference
Aster
% difference
Ug field

(for = 0.)
Not E, F
ur (m)
3.566 X 107
3.541 X 107
-0.701
U (m)
0.
3.94 10-14
Not B
zz (Pa)
2.496 X 105
2.598 X 105 +

4.09
Up field

(for = 0.)
Not E
ur (m)
7.82 X 106
7.71 X 106 1.4
Not F

7.82 X 106
7.70 X 106 1.5
Not B
rr (Pa)
1.63 X 106
1.41 X 106
-13.4

5.51 X 106
5.65 X 106
2.7
zz (Pa)

1.65 X 106
1.89 X 106
14.7
(Pa)
Up field + Ug

(for = 0.)
Not E
ur (m)
7.46 X 106
7.358 X 106 1.3
Not F
ur (m)
7.44 X 106
7.348 X 106 1.2
Not B

rr (Pa)
1.56 X 106
1.34 X 106
-13.7

5.25 X 106
5.398 X 106
2.8
zz (Pa)

1.57 X 106
1.80 X 106
15.0
(Pa)

4.2 Remarks

· The values of reference for the pressure (Up field) are obtained in modeling C, with to start from a grid 3D.
· For gravity, it should be stressed that the order of the components in GRAVITY is: R, Z (whereas in FORCE_INTERNE the order is R, Z,).

4.3
Contents of the file results

Displacements, constraints.

---

5 Modeling B

5.1 Characteristics of modeling B

AXIS_FOURIER, T6 meshs

With
E
D
B
F
C
Z

R

Cutting:
80 elements according to the length

2 elements according to the ray

Loadings:

C1: vertical gravity (Ug field) in the form of voluminal density of forces G = 76.518 Pa
C2: pressure (Up field)

Components of displacements: ur (radial), uz (axial), U (circumferential)

Names of the nodes:

With = N1
B = N2
C = N3

D = N4
E = N249
F = N87

5.2
Characteristics of the grid

A number of nodes: 805
A number of meshs and types: 320 TRIA6

5.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “AXIS_FOURIER”
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO
FORCE_INTERNE
CALC_CHAM_ELEM OPTION
“SIGM_ELNO_DEPL”
MODE_FOURIER

AFFE_CHAR_MECA_F PRES_REP
GROUP_MA

COMB_CHAM_NO
COMB_FOURIER

COMB_CHAM_ELEM
COMB_FOURIER
MACRO_ELAS_MULT CHAR_MECA_GLOBAL
MODE_FOURIER

CAS_CHARGE
TYPE_MODE
CHAR_MECA

---

6 Results of modeling B

6.1 Values tested

Standard localization
of

value
Reference
Aster
% difference
Ug field

(for = 0.)
Not E, F
ur (m)
3.566 X 107
3.541 X 107
-0.70
U (m)
0.
0.
Not B
zz (Pa)
2.496 X 105
2.60 X 105 +
4.1
Up field

(for = 0.)
Not E
ur (m)
7.82 X 106
7.71 X 106 1.4
Not F

7.82 X 106
7.70 X 106 1.5
Not B
rr (Pa)
1.63 X 106
1.41 X 106
-13.4

5.51 X 106
5.65 X 106

2.7
zz (Pa)

1.65 X 106
1.89 X 106
14.7
(Pa)
Up field + Ug

(for = 0.)
Not E
ur (m)
7.46 X 106
7.358 X 106 1.3
Not F
ur (m)
7.46 X 106
7.348 X 106 1.5
Not B
rr (Pa)
1.56 X 106
1.34 X 106
-13.7

5.25 X 106
5.398 X 106
2.8
zz (Pa)

1.57 X 106
1.80 X 106
15.0
(Pa)

6.2 Remarks

· The values of reference for the pressure (Up field) are obtained in modeling C, with to start from a grid 3D.
· The results obtained are rigorously identical to those of modeling A with GRAVITY.

6.3
Contents of the file results

Displacements, constraints.

---

7 Modeling
C

7.1
Characteristics of modeling C

3D, H20 Meshs and P15
Z
F
WITH, E
y, v
B
B, F
X
y

X, U

Position of the points: With, B in the section Z = 0

E, F in the median section Z = L/2

Cutting:
20 elements according to the length

2 elements according to the ray, 8 elements according to the circumference.

The loading being symmetrical, the half only of the cylinder is modelled.

Boundary conditions:

· section embedded ends (U = v = W = 0)
· conditions of symmetry in the xz plan: v = 0

1)
Pressure on the circumference (Up field)
The surface of the cylinder is divided into 8 lines of elements according to the circumference (1 line elements represents a sector of /8 radians.
The pressure being in "Cos", it is supposed to be uniform on each line. For any point of

the surface of angle, (ranging between 1 and 2, 1 = (N 1)
,
, 1 N 8, the value of
8
2 = N 8
pressure assigned to the line of elements containing this point is taken equalizes with:
p0 (cos
2
1 + cos 2).

2)
Vertical gravity according to X (Ug field)

Names of the nodes:

With = N845
B = N965
E = N865
F = N995

7.2
Characteristics of the grid

A number of nodes: 1285
A number of meshs and types: 160 HEXA20, 80 PENTA15

7.3 Functionalities
tested

Orders

"MECHANICAL" AFFE_MODELE "AXIS_FOURIER"
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

FORCE_INTERNE
GROUP_MA
GRAVITY
AFFE_CHAR_MECA_F PRES_REP

GROUP_MA

CALC_CHAM_ELEM OPTION
SIGM_ELNO_DEPL
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/03/008/A

---

8 Results of modeling C

8.1 Values tested

Standard localization
of
value
Reference
Aster
% difference
Up field

Not E
U (m)

7.82 X 106

v (m)
0.
10-21
Not F
U (m)

7.816 X 106

v (m)
0.
10-21
Not B
xx (Pa)

1.63 X 106

1.65 X 106
yy (Pa)

5.51 X 106
zz (Pa)
Up field + Ug

Not E
U (m)

7.46 X 106

v (m)
0.
10-21
Not F
U (m)

7.44 X 106

v (m)
0.
10-21
Not B
xx (Pa)

1.56 X 106

1.57 X 106
yy (Pa)

5.25 X 106
zz (Pa)

8.2 Remarks

· It does not have there values of reference for this modeling. The results are to be compared with those of modelings AXIS_FOURIER (A, B, D).
· At the point B (located in the symmetry plane), one a: rr = xx, = yy

---

9 Modeling
D

9.1
Characteristics of modeling D

AXIS_FOURIER, T6 meshs

With
E
D
B
F

C
Z

R

Cutting:
80 elements according to the length

2 elements according to the ray

Loadings:

C1:
vertical gravity (Ug field)
C2:
pressure (Up field)

Components of displacements: ur (radial), uz (axial), U (circumferential)

Names of the nodes:

With = N1
B = N2
C = N3
D = N4
E = N249
F = N87

9.2
Characteristics of the grid

A number of nodes: 805
A number of meshs and types: 320 TRIA6

9.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “AXIS_FOURIER”
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

AFFE_CHAR_MECA_F FORCE_INTERNE

CALC_CHAM_ELEM OPTION
“SIGM_ELNO_DEPL”
MODE_FOURIER
AFFE_CHAR_MECA_F PRES_REP
GROUP_MA

COMB_CHAM_NO
COMB_FOURIER

COMB_CHAM_ELEM
COMB_FOURIER
MACRO_ELAS_MULT CHAR_MECA_GLOBAL
MODE_FOURIER

CAS_CHARGE
TYPE_MODE

---

10 Results of modeling D

10.1 Values tested

Standard localization
of
value
Reference
Aster
% difference
Ug field

(for = 0.)
Not E, F
ur (m)
3.566 X 107
3.535 X 107
-0.84

U (m)
0.
0.
Not B
zz (Pa)
2.496 X 105
2.60 X 105 +
4.1
Up field

(for = 0.)
Not E
ur (m)
7.82 X 106
7.71 X 106 1.4
Not F

7.82 X 106
7.70 X 106 1.5
Not B
rr (Pa)
1.63 X 106
1.41 X 106
-13.4

5.51 X 106
5.65 X 106
2.7
zz (Pa)

1.65 X 106
1.89 X 106
14.7
(Pa)

10.2 Remarks

· The values of reference for the pressure (Up field) are obtained in modeling C, with to start from a model 3D.
· The results obtained are identical to those of modelings A and B.

10.3 Contents of the file results

Displacements, constraints.

---

11 Summary of the results

Maximum differences (in %) between modelings AXIS_FOURIER and modeling 3D, observed at the points E, F,
B (in the plan = 0°), on the combined loading cases.

Localization
Variation
AXIS_FOURIER/3D
In (%)
Displacements U:
NOT F
1.5
= U in 3D
= ur in AXI
Constraints zz
NOT B
2.8
Constraints xx (3D)

NOT B
-14.1
= rr (AXI)
Constraints yy (3D)
NOT B
14.6
= (AXI)

· The results between modelings 3D on the one hand and AXIS_FOURIER on the other hand, are concordant with regard to displacements (variation of 1.5%) and the bending stress zz (variation of 2.8%).
· A embedding, the relation xx = yy = 0 involves:

xx = yy =

1 - zz

The relation of embedding is well checked at the point B, in modeling 3D.

· In addition, at the point B, one has moreover:

xx = rr
yy =

In modeling AXIS_FOURIER, the difference between the two constraints is approximately 25%.

· The second calculation on model AXIS_FOURIER was carried out with a finer grid: 4 elements in the thickness instead of 2, denser grid in the vicinity of embedding AB (total 800 TRIA6).
The variation observed on the constraints rr and at point AB remains: rr = 1.51 X 106, = 2.08 X 106 (loading case combined).
The relation of embedding xx = yy thus is checked much better on the model 3D, with one grid in the thickness however coarse.
Handbook of Validation
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Code_Aster ®
Version
6.4

Titrate:
SSLV306 - Beam 3D in imposed displacements

Date
:

17/06/03
Author (S):
X. DESROCHES Key
:
V3.04.306-A Page:
1/6

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
Document: V3.04.306

SSLV306 - Beam 3D in imposed displacements

Summary:

The purpose of the test is to validate the displacements imposed on faces (FACE_IMPO), their values being variable
in space. These values are imposed at the end of a beam 3D, modelling a bending strain.

1
Problem of reference

1.1 Geometry

Length
: L
= 2 m
Square section, on side
: has
= 0.2 m
Moment of inertia
: I
= 1.333 X 104 m4

1.2
Material properties

E = 2.1 X 1011 Pa
= 0.3

1.3
Boundary conditions and loadings

· Encastrement of section ABCD
· Déplacement imposed on face EFGH:
- constant
vo in the direction y, vo = 0.952 X 105 m
-
varying according to the position there point of the section, and being worth:
uo = y O, O = 0.714 X 105 radians

1.4 Conditions
initial

Without object for the static analysis.

2
Reference solution

2.1
Method of calculation used for the reference solution

The displacements imposed equivalent on a force applied at the end of resultant:

3EI

F =
v =
NR
O
100
L3

O represents the rotation of section EFGH:

FL2
O =

2EI

The bending stress xx with embedding is worth then:

(
)
FL
ABCD
xx
= ±

I/y

2.2
Results of reference

· Déplacement v of the points E, F, G, H
· Stresses bending xx at the points A, B, C, D

2.3
Uncertainty on the solution

Analytical solution.

Titrate:
SSLV306 - Beam 3D in imposed displacements

Date
:

17/06/03
Author (S):
X. DESROCHES Key
:
V3.04.306-A Page:
4/6

3 Modeling
With

3.1
Characteristics of modeling

3D, H20 meshs

y, v

Z, W
D
C
B
H
G
E
F

X, U

Loading by displacements imposed on face EFGH:

· DY: 0.952 X 105

· DX: function of there defined in 2 points: F (0) = 0
F (0,1) = -0.0714E-5

Cutting:
· 20 elements according to the length
· 2 elements according to the width and the thickness

3.2
Characteristics of the grid

A number of nodes: 621
A number of meshs and types: 80 HEXA20

3.3 Functionalities
tested

Orders

“MECHANICAL” AFFE_MODELE “3D”
ALL
AFFE_CHAR_MECA DDL_IMPO
GROUP_NO

AFFE_CHAR_MECA_F FACE_IMPO
GROUP_MA

CALC_CHAM_ELEM OPTION
“SIGM_ELNO_DEPL”

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal systems
HT-66/03/008/A

Code_Aster ®
Version
6.4

Titrate:
SSLV306 - Beam 3D in imposed displacements

Date
:

17/06/03
Author (S):
X. DESROCHES Key

4
Results of modeling A

4.1 Values
tested

Standard localization
of
value
Reference
Aster
% difference
Points E, F, G, H
v (m)
9.52 X 106
9.52 X 106 0
Points E, F
U (m)
7.14 X 107
7.14 X 107 0.
Points G, H
U (m)
7.14 X 107
7.14 X 107 0.
Points A, B
xx (Pa)
1.5 X 105
1.64 X 105 9.5
Points C, D
xx (Pa)
1.5 X 105
1.64 X 105 9.5

5
Summary of the results

The functionality "displacements imposed function" provides the awaited results; values of stress bending are satisfactory, given that the dealt with problem is a problem of inflection.

Titrate:
SSLV307 - Cylinder obliques under uniform axial loading

Date:
23/09/02
Author (S):
X. DESROCHES *Key*
:
V3.04.307-A Page:
1/8

Organization (S): EDF/AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
Document: V3.04.307

SSLV307 - Cylinder obliques under load
axial uniform

Summary:

The purpose of the test is to validate the various types of linear relations, defined by key words
LIAISON_DDL,
LIAISON_OBLIQUE, LIAISON_GROUP.

It also makes it possible to test the option "symmetries cyclic" starting from the modeling of a sector of the cylinder.

The analysis is carried out in 3D.

1
Problem of reference

1.1 Geometry

Average radius: Ro = 1 m
Thickness:
H = 0.02 m
Height:
L = 4 m

3
Cosine directors of the axis of the cylinder: (0.0, 0,5,
)
2
Center local X parallel with the total axis X.

1.2
Material properties

E = 2.1 X 1011 Pa

v = 0.3

1.3
Boundary conditions and loadings

· Axial Déplacement no one at the low end (W = 0)
For the other boundary conditions (linear relations), to see paragraph [§3].
· Uniform Axial loading per unit of length Q = 10000 N/m, applied at the high end.

1.4 Conditions
initial

Without object for the static analysis.
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

2
Reference solution

2.1
Method of calculation used for the reference solution

· Radial Déplacement in local reference mark (X, y, Z):

1 2
2

qvRo
3

U

2
U +
V -
W

R =
= -
5
.
0

Eh

2

where U, V, W = component of displacement in the total reference mark (X, Y, Z).

· If,
xx yy zz = 11 is the constraints in the local reference mark, the constraints expressed in the total reference mark are worth:

xx = xx
= 3 4 yy +1/411
11 = Q/H
zz = 1 4 yy + 3 411

3
3
yz = -
yy +
11
4
4

In the local plan (X, Z), yy = 0 (circumferential constraint),

from where 1 4
yy
11, zz = 3 4 11

2.2
Results of reference

· Déplacement raidal: ur = 7.14 X 107 m
· In the local plan (X, Z), yy = 1.25 X 105 Pa, zz = 3.75 X 105 Pa

2.3
Uncertainty on the solution

· Analytical Solution

2.4 References
bibliographical

[1]
R.J. ROARK and W.C. YOUNG: Formulated for stress and strain, 5è edition. New York,
Mc Graw-Hill, 1975
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

Elements 3D (PENTA15 + HEXA20)

Z, W

y

F

E

X, U

With
B X

Section of the cylinder
y, v

Modeling:

1/4 of the cylinder following the circumference
2 zones:
zone 1 = left lower
(0
Z L/2)

zone 2 = left higher (L/2 Z L)

Cutting:

20 elements according to the length
16 elements according to the circumference

2 elements in the thickness

Co-ordinates of points (R, Z)

WITH G B E
G1
F
A2
H
B2
E2 H1
F2
A3 I B3 E3 I1 F3
A'2
H'
B' 2e'2 H'1 F'2
R IH R Re IH R Re IH R Re IH R Re IH R Re IH R Re

0. 0. 0. 90. 90. 90. 0. 0 .0. 90. 90. 90. 0. 0. 0. 90. 90. 90.
Z 0. 0. 0. 0. 0. 0. L/2 L/2
L/2
L/2
L/2
L/2 L L L L L L

IH = interior ray
Re = external ray

the points A2, H, B2, E2, H2, F2 are in the section Z = L/2 of zone 1
the points A'2, H', B'2, E'2, H'2, F'2 are opposite respective in zone 2

Boundary conditions:

· Conditions of support W = 0 at the base (section Z = 0.) introduced by key word LIAISON_OBLIQUE
· Conditions of symmetry v = 0. on face AB introduced by key word LIAISON_OBLIQUE
· Conditions of symmetry U = 0. on face EF introduced by key word LIAISON_OBLIQUE
· Identification of the nodes common to the 2 zones (section Z = L/2) by key word LIAISON_GROUP.

Loading:

Density of surface charge p = q/h = 500000 N/m2, along the axis, is in total reference mark:

Fx = 0.

Fy = p/2

3
Fz = p

2

Name of the nodes:

plan Z = 0.
WITH = NR 1
B = NR 321
E = NR 1740 F = NR 1541 G = NR 1540

plan Z = 2
A2 = NR 961
B2 = NR 993

E2 = NR 2141 F2 = NR 2122 H = NR 962
H1 = NR 2121
(zone 1)

plan Z = 2
A'2 = NR 3361 B'2 = NR 3364 E'2 = NR 2159 F'2 = NR 2155
H' = NR 3360
H'1 = NR 2156
(zone 2)

plan Z = 4
A3 = NR 3359 B3 = NR 3355 I = NR 3356
E3 = NR 2151 F3 = NR 2154
I1 = NR 2150

3.2
Characteristics of the grid

A number of nodes: 4298

A number of meshs and types: 160 HEXA20, 320 PENTA15

3.3 Functionalities
tested

Orders
AFFE-MODELE
“MECHANICAL”
“3D”
AFFE_CHAR_MECA
FORCE_CONTOUR
LIAISON_OBLIQUE
LIAISON_GROUP

AFFE_CHAR_MECA_F
LIAISON_DDL
CALC-CHAM-ELEM
OPTION
"SIGM_ENLO-DEPL"

4
Results of modeling A

4.1 Values
tested

Values of displacements U, V, W read on file

Standard localization
of Reference
Aster
% difference
value
Not G
U (m)
7.143 X 107
7.13895 X 107
0.057

V
(m)
0. 10-22
-
W
(m)
0. 10-23
-
Not H, H'
U (m)
7.143 X 107
7.13859 X 107
0.062
Not I
U (m)
7.143 X 107
7.13739 X 107
0.078
Not G1
U (m)
0.
10-23

Points H1, H'1
U (m)
0.
10-22

Values of displacements U, v, ur in local reference mark calculated starting from U, V, W

Standard localization
of Reference
Aster
% difference
value
Not G
ur (m)
7.143 X 107
7.13895 X 107
0.057

v
(m)

0. 10-22
-
Not H, H'
ur (m)
7.143 X 107
7.13859 X 107
0.062
v
(m)
0. 10-12
-
Not I
ur (m)
7.143 X 107
7.13739 X 107
0.078
v
(m)
0. 10-12
-
Not A2, A'2
v (m)
0.
10-12
-
Points B2, B'2
-
Not G1
U (m)
0.
10-23

ur (m)
7.143 X 107
7.14676 X 107
-0.053
Points H1, H'1
U (m)
0.
10-22
-

ur (m)

7.143 X 107
7.14708 X 107
-0.057
Not I1
U (m)
0.
10-22
-

ur (m)
7.143 X 107
7.14796 X 107
-0.069
Points E2, E'2
U (m)
0.
10-21
-
Points F2, F'2
U (m)
0.
10-22

Points A, B, G

A2, B2, H
YY (Pa)
1.25 X 105
1.2500 X 105
0.
A'2, B'2, H'
A3, B3, I
Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:

Points A, B, G

A2, B2, H
ZZ (Pa)
3.75 X 105
3.700 X 105
0.
A'2, B'2, H'
A3, B3, I

4.2 Remarks

· Radial displacement ur is obtained with a good precision.
3
· The conditions of symmetry on face AB (v = 0 locally, is
V 05 W = 0) are checked
2
at the points A2, A'2, G, B2, B'2, H, H', I considered.
In the same way, the conditions of symmetry on face EF (U = U = 0) are checked at the points E2, E'2,
F2, F'2, G1, H1, H'1, I1 considered.
Key word LIAISON_OBLIQUE is thus validated.

· The identification of the nodes common to the 2 zones by key word LIAISON_GROUP is also validated: displacements U, V, W are identical to the points A'2, B'2, H', E'2, F'2, H'1 in comparison of displacements to opposite respective A2, B2, H, E2, F2, H1.

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Titrate:
SSLV311 - Murakami 9.39. Fissure in quarter of ellipse to the corner of a disc
Date:
15/02/06
Author (S):
E. GALENNE
Key: V3.04.311-A Page: 1/8

Organization (S): EDF-R & D /AMA

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
V3.04.311 document

SSLV311 - Murakami 9.39. Fissure in quarter of ellipse with the corner of a thick disc in rotation

Summary:

This test results from the validation independent of the version in breaking process.

Applicability:
Linear breaking process
Type of analysis:
Statics

Type of behavior:
Isotropic linear rubber band
Type of model:
Three-dimensional
A number of modelings:
1
Objective:
Basic test into three-dimensional for isotropic elastic materials, in field limited in three directions, in the presence of a voluminal loading.
Explored parameters:
-
Fixed parameters:
A/t reports/ratios, b/a, R2/R1, t/R1
Precision of the results:
Average standard deviation of 3% with the analytical reference solution

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-62/06/005/A

1
Problem of reference

1.1 Geometry

B
With

Internal ray:
R1 = 0,1 m
External ray:
R2 = 0,6 m
Thickness:
T = 0,2 m
Half large axis:
= 0,05 m have
Small half centers:
B = 0,0125 m

1.2
Properties of material

Young modulus
E = 2.105 MPa
Poisson's ratio = 0.3

Density
= 7800 kg/m3

1.3
Boundary conditions and loading

The model will be limited to the part of the thick disc located in the half space Y 0, the plan of fissure vertical being a symmetry plane.

In the absence of nodes on the axis of revolution, a rigid mode will be blocked by a linear relation between degrees of freedom.
That is to say points:
With (R1,0, T) B
(- R1,0, T)

Blocking of the translation in X: UX (A) + UX (B) = 0
Blocking of the translation in Y: UY = 0 in plan XOZ, except for the lips of the crack.
Blocking of the translation in Z: UZ (A) = 0

Blocking of rotation around OX: ensured by the C.L of symmetry in plan XOZ
Blocking of rotation around OY: UZ (B) = 0
Blocking of rotation around OZ: ensured by the C.L of symmetry in plan XOZ

Loading: stationary angular velocity = 500 radians/second

2
Reference solution

2.1
Method of calculation used for the reference solution

Method of integral equation of border.

2.2
Results of reference

3 +

2
1 -
2
2
K =
· R +
R
B F where the geometrical factor of correction is given,
I
2
1
I
4

3 +

·
·
according to the parametric angle of the ellipse, with the figure below.

The selected a/t report/ratio corresponds to the higher curve (squares).

2.3
Uncertainty on the solution

The maximum change enters the points marked and the curve being of 2%, the misreading on the curve
is lower than the announced maximum error (5%).

2.4 References
bibliographical

[1]
Y. MURAKAMI: Stress Intensity Factors Handbook, box 9.39, pages 786-791. The Society of Materials Science, Japan, Pergamon Press, 1987.

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3 Modeling With

3.1 Characteristics of modeling

3.2
Characteristics of the grid

The initial grid consists of 8890 nodes and 2203 elements, including 1264 elements CU20 and 939 elements PR15.
After the conversion of the grid of quadratic to linear, the number of nodes is reduced to 2230.
This conversion is made essential by the use of the operator DEFI_FISS_XFEM, who function for the moment that with linear elements.

3.3
Functionalities tested

Calculation of the factors of intensity of the constraints buildings, in all the nodes of the bottom of crack, by
method THETA.

The factors of intensity of the constraints buildings are calculated on a crown of lower ray Rinf=0,00075 m and of ray higher Rsup = 0,0025 Mr.

Orders

CREA_MAILLAGE QUAD_LINE

AFFE_CHAR_MECA FORCE_INTERNE

FORMULATE

DEFI_FISS_XFEM

CALC_G_LOCAL_T "CALC_K_G"

SYME_CHAR

EXCIT

Handbook of Validation
V3.04 booklet: Linear statics of the voluminal structures
HT-62/06/005/A

Code_Aster ®
Version
8.2

Titrate:
SSLV311 - Murakami 9.39. Fissure in quarter of ellipse to the corner of a disc
Date:
15/02/06
Author (S):
E. GALENNE
Key: V3.04.311-A Page: 6/8

4
Results of modeling A

4.1 Values tested

Identification
Reference (Pa.m)
Aster (Pa.m)
% difference
KI, = 0 degrees
5,657E+07 5,789E+07 -2,33
KI, = 1,4 degrees
5,945E+07 5,360E+07 9,84
KI, = 2,8 degrees
6,292E+07 6,596E+07 -4,84
KI, = 4,3 degrees
6,638E+07 6,606E+07 0,48
KI, = 5,9 degrees
6,984E+07 6,902E+07 1,18
KI, = 7,6 degrees
7,273E+07 7,289E+07 -0,22

KI, = 9,5 degrees
7,562E+07 7,597E+07 -0,47
KI, = 11,6 degrees
7,908E+07 8,053E+07 -1,83
KI, = 14,4 degrees
8,197E+07 8,261E+07 -0,78
KI, = 16,9 degrees
8,543E+07 8,695E+07 -1,78
KI, = 20,5 degrees
8,889E+07 8,785E+07 1,17
KI, = 25,1 degrees
9,178E+07 9,190E+07 -0,13
KI, = 31,1 degrees
9,466E+07 9,173E+07 3,09
KI, = 39,5 degrees
9,640E+07 9,562E+07 0,81
KI, = 51,5 degrees
9,755E+07 9,510E+07 2,51
KI, = 68,5 degrees
9,755E+07 9,824E+07 -0,71
KI, = 90 degrees
9,640E+07 9,720E+07 -0,83

The parametric angles of the values tested correspond to the position of the 17 points of the bottom of fissure. The figure below makes it possible to compare the result of calculation with the reference solution.
The average standard deviation is very satisfactory:
(K ref. - K Aster 2
I
I
) ds
Average standard deviation =

=
= 3,11 %
(Kref 2
I
) ds

100
95
90
85
0.5)

80
75
70
65
*K1 (MPa/m^*
60
K1 - Reference
55
K1 - Aster
50
0
10
20
30
40
50
60
70
80
90
Angle (°)

Note:

The voluminal loading is introduced here using key word FORCE_INTERNE (order AFFE_CHAR_MECA) and of FORMULA. The results are equivalent if the key word is used ROTATION.

---

5 Summary of the results

Within sight of the precision announced on the results of reference (5%) and the average standard deviation
obtained (3,11%), the results provided by Code_Aster are satisfactory.

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Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
Document: V3.05.100

SSLX100 - Mix 3D - Hull - Beam in inflection

Summary:
This test makes it possible to validate for a linear elastic design:
· a mixture of various mechanical models: model 3D (element HEXA20), model of hull (element DKT) and model of beam (elements POU_D_E, or elements COQUE_C_PLAN),
· of the linear relations between degrees of freedom.
The test is based on the elastic analytical solution of a beam in inflection, the reduced number of elements for the various models leads to a poor solution, which is however improved clearly with employment of boundary conditions appropriate to the theory of the beams.

SSLX100 Mixes 3D - Hull - Beam in inflection
Date: 01/12/98
Author (S)
:
J.P. LEFEBVRE, F. VOLDOIRE
Key:
V3.05.100-B Page:
2/10

1
Problem of reference
1.1 Geometry

y
hull thickness 1
beam of section
M2
rectangular
B
C2
has
O
C
D
M
X
M1
With
C1
F = - 1.
NR
M4
L1
L2
L3
Z
y
Z
B
has
beam of section
rectangular
L1 = L2 = L3 = 10 mm
B = 1 mm
= 3 mm have

1.2
Material properties
E = 200.000 MPa
= 0.3
= 0.0 make it possible to avoid the variation of orthogonal curve induced by the effect Poisson in plates, which causes a difference between the theories of beams and plates, out of average fibre.
1.3
Boundary conditions and loadings
· force Fy=-1 (load 1) or couples Cz=1 (load 2)
· defined or applied to neutral fibre
· embedding of the section X = 0
· continuity of displacements of translation on AB
· continuity of displacements of translation out of C
· equality of displacements of rotation around Z on C1-C2
· for the points M of the section (M1 m2 M4) displacements of translation U (M) depend linearly displacement of rotation Z of the points P of AB
U (M) = Z (P). y + dx (P)

2
Reference solution
2.1
Method of calculation used for the reference solution
Analytical solution, isostatic structure.
The elastic arrow, elastic constraints and axial deformations and bending moment in all not X-coordinate X are given by:
· Charge n°1: force Fy = 1
My (X) = Fy. L (1 - x/L)
(= E. Iz. uy " (X) in elasticity)

uy (X) = Fy L. x2. (3 - x/L)/(6. E.Iz)
(in elasticity)

(in elasticity)
xx (X, y) = Fy. L (1 - x/L). y/(E.Iz)

(in elasticity)
xx (X, y) = - Fy. L (1 - x/L). y/Iz
· Charge n°2: Cz=1 or rotation drz couples = Cz.L/(E.Iz)
My (X) = Cz
(= E. Iz. uy " (X) in elasticity)
uy (X) = Cz. x2. /(2. E.Iz)
(in elasticity)

(in elasticity)
xx (X, y) = Cz. y/Iz

(in elasticity)
xx (X, y) = - Cz. y/(E.Iz)
with:
L = L1 + L2 + L3 = 30 mm
Iz = A. h3/12 = 0.25 mm4
drz = 0.0006
2.2
Results of reference
Axial arrows, constraints and deformations and bending moments in 4 points of the axis of the beam.
2.3
Uncertainty on the solution
Analytical solution.
Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
HI-75/98/040 - Ind A

---

3 Modeling With

3.1 Characteristics of modeling

Elements HEXA20, DKT and POU_D_E

N19
N18
N17
N25
N20
N16
N24
T4
N15
N13
N14
N12
N11
N26
T3
S1
S2
HE1
N10
N23
N23
N9
N28
N29
T2
N5

T1
N7
identical
N8
N6
N4
N1
N21
N22
N2
N3
Not NR --> N1
Not A --> N4
Not C --> N23
Not D --> N29
Charge n°1: force Fy
Total embedding on the section out of O

3.2

Characteristics of the grid

A number of nodes: 28

A number of meshs and types: 1 HEXA20, 4 TRIA3/DKT, 2 SEG2/POU_D_E

3.3 Functionalities

tested

Orders

Keys

AFFE_MODELE
AFFE
MODELING
“3D”
[U4.22.01]
AFFE
MODELING
“DKT”
AFFE
MODELING
“POU_D_E”
AFFE_CARA_ELEM
HULL
[U4.24.01]
BEAM
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]

LIAISON_GROUP
LIAISON_DDL
FORCE_NODALE
MECA_STATIQUE
[U4.31.01]
Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
SSLX100 Mixes 3D - Hull - Beam in inflection
Date: 01/12/98
Author (S)
:
J.P. LEFEBVRE, F. VOLDOIRE
Key:
V3.05.100-B Page:
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4 Results of modeling A

4.1 Values tested

· Charge n°1: force Fy

Identification	**Reference**	**Aster**	**% difference**
one (N1 node)	0.	0.	0.
uM (N26 node)	0.0267	0.0231	13.5
uA (N4 node)	0.0267	0.0230	13.8
uC1 (N22 node)			

0.0933
0.0855
8.4
CPU (N23 node)
0.0933
0.0856
8.3
uD (N29 node)
0.18
0.1686
6.4
MyN (N1 node)
-30.
MyM (N26 node)
-20.
MyA (N4 node)
-20.
MyC1 (N22 node)
-10.
MyC (N23 node)
-10.
MyD (N29 node)
0.

4.2 Parameters of execution

Version: 4.00.02
Machine: CRAY C98
System:
UNICOS 9.0
Obstruction memory:
8 MW
Time CPU To use:
4 seconds

---

5 Modeling B

5.1 Characteristics of modeling

Elements HEXA20, DKT and POU_D_E

N19
N18
N17
N25
N20
N16
N24
N15
T4
N13
N14
N12
N11
N26
T3
S1
HE1
S2
N10
N23
N27
N9
N28
N29
T2
N5
T1
N7
N8
N6
N4
N1

N21
N22
N2
N3
Not NR --> N1
Not A --> N4
Not C --> N23
Not D --> N29
Charge n°1: force Fy
Embedding on the section out of O carried out by a connection 3D_POUTRE between the face N1 N13 N19 N7 and
a discrete element located on the origin.
Additional relation, compared to modeling A, between C1 C2 and C, introduced by LIAISON_ELEM: "COQ_POU".

5.2
Characteristics of the grid

A number of nodes: 29
A number of meshs and types: 1 HEXA20, 4 TRIA3/DKT, 2 SEG2/POU_D_E, 1 POI1/DIS_TR, 1 QUAD8, 2 SEG2/BORD_DKT

5.3 Functionalities
tested
Orders
Keys

AFFE_MODELE
AFFE
MODELING
"3D"
[U4.22.01]
AFFE
MODELING
"DKT"
AFFE
MODELING
"POU_D_E"
AFFE_CARA_ELEM
HULL
[U4.24.01]
BEAM
DISCRETE
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
LIAISON_GROU

LIAISON_ELEM
OPTION
“3D_POU”
FORCE_NODALE
“COQ_POU”
MECA_STATIQUE
OPTION
“SIEF_ELGA_DEPL”
[U4.31.01]
“EFGE_ELNO_DEPL”
POST_RELEVE_T
ACTION
OPERATION
“AVERAGE”
[U4.74.04]
RESULTANT
“DX” “DY” “DZ”
MOMENT
“DRX” “DRY” “DRZ”

---

6 Results of modeling B

6.1 Values tested

· Charge n°1: force Fy

Identification
Reference
Aster

% difference
one (N1 node)
0.
3.81 E18
0.
uM (N26 node)
0.0267
0.0260
2.6
uA (N4 node)
0.0267
0.0259
2.9
uC1 (N22 node)
0.0933
0.0928
0.5
CPU (N23 node)
0.0933
0.0929
0.4
uD (N29 node)
0.18
0.1804
+0.2
Mz (not O)
-30.
-30.
0
Mz (not M)
-20.
-20.
0
Mz (point C)
-10.
-10.
0
Mz (N23 node)
-10.
-10.
0
Mz (N29 node)
0.

0.
0
6.2 Remarks
The moments resulting at the points O, M and C are obtained by POST_RELEVE (moment resulting from
nodal forces on the edges A B and C1 C2).
6.3 Parameters
of execution
Version: 4.00.02
Machine: CRAY C98
System:
UNICOS 9.0
Obstruction memory:
8 MW
Time CPU To use:
4 seconds

---

7 Modeling
C
7.1
Characteristics of modeling
Elements HEXA20, DKT and COQUE_C_PLAN
N19
N18
N17
N25
N20
N16

N24
T4
N15
N13
N14
N12
N11
N26
T3
S1
HE1
N10
N23
N23
N9
N28
N29
T2
N5
T1
N7
identical
N8
N6
N4
N1
N21
N22
N2
N3
Not NR --> N1
Not A --> N4
Not C --> N23
Not D --> N29
In N29: charge n°1: force Fy, load n°2: Cz or rotation drz couples
Displacements DY and DZ on section 0 null on average (order LIAISON_DDL).

Note:

As the width of the beam is a=3mm, the Young modulus is multiplied by 3 in material of Coque_C_Plan.

7.2

Characteristics of the grid

A number of nodes: 29

A number of meshs and types: 1 HEXA20, 4 TRIA3/DKT, 1 SEG3/COQUE_C_PLAN

7.3 Functionalities
tested
Orders
Keys
AFFE_MODELE
AFFE
MODELING
“3D”
[U4.22.01]
AFFE
MODELING
“DKT”
AFFE
MODELING
“COQUE_C_PLAN”
AFFE_CARA_ELEM
HULL
[U4.24.01]
BEAM
AFFE_CHAR_MECA
DDL_IMPO
[U4.25.01]
LIAISON_GROU
LIAISON_DDL
FORCE_NODALE
MECA_STATIQUE
[U4.31.01]
RECU_CHAMP
RESULT
NOM_CHAM
“DEPL”
[U4.62.01]
CALC_ELEM
RESULT
OPTION
“EFGE_ELNO_DEPL”
[U4.61.02]
“SIGM_ELNO_DEPL”
“EPSI_ELNO_DEPL”

---

8 Results of modeling C

8.1 Values tested

Identification	**Reference**	**Aster** (= 0.3)	**% difference**
Charge 1: force Fy			
one (N8 node)	0.	5.97 10-5	0.00
uM (N26 node)	0.0267	0.02528	5.30
uA (N4 node)	0.0267	0.02519	5.64
uC1 (N22 node)	0.0933	0.09136	2.08
CPU (N23 node)	0.0933	0.09148	1.95
uD (N29 node)	0.18		

0.1766
-1.90
MyN (N8 node)
-30.
n.c.
MyM (N26 node)
-20.
n.c.
MyA (N4 node)
-20.
n.c.
MyC1 (N22 node)
-10.
n.c.
MyC (N23 node)
-10.
n.c.
MyD (N28 node)
-5.
-5.0012
0.025
xx (X, h/2) (N28 node)
-30.0000
-30.0007
0.025
xx (X, h/2) (N28 node)
5.0 10-5
5.0012 10-5
0.025
Charge 2: Cz couples
one (N1 node)
0.
2.28 10-6
0.00
uM (N26 node)
0.0010
0.001005
0.451
uA (N4 node)
0.0010
0.000998
-0.224
uC1 (N22 node)

0.0040
0.003998
-0.052
CPU (N23 node)
0.0040
0.004005
0.117
uD (N29 node)
0.0090
0.009005
0.058
MyD (N28 node)
1.0
0.99952
-0.048
xx (X, h/2) (N28 node)
6.0000
5.9971
-0.048
xx (X, h/2) (N28 node)
1.0 10-5
0.9995 10-5
-0.048

8.2 Remarks

The calculation of the efforts and the moment in the Coque_C_Plan element is carried out with the node N28 medium
so that the interpolation is correct; knowing that the Young modulus is triple so that the product E. Iz that is to say identical in all the model, the constraints are it too.

8.3 Parameters
of execution

Version: 4.02.12
Machine: CRAY C98
System:
UNICOS 9.0
Obstruction memory:
8 MW
Time CPU To use:
16,2 seconds

9
Summary of the results

· The grid is very coarse in elements 3D and plate. The test deserves a modeling more fine, since the results are influenced by the way of describing the conditions of embedding out of O. the modeling A led to an error of 14% to the maximum,

· however that with a good taking into account of these conditions, the solution is clearly better (modeling B led to an error of 3% maximum).

· The comparisons of the constraints and efforts give good results (modeling B). For the element of hull 1D, the results are very good.

Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
Document: V3.05.101

SSLX101 - Pipe right modelled in hulls
and in beams

Summary:

The purpose of this test is to validate the connection hull-beam. The pipe is embedded at an end, and subjected to 4
successive efforts (traction and 3 moments) on the other end. A half of the pipe is with a grid in hulls, the other is with a grid in beams. Embedding and the connection between the hull part and the beam are carried out by
a connection hull-beam, allowing in particular to transmit to the hull only the torque efforts of beam type, without generating secondary stresses.

The reference solution is analytical (RDM). The variation with the numerical solution (from 3 to 5%) is explained by
fact that the grid in hulls actually consists of element plans (facets). The geometry of the pipe is thus itself approximate. The solution obtained makes it possible to check that connection enters the elements of
hull and the element of beam is correct.

Titrate:

SSLX101 - Pipe right modelled in hulls and beams

Date:
05/02/00
Author (S):
J.M. PROIX
Key: V3.05.101-A Page: 2/8

1
Problem of reference

1.1 Geometry

Right pipe length 80m, modelled in hulls between 0 and 40m, and in beams between 40 and 80m.
External ray: 2m, thickness: 0.1m.
The axis of the pipe is in the Oxy plan, tilted of 30 degrees compared to OX.

y
x1
P2
P1
X
Z

1.2
Material properties

E = 2.1011 Pa
= 0.3

1.3
Boundary conditions and loadings

Embedding "of beam type" in X = y = 0, realized by a connection hull-beam between the C1 edge of hull and a P1 point (located out of O). It is this point which is blocked.

*4 unit loading cases applied to the point P2 (80*cos30, 80*sin30, 0)*

Fx1=1N traction following the axis Ox1, is Fx = cos30.Fx and Fy = sin30.Fx1
Torque Mx1 = 1Nm around Ox1, is MX = cos30.Mx1 and My = sin30.Mx1
Bending moment My1= 1Nm around Oy1 is Mx= - sin30.My1 and My = cos30.My1

Bending moment around OZ, is Mz=1Nm
Handbook deValidation
V3.05 booklet: Linear statics of the assembled structures
HI-75/01/010/A

Code_Aster ®
Version
5.0

Titrate:
SSLX101 - Pipe right modelled in hulls and beams

Date:
05/02/00
Author (S):
J.M. PROIX
Key: V3.05.101-A Page: 3/8

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution for each of the 4 cases of loading:

In theory of beams, within the framework of the assumptions of Euler-Bernouilli, the solution of the problem of
reference is that of a right beam subjected to efforts and moments at an end and embedded
at the other end:

X
Traction: U
= F
E
X
X
X
1
1 ES
1
X
Torsion: X = M X

E X
1
1 GJ
1
M there X
Inflection around OY: =
. E
1
y
y
1
I.E.(internal excitation)
1
y1
M
Inflection around O
Z X
Z: Z =
.
.ez
EIz

2.2
Results of reference

Traction:

L
ux
=
1 (P2)
Fx1 ESL
thus
ux (P2) = Fx
.cos ()
30
1 ES
L
uy (P2) = Fx
sin ()
30
1 ES

Torsion:

L
X
=
1 (P2)
Mx1 GJ
thus
L
X (P2) =
MX
cos ()
30
1 GJ

L
y (P2) =
MX
sin ()
30
1 GJ

Inflection around: OY
1

L
y =
M y
1
1 I.E.(internal excitation) y1
thus X =
- y .si (
N
)
30
1

y =
y
(
cos
)

30
1
L2
and
Z
U =
- My1 2EIy1
Handbook deValidation
V3.05 booklet: Linear statics of the assembled structures
HI-75/01/010/A

Inflection around: *OZ*

L
Z =
Mz EIz
L2
and
uy = Mz

1
2EIz
thus
ux =
uy sin ()
30
1
uy = uy cos ()
30
1

Note:

The use of the connection hulls beams for embedding and the loadings allows
to remain within the framework of the assumption of Euler-Bernouilli (cf [R3.03.06]). The analytical solution
the preceding one is thus well the reference solution of the problem.

2.3
Uncertainty on the solution

---

3 Modeling
With

3.1
Characteristics of modeling

1 mesh POI1 (modeling DIS_TR), 1280 meshs QUAD4 (modeling DKT), 4 meshs SEG2 (POU_D_E). 32 meshs SEG2 on each edge of the hull.

3.2
Characteristics of the grid

A number of nodes: 4416
A number of meshs and types: 1 POI1, 4 SEG2, 1280 QUAD4

3.3 Functionalities
tested

Orders

Keys
AFFE_MODELE
MODELING
DKT

[U4.22.01]
POU_DE

DIS_TR

AFFE_CARA_ELEM
HULL
[U4.24.01]
BEAM

DISCRETE

AFFE_CHAR_MECA
LIAISON_ELEM
COQUE_POU
[U4.25.01]
MACRO_ELAS_MULT
[U4.31.03]

4
Results of modeling A

4.1 Values tested

Displacements and rotations at the P2 point (to be multiplied by 1.E-10 m).

Loading case
Identification
Reference
Aster *%*
difference
Traction DX
2.8273 2.7942
1.2
Traction DY
1.6324 1.6132
1.2
Torsion DRX
1.93195
1.8713 3.1
Torsion DRY
1.1154

1.0804 3.1
Inflection Y
DZ
-68.64
-64.88
5.5
Inflection Y
DRX
-0.858
-0.827
3.7
Inflection Y
DRY
1.4861
1.4319
3.7
Inflection Z
DX
-34.32
-32.44
5.5
Inflection Z
DY
59.44
56.19
5.5
Inflection Z
DRZ
1.716
1.653
3.7

4.2 Parameters of execution

Version: 5.2

Machine: SGI/ORIGIN 2000
System:

Obstruction memory: 128 Mo

Time CPU To use:
11 seconds

---

5 Modeling B

5.1 Characteristics of modeling

The beam part is modelled by pipe sections. The hull part is modelled in DKT.

5.2 Characteristics of the grid

A number of nodes: 4420
A number of meshs and types:
· 1 mesh POI1 (modeling DIS_TR),
· 1344 meshs QUAD4 (modeling DKT), 32 meshs SEG2 on each edge of the hull
· 4 meshs SEG3 (PIPE)

5.3 Functionalities tested

Orders

Keys
AFFE_MODELE
MODELING
DKT
[U4.22.01]
POU_DE

DIS_TR

AFFE_CARA_ELEM
HULL
[U4.24.01]
BEAM

DISCRETE

AFFE_CHAR_MECA
LIAISON_ELEM
COQUE_TUYAU
[U4.25.01]
MACRO_ELAS_MULT
[U4.31.03]

6
Results of modeling A

6.1 Values tested

Displacements and rotations at the P2 point (to be multiplied by 1.E-10 m).

Loading case
Identification
Reference
Aster *%*
difference
Traction DX
2.8273 2.7942
1.2
Traction DY
1.6324 1.6132
1.2
Torsion DRX

1.93195
1.8713 3.1
Torsion DRY
1.1154
1.0804 3.1
Inflection Y
DZ
-68.64
-64.92
5.4
Inflection Y
DRX
-0.858
-0.827
3.7
Inflection Y
DRY
1.4861
1.4325
3.7
Inflection Z
DX
-34.32
-32.40
5.6
Inflection Z
DY
59.44
56.11
5.6
Inflection Z
DRZ
1.716
1.652
3.7

6.2 Parameters of execution

Version: 5.1

Machine: SGI/ORIGIN 2000
System:

Obstruction memory: 128 Mo
Time CPU To use:
15 seconds

7
Summary of the results

The reference solution is analytical (RDM). The variation with the numerical solution (from 3 to 5%) be explained by the fact that the grid in hulls actually consists of plane elements (facets). geometry of the pipe is thus itself approximate. The solution obtained makes it possible to check that it connection between the elements of hull and the element of beam is correct.

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Titrate:
SSLX102 - Piping bent in inflection

Date:
19/09/02

Author (S):
J. Mr. PROIX*, P. MASSIN, C. Key DURAND*

:
V3.05.102-B Page:

Organization (S): EDF/AMA

Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
V3.05.102 document

SSLX102 - Piping bent in inflection

Summary:

This test validates the modeling of the phenomena of ovalization in pipings: an elbow, prolonged by right pipes is subjected to one bending moment. This one causes in the elbow an ovalization which propagate and diminishes in the right parts, and which modifies the rigidity of the whole of piping. For
to check the exactitude of the results, one tests the flexibility of the whole of piping (value of displacement with
the end for one imposed moment) and elements of hulls DKT.
The case test comprises six modelings:

· For modeling A, the elbow is with a grid in hulls (modeling DKT), modeling pipe is used for the right parts, the connection is ensured by a connection COQUE_TUYAU.

· For modelings B and C, modeling PIPE is assigned to the whole of piping: TUYAU_3M for B and TUYAU_6M for C (M = modes of Fourier).

· In modeling D, piping is with a grid in hulls (elements COQUE_3D), the ends are with a grid in beams to apply the loadings.
· Modélisation E: Modeling PIPE (3 modes of Fourier) is assigned to the whole of *piping.*
· For modeling F, the elbow is with a grid in voluminal meshs, the right parts in elements

PIPE and the connection is ensured by a connection 3D_TUYAU.

Modeling A makes it possible to validate the good transmission of ovalization (mode 2) between the elements PIPE,
and validates connection COQUE_TUYAU, two modelings B and C make it possible to validate the elements PIPE
(with 3 and 6 modes of Fourier) in linear elasticity and last modeling makes it possible to validate the maid
transmission of ovalization (mode 2) between the elements PIPE, and validates the connection 3D_TUYAU.
Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

Piping bent in plan XY. The right parts have as a length L = 1200 Misters.
The elbow has as a radius of curvature: Rc = 305mm

With
B
C
D
Mz

The tubular section has for average radius R = 105.5mm and a thickness E = 8.18mm

1.2
Properties of materials

E = 200000 MPa
= 0.3

1.3
Boundary conditions and loadings

Embedding in A

2 loading cases:

1) Moment MZ imposed in D: MZ=17000Nm (cross-bending).
2) Inflection except plan: My moment imposed in D
My = 17000 Nm

1.4 Conditions
initial

Without object.
Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
HT-66/02/001/A

Code_Aster ®
Version
5.4

Titrate:
SSLX102 - Piping bent in inflection

Date:
19/09/02
Author (S):

2
Reference solution

2.1
Method of calculation used for the reference solution

Comparison with other numerical results obtained with grids 3D or hulls (in
tally in particular of the tripartite Card 3455 of the ECA, (see references), and with a calculation COQUE_3D
enough fine (modeling D).

2.2
Results of reference

For one moment applied MZ in D of 17000 Nm, displacement DY of the same point D is worth:

Type of calculation	*Dy not D (mm)*
Calculation ECA (hulls + Victus)	*0.02*
Calculation COQUE_3D	*0.02012 (modeling D)*

We choose for reference the value Dy = 0.02 Misters.

For the inflection except plan, the value of reference (fine calculation COQUE_3D) is worth 1.5657 102 Misters.

2.3
Precision on the results of reference

Owing to the fact that the reference solution is numerical, one can evaluate the precision according to [§2.2] to 2%.

2.4 References
bibliographical

[1]
M.N. BERTON: "Elastoplastic Calculations of pipings with CASTEM 2000. Formulation VICTUS. Synthesis of card 3455". Note CEA/LDM 96/6036
[2]
J.M. PROIX, A. BEN HAJ YEDDER: "Project CACIP: study of a piping bent in inflection". Note EDF/DER HI-75/98/001/0
Handbook of Validation
V3.05 booklet: Linear statics of the assembled structures
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

The elbow is with a grid in hulls (meshs QUAD4, modeling DKT). All the right parts are with a grid in elements pipes (meshs SEG3, modeling PIPE).

3.2
Characteristics of the grid

320 meshs QUAD4

8 meshs SEG3
32 meshs SEG2 (edges of hulls).

3.3 Functionalities
tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE
AFFE
MODELING
“TUYAU_3M”
AFFE_CHAR_MECA
LIAISON_ELEM
OPTION
“COQUE_TUYAU”
MECA_STATIQUE

4
Results of modeling A

4.1 Values
tested

Loading case
Displacement of the point D
Reference
Aster %
diff
Mz = 17000 Nm
DY (mm)
0.02
0.01941
3.0
My = 17000 Nm
DZ (mm)
-0.015657
-0.0157

5 Modeling
B

5.1
Characteristics of modeling

The whole of piping is with a grid with bent elements PIPE, rights or.

5.2
Characteristics of the grid

86 meshs SEG3

5.3 Functionalities
tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE

AFFE
MODELING
“TUYAU_3M”

6 Results of modeling B

6.1 Values tested

Loading case	*Displacement of the point D*	*Reference*	*Aster*	*% diff*
Mz = 17000 Nm	*DY (mm)*	*0.02*	*0.0186*	*6.8*
My = 17000 Nm	*DZ (mm)*	*-0.015657*	*-0.0154*	*1.9*

7 Modeling C

7.1 Characteristics of modeling

All piping is modelled in TUYAU_6M (6 modes of Fourier).

7.2 Characteristics of the grid

86 meshs SEG3

7.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE
AFFE
MODELING
"TUYAU_6M"

8
Results of modeling C

8.1 Values tested

Loading case	Displacement of the point D	Reference	Aster	% diff
Mz = 17000 Nm	DY (mm)	0.02	0.0199	0.01
My = 17000 Nm	DZ (mm)	-0.015657	-0.01598	2

---

9 Modeling D

9.1 Characteristics of modeling

· Piping is with a grid in hulls (elements hulls 3D).
· The ends are with a grid in beams (POU_D_T) to be able to apply them easily boundary conditions.
· This modeling constitutes a reference solution for modelings A, B and C in private individual for the inflection except plan where one does not have results published.

9.2 Characteristics of the grid

680 meshs QUAD8
2 meshs SEG2

9.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
CREA_MAILLAGE
MODI_MAILLE
OPTION
"QUAD8_9"
AFFE_MODELE
AFFE
MODELING
"COQUE_3D"
AFFE_CHAR_MECA
LIAISON_ELEM
OPTION
"COQUE_POU"

10 Results of modeling D

10.1 Values tested

Loading case
Displacement of the point D
Reference
Aster %
diff

Loading case	Displacement of the point D	Reference	Aster	% diff
Mz = 17000 Nm	DY (mm)	0.02	0.0192	0.6
My = 17000 Nm	DZ (mm)	-0.015657	-0.015601	0.4

11 Modeling E

11.1 Characteristics of modeling

The whole of piping is with a grid with bent elements PIPE, rights or, resting on meshs with 4 nodes.

11.2 Characteristics of the grid

18 meshs SEG4 (10 in the elbow, 4 in each right part).

11.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE
AFFE
MODELING
"TUYAU_3M"
CREA_MAILLAGE
MODI_MAILLE
OPTION
"SEG3_4"
DEFI_GROUP
CREA_GROUP_NO
OPTION
"NOEUD_ORDO"
AFFE_CARA_ELEM
ORIENTATION
CARA
"GENE_TUYAU"
STAT_NON_LINE
COMP_INCR
RELATION
"ELAS"

12 Results of modeling E

12.1 Values tested

Loading case
Displacement of the point D Reference (MOD B)
***Aster** %*
diff
Mz = 17000 Nm
DY (mm)
0.0186
0.01854
0.4
My = 17000 Nm
DZ (mm)
-0.0154
-0.0153
0.2

---

13 Modeling F

13.1 Characteristics of modeling

The two right parts of piping are with a grid with bent elements PIPE, resting on meshs with 3 nodes. The elbow is with a grid with voluminal meshs HEXA20.

This modeling thus makes it possible to validate the good transmission of ovalization (mode 2) between
elements PIPE on the right parts and the elbow in 3D, and validates the connection 3D_TUYAU.

13.2 Characteristics of the grid

234 meshs SEG3.
512 meshs HEXA20.

13.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE
AFFE
MODELING
"TUYAU_3M"
AFFE
MODELING
`3D
AFFE_CARA_ELEM
ORIENTATION
CARA
"GENE_TUYAU"
MECA_STATIQUE

14 Results of modeling F

14.1 Values tested

Loading case
Displacement of the point D
Reference
Aster %

diff
Mz = 17000 Nm
DY (mm)
0.0200
0.01922
4.4
My = 17000 Nm
DZ (mm)
-0.015657
-0.01561
0.0

---

15 Summary of the results

This test not having reference solutions analytical, but numerical, the variations noted (in on this side 2% except 1 value) can be regarded as reasonable.

More precisely, for modeling A (elbow with a grid in hulls DKT and right beams in PIPE) one can estimate that the solution obtained (2.7% of variation in cross-bending, and 0.4% in inflection except plan,
compared to the reference: grid all in hulls of modeling D) makes it possible to validate the good operation of connection coque_tuyau.

For modeling B (elements PIPE, 3 modes of Fourier), the important variation on cross-bending

(6.8%) is due to the fact that piping is relatively thin, therefore that ovalization in the made elbow to appear of the modes of Fourier of a nature higher than 3.

In fact, modeling C (PIPES, 6 modes of Fourier) is very close to the reference (0.01% in cross-bending, and 2% in inflection except plan). The element pipe is thus validated in elasticity for these loadings, compared to a solution in hulls (modeling D).

Modeling E (elements PIPE with 4 nodes) gives results identical to modeling B, at a cost of weaker calculation due to a less fine grid.

Titrate:
SSLA100 - Infinite cylinder subjected to a field of voluminal forces
Date:
30/11/01
Author (S):
B. RIOU Key
:
V3.06.100-A Page:
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Organization (S): EDF/ERMEL/PEL

V3.06 booklet: Linear statics of the axisymmetric structures
Document: V3.06.100

SSLA100 - Infinite cylinder subjected to a field of
voluminal and surface forces

Summary:

This test of linear quasi-static mechanics makes it possible to validate the assignment of a loading of field of
forces, surface or voluminal.

The studied structure is cylindrical. The fields with the nodes of voluminal and surface density of forces are
read in a file with the Ideas format. For the voluminal loading, the field read varies quadratically in function of the distance to the axis; for the surface loading, the field read corresponds to an internal pressure.

Three modelings of the same problem are carried out:

- *modeling 3D;*
- *axisymmetric modeling 2D;*
- *modeling 2D plane deformations;*

The reference solution is analytical.

1
Problem of reference

1.1 Geometry

Z
y
X

Selected geometrical dimensions are as follows:

•
height
= 0.5 m;
•
interior ray
= 1 m;
•
external ray = 1.2 Mr.

1.2
Properties of material

The cylinder consists of a homogeneous material which follows a law of elastic behavior linear:

•
E = 10 Pa;
•
= 1 Kg/m3;
•
= 0.3 .

1.3
Boundary conditions and loadings (cf [Figure 1.3-a])

The voluminal force considered is radial, it varies in a quadratic way with the ray: FV = .r ²
with = 1 N/m3.
The surface force considered is applied to the internal wall of the cylinder, perpendicular to wall (is equivalent to an internal pressure imposed on the cylinder): FS (R = Rint) = 1N/m ².

The boundary conditions make it possible to be placed on the assumption of the plane deformations on one
section of the cylinder: vertical displacements blocked on the sections high and low of the cylinder.

Note:

For modeling 3D, the suppression of the clean modes is ensured by the conditions of plane 2D applied to the low section of the cylinder. This type of boundary conditions allows to obtain an axisymmetric in displacement, directly comparable solution with analytical solution.

Modeling 3D:
FS
Uz = 0
FV
Uz = 0
Axisymmetric modeling 2D:
Uz = 0
FS
FV
Uz = 0

Modeling plane 2D:
FV
UY = 0
FS
UX = 0
UX = 0
UY = 0

Appear 1.3-a: Boundary conditions and loadings

2
Reference solution

2.1
Method of calculation used for the reference solution

The problem of linear static mechanics axisymmetric considered can be solved in manner analytical. One solves independently the response to the request forces voluminal and forces surface to summon them then.

Voluminal force quadratic FV (R) = R ²

One considers the equilibrium equations in cylindrical co-ordinates:

1

-
R
R
rz
R

+
+
+
+
=

F
0
R
R

R
Z
R

1

Z

R

R

+
+
+ 2
+ F = 0 which is simplified being given axial symmetry
R
Z

R
R

zz
rz

Z

R
+
+
+ 2
+
= 0

F
Z
R

Z
R
R

-
R
R

in:
+
+
=

Fr 0
R
R

By using the law of behavior then the relations deformation-displacements, one leads to
u'
U
F
the following differential equation: U
V
''+
-
+
= 0
R
R ²

E (1 -)
(1 +)(1 - 2)
The voluminal force applied is of the type: fV= .r ²

The solution of the differential equation is written then:

- C
1
(+) 1
(- 2) r4
U =
1 -
+ C R
éq
2.1-1
R
15th 1
(-
2
2
)
The two constants of integrations c1 and c2 are given thanks to the boundary conditions:

(
)
int
R
= 0

(R)

ext. = 0

4 - 3 2 1 + R2 R2 (R3 - R3)

C
int ext.
int
ext.
1 =

1 -
15
E
R2 - R2
One obtains:
ext.

int

1
(+) 1
(- 2) 4 - 3
R3 - R3
C
=

(R3 - R2
int
ext.
2

)
E
ext.
1 - 15
int R2 - R2

ext.
int
Surface force standard pressure FS (Rint) = P

The problem to be solved is of comparable nature, but with a voluminal force applied null: fV= 0
= 0.
Handbook of Validation
V3.06 booklet: Linear statics of the axisymmetric structures
HM-77/01/149/A

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Version
6.0

Titrate:

- C
The solution in displacement [éq 2.1-1] is written then: U =
1 + C R, having to observe the conditions:
R
2
2

(
)
int
R
= - P

(R)

ext. = 0

What gives:

1 +
R2
R2

U
P
int
ext.
=

+ 1
(- 2) R
éq

2.1-2
E
R2 - R2int R
ext.

2.2
Results of reference

Numerical application:

.
height
= 0.5 m;
.
interior ray
= 1 m;
.
external ray
= 1.4 m;
.
E
= 10 Pa;
.

= 1 Kg/m3;
.

= 0.3 ;
.

= 1 N/m5;
.
P
= 1 N/m ².
by injecting the numerical values in the solutions [éq 2.1-1] and [éq 2.1-2] one finds afterwards summation:

U (.
1)
0 = .
0 52130982m

U (.
14) = .
0 44203108m

2.3
Uncertainties on the solution

Null (analytical reference solution).
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HM-77/01/149/A

---

3 Modeling With

3.1 Characteristics of modeling

The cylinder is modelled in voluminal elements 3D:

P2
P1

3.2 Characteristics of the grid

The cylinder is represented by a regular grid of quadratic elements with 20 nodes containing:

- *8 elements;*
- *96 nodes.*

The grid contains 1 only element in the radial and vertical direction and 8 cuttings on circumference.

3.3 Functionalities tested

Orders Key word factor

Key word
LIRE_RESU NOM_CHAM
FVOL_3D
LIRE_RESU NOM_CHAM
FSUR_3D
AFFE_CHAR_MECA EVOL_CHAR

4
Results of modeling A

4.1 Values tested

Identification	***Moments***	***Reference***	***Aster***	*% **difference***
UX in P1	*1*	*0.52130982*	*0.52097*	*6.54 10-2 %*
UX in P2	*1*	*0.44203108*	*0.44178*	*5.74 10-2 %*

4.2 Parameters of execution

Version: 6.01.19

Machine: Origin 2000

Obstruction memory: 16 Mo
Time CPU To use: 2.64 seconds
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V3.06 booklet: Linear statics of the axisymmetric structures
HM-77/01/149/A

Code_Aster ®
Version
6.0

5 Modeling B

5.1 Characteristics of modeling

A longitudinal section of the cylinder is modelled in voluminal elements 2D, while considering the assumption of axisymetry.

P1
P2

5.2 Characteristics of the grid

The cylinder is represented by a regular grid of quadratic elements with 8 nodes containing:

- *4 elements;*
- *21 nodes.*

The grid contains 2 cuttings in the radial direction and 2 cuttings in the vertical direction.

5.3 Functionalities tested

Orders Key word factor
Key word
LIRE_RESU NOM_CHAM
FVOL_2D

LIRE_RESU NOM_CHAM
FSUR_2D
AFFE_CHAR_MECA
EVOL_CHAR

6
Results of modeling B

6.1 Values tested

Identification	***Moments***	***Reference***	***Aster***	*% **difference***
UX in P1	*1*	*0.52130982*	*0.52129*	*4.07 10-3 %*
UX in P2	*1*	*0.44203108*	*0.44202*	*3.95 10-3 %*

6.2 Notice

Modeling more powerful than the 3D because 2 cuttings in the radial direction and not of discretization circonférencielle.

6.3 Parameters of execution

Version: 6.01.19

Machine: Origin 2000

Obstruction memory: 16 Mo
Time CPU To use: 1.89 seconds
Handbook of Validation
V3.06 booklet: Linear statics of the axisymmetric structures
HM-77/01/149/A

---

7 Modeling C

7.1 Characteristics of modeling

A transverse section of the cylinder is modelled in voluminal elements 2D, while considering the assumption of the plane deformations.

P1
P2

7.2 Characteristics of the grid

The cylinder is represented by a regular grid of quadratic elements with 8 nodes containing:

- *8 elements;*
- *40 nodes.*

The grid contains 1 only cutting in the radial direction and 8 cuttings in the vertical direction (like the 3D).

7.3 Functionalities tested

Orders Key word factor

Key word
LIRE_RESU NOM_CHAM
FVOL_2D
LIRE_RESU NOM_CHAM
FSUR_2D
AFFE_CHAR_MECA
EVOL_CHAR

8
Results of modeling C

8.1 Values
tested

Identification Moments Reference
Aster %
difference
UX in P1
1
0.52130982
0.52131
6.76 10-2 %
UX in P2
1
0.44203108
0.44204
5.74 10-2 %

8.2 Remarks

Modeling of performance very close to the 3D because same discretizations circonférencielle and radial.

8.3 Parameters
of execution

Version: 6.0

Machine: Origin 2000

Obstruction memory: 16 Mo
Time CPU To use: 1.89 seconds
Handbook of Validation
V3.06 booklet: Linear statics of the axisymmetric structures

9
Summary of the results

The results obtained by the code_Aster are very close to the analytical solution, in spite of very coarse grids.

Modelings 3D and 2D plane give further information very close because they present them same discretizations circonférencielle and radial. Axisymmetric modeling 2D is more powerful because it presents 2 cuttings in the radial direction and not of discretization circonférencielle.

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Version
6.0

Titrate:
SSLA100 - Infinite cylinder subjected to a field of voluminal forces
Date:
30/11/01
Author (S):
B. RIOU Key
:
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Organization (S): EDF-R & D /AMA

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V3.06 booklet: Linear statics of the axisymmetric structures
Document: V3.06.103

SSLA103 - Calculation of the withdrawal of desiccation and of endogenous withdrawal on a cylinder

Summary:

The purpose of this case-test is to validate the calculation of the withdrawal of desiccation and the endogenous withdrawal. It also tests possibility of making depend the characteristics materials on the hydration and drying (in the case of it model of Mazars). It is about a cylinder which undergoes a drying and a uniform hydration. The temperature also vary.

The cylinder is modelled by four elements quadrangles with 8 nodes for modelings A, C, E and F and by an element HEXA20 for modelings B and D. For modelings A and B, the behavior is presumedly elastic, which makes it possible to validate the calculation of withdrawal at the same time with STAT_NON_LINE and with MECA_STATIQUE. Modelings C and D make it possible to validate the calculation of withdrawal with the law of MAZARS

local and not-local (without activation of the damage). Modeling E validates the calculation of withdrawal with
law ENDO_ISOT_BETON and modeling F coupling ENDO_ISOT_BETON/BETON_UMLV_FP

The results obtained by Code_Aster are identical to the analytical solution of reference.

1
Problem of reference

1.1 Geometry

Cylindrical test-tube

Z
D
C
D
a=1 m
has
R
With
B
has

1.2

Material properties

For modelings A and B, the material is supposed to be elastic and the characteristics materials are constants to be able to validate calculation with MECA_STATIQUE,
For modelings C and D, one uses the law of MAZARS and certain parameters depend on the hydration and of drying.
Modeling E makes it possible to test law ENDO_ISOT_BETON, and modeling F the coupling ENDO_ISOT_BETON/BETON_UMLV_FP, knowing that the parameters materials of the law BETON_UMLV_FP are selected so that one does not have creep and thus which one finds it behavior of law ENDO_ISOT_BETON. In both cases, the characteristics materials are constants.
Let us announce that being given the loading (dilation, hydration and free drying), any damage does not develop: one thus finds in all the cases, the elastic solution.

Modeling A and isotropic b: Elasticity
Modeling C and D: MAZARS
E = 30000 MPa
E = 10000 MPa for C=100l/m3
= 0.2
30000 MPa for C= 80l/m3
= 1.66 10-5 (l/m3) - 1
= 0.25 for h=0

0.15 for h=1
endo = 1.5 10-5

= 1.0 10-5 °C-1
= 1.66 10-5 (l/m3) - 1

endo = 1.5 10-5
= 1.0 10-5 °C-1

Ac = 1.4
At = 0.8 for C=100l/m3
0.6 for C= 80l/m3
Bc = 2000
LT = 10000 for h=0
11000 for h=1
d0 = 10-4
= 1.06

Modeling E: ENDO_ISOT_BETON
Modeling F:
E = 30000 MPa
ENDO_ISOT_BETON/BETON_UMLV_FP
= 0.2

= 1.66 10-5 (l/m3) - 1
See modeling E +

S
19
K = 10 MPa
endo = 1.5 10-5
R
= 1.0 10-5 °C-1
S
19
K = 10 MPa

I
T
D
19
K = 10
y = 4.0 MPa,
MPa
R
C
y = 53.4 MPa

S
19
= 10 MPa.j
E
R
T = -1.0 103 MPa

S
19
= 10 MPa.j
I
D
19
= 10 MPa.j
R
D
19
= 10 MPa.j
I

1.3
Boundary conditions and loadings

On side AB: uz = 0

One varies uniformly on the structure:
· the temperature of T = 20°C at initial time until t=120°C at final time
· water content of 100 l/m3 at initial time up to 80 l/m3 at final time
· the hydration varies from 0. at initial time with 1. at final time.

2
Reference solution

2.1
Method of calculation used for the reference solution

Being given the nature of the requests, the total deflection is only due to the withdrawal and to thermal dilation. Consequently, one a:

HT
rd
Re
= + + = (T - T I - C - C I - H I
ref.) D
(0
) D
D
with:

- *T, the temperature at time T*
- *Tref, the temperature of reference*
- *C0, water content initial (water content HR=100%).*
- *C, water content at time T*
- *H, the degree of hydration at time T*
- *, the dilation coefficient*
- *, the coefficient of withdrawal of desiccation*
- *, the endogenous coefficient of withdrawal*

The elastic strain being null in this problem, the constraints are null, like the damage in the case of modelings with the law of MAZARS and ENDO_ISOT_BETON.

2.2
Results of reference

One checks the value of the deformation after 3600 days, as well as the constraint. One also checks that the plastic deformation is null, as well as the damage for modelings
concerned. The results are tested with STAT_NON_LINE like with MECA_STATIQUE (for modelings A and B)

---

3 Modeling
With

3.1
Characteristics of modeling

Y
D3
N2
N5
N7
N3
N6
N4
N8
N1

N17
D4
N15
D2
N10 N11
N16
N9
N14
N21
N13 N12
N20
N19 N18
X
D1

The loading and the boundary conditions are modelled by:

FACE_IMPO =_F (GROUP_MA = D1, DY= 0.)
TEMP_CALCULEE=TEMP1
SECH_CALCULEE=SECH1
HYDR_CALCULEE=HYDR1

3.2
Characteristics of the grid

A number of nodes:
21
A number of meshs and types: 4 QUAD8

3.3 Functionalities
tested

Orders

DEFI_MATERIAU ELAS_FO
ALPHA

K_DESSIC

B_ENDOGE

AFFE_MATERIAU AFFE
SECH_REF
AFFE_CHAR_MECA FACE_IMPO

TEMP_CALCULEE
SECH_CALCULEE
HYDR_CALCULEE
STAT_NON_LINE COMP_INCR
RELATION ELAS
CALC_ELEM OPTION "EPSP_ELNO"

MECA_STATIQUE

CALC_ELEM OPTION "SIGM_ELNO_DEPL"

3.4
Results of modeling A

For calculation with STAT_NON_LINE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIEF_NOEU_ELGA are null as well as the plastic deformation (EPSP_NOEU).
For calculation with MECA_STATIQUE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIGM_NOEU_DEPL are null.

Calculation STAT_NON_LINE

Variables Moment Reference
Aster *%*
difference
xx
3600 6.53
10-4 6.53
10-4 8.30
10-14

3600 6.53
10-4
6.53 10-4 -4.98
10-14
yy
p
xx
3600 0.

1.15
10-8 -
p

3600 0.
-1.63
10-8 -
yy
xx
3600 0.
-6.63
10-19 -

3600 0.
2.42
10-19 -
yy

Calculation MECA_STATIQUE

Variables Moment Reference
***Aster** %*
difference
xx
3600 6.53
10-4 6.53
10-4 1.83
10-13

3600 6.53
10-4 6.53
10-4 -3.15
10-13
yy
xx
3600 0.
1.66
10-9 -

3600 0.
-8.04
10-8 -
yy

---

4 Modeling B

4.1 Characteristics of modeling

face
C yz
face
C xz
Z
y
F
F it
C xy
X

The loading and the boundary conditions are modelled by:

FACE_IMPO = (_F (GROUP_MA = "FACEXY", DZ= 0.),
_F (GROUP_MA

=
“FACEXZ”,
DY=
0.),
_F (GROUP_MA
=
“FACEYZ”,
DX=
0.))
TEMP_CALCULEE=TEMP1
SECH_CALCULEE=SECH1
HYDR_CALCULEE=HYDR1

4.2
Characteristics of the grid

A number of nodes:
20
A number of meshs and types: 1 HEXA20

4.3 Functionalities
tested

Orders

DEFI_MATERIAU ELAS_FO
ALPHA

K_DESSIC

B_ENDOGE

AFFE_MATERIAU AFFE
SECH_REF
AFFE_CHAR_MECA FACE_IMPO

TEMP_CALCULEE
SECH_CALCULEE
HYDR_CALCULEE
STAT_NON_LINE COMP_INCR

RELATION ELAS
CALC_ELEM OPTION "EPSP_ELNO"

MECA_STATIQUE

CALC_ELEM OPTION "SIGM_ELNO_DEPL"

4.4
Results of modeling B

For calculation with STAT_NON_LINE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIEF_NOEU_ELGA are null as well as the plastic deformation (EPSP_NOEU).
For calculation with MECA_STATIQUE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIGM_NOEU_DEPL are null.

Calculation STAT_NON_LINE

Variables Moment Reference
***Aster** %*
difference
xx
3600 6.53

10-4 6.53
10-4 -8.30
10-14

3600 6.53
10-4 6.53
10-4 -4.98
10-14
yy
p
xx
3600 0.
9.39
10-9 -
p

3600 0.
1.56
10-8 -
yy
xx
3600 0.
-1.85
10-19 -

3600 0.
-2.94
10-19 -
yy

Calculation MECA_STATIQUE

Variables Moment Reference
***Aster** %*
difference
xx
3600 6.53
10-4 6.53
10-4 -6.64
10-14

3600 6.53
10-4 6.53

10-4 8.30
10-14
yy
xx
3600 0.
6.09
10-9 -

3600 0.
2.30
10-8 -
yy

---

5 Modeling C

5.1 Characteristics of modeling

Y
D3
N2
N5
N7

N3
N6
N4
N8
N1
N17
D4
N15
D2
N10 N11
N16
N9
N14
N21
N13 N12
N20
N19 N18
X
D1

The loading and the boundary conditions are modelled by:

FACE_IMPO =_F (GROUP_MA = D1, DY= 0.)
TEMP_CALCULEE=TEMP1
SECH_CALCULEE=SECH1
HYDR_CALCULEE=HYDR1

5.2
Characteristics of the grid

A number of nodes:
21
A number of meshs and types: 4 QUAD8

5.3 Functionalities
tested

Orders

DEFI_MATERIAU ELAS_FO
ALPHA

K_DESSIC

B_ENDOGE

MAZARS_FO

AFFE_MATERIAU AFFE
SECH_REF
AFFE_CHAR_MECA FACE_IMPO

TEMP_CALCULEE
SECH_CALCULEE
HYDR_CALCULEE
STAT_NON_LINE COMP_INCR
RELATION MAZARS
CALC_ELEM OPTION "EPSP_ELNO"

5.4
Results of modeling C

For calculation with STAT_NON_LINE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIEF_NOEU_ELGA are *null as well as the plastic deformation (EPSP_NOEU) and the variable of damage (VARI_NOEU_ELGA, V1).*

Variables Moment Reference
***Aster** %*
difference
xx
3600 6.53
10-4 6.53
10-4 -5.65
10-5

3600 6.53
10-4 6.53
10-4 -3.58
10-5
yy
p
xx
3600 0.
0.619
-
p

3600 0.
0.032
-
yy
xx
3600 0.
-3.91
10-10 -

3600 0.
-2.05
10-10 -
yy
D
3600 0.
0.0
-

---

6 Modeling D

6.1 Characteristics of modeling

face
C yz
face
C xz
Z
y
F
F it
C xy
X

The loading and the boundary conditions are modelled by:

FACE_IMPO = (_F (GROUP_MA = "FACEXY", DZ= 0.),
_F (GROUP_MA
=
"FACEXZ",

DY=
0.),
_F (GROUP_MA
=
“FACEYZ”,
DX=
0.))
TEMP_CALCULEE=TEMP1
SECH_CALCULEE=SECH1
HYDR_CALCULEE=HYDR1

6.2
Characteristics of the grid

A number of nodes:
20
A number of meshs and types: 1 HEXA20

6.3 Functionalities
tested

Orders

DEFI_MATERIAU ELAS_FO
ALPHA

K_DESSIC

B_ENDOGE

MAZARS_FO

NON_LOCAL

AFFE_MODELE

AFFE_MATERIAU AFFE
SECH_REF

AFFE_CHAR_MECA FACE_IMPO

TEMP_CALCULEE
SECH_CALCULEE
HYDR_CALCULEE
STAT_NON_LINE COMP_INCR
RELATION MAZARS
CALC_ELEM OPTION “EPSP_ELNO”

6.4
Results of modeling D

For calculation with STAT_NON_LINE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIEF_NOEU_ELGA are null as well as the plastic deformation (EPSP_NOEU) and the variable of damage VARI_NOEU_ELGA, V1.

Variables Moment Reference
***Aster** %*
difference
xx
3600 6.53
10-4 6.53
10-4 1.16

10-13

3600 6.53
10-4 6.53
10-4 8.30
10-14
yy
p
xx
3600 0.
1.7510-8 -
p

3600 0.
2.95
10-8 -
yy
xx
3600 0.
-2.91
10-20 -

3600 0.
-8.78
10-19 -
yy
D
3600 0.
0.
-

---

7 Modeling E

7.1 Characteristics of modeling

Y
D3
N2
N5
N7
N3
N6
N4
N8
N1
N17
D4
N15
D2
N10 N11
N16
N9
N14
N21
N13 N12
N20
N19 N18
X
D1

The loading and the boundary conditions are modelled by:

FACE_IMPO =_F (GROUP_MA = D1, DY= 0.)
TEMP_CALCULEE=TEMP1
SECH_CALCULEE=SECH1

HYDR_CALCULEE=HYDR1

7.2
Characteristics of the grid

A number of nodes:
21
A number of meshs and types: 4 QUAD8

7.3 Functionalities
tested

Orders

DEFI_MATERIAU ELAS_FO
ALPHA

K_DESSIC

B_ENDOGE

BETON_ECR_LINE

AFFE_MATERIAU AFFE
SECH_REF

AFFE_CHAR_MECA FACE_IMPO

TEMP_CALCULEE
SECH_CALCULEE
HYDR_CALCULEE
STAT_NON_LINE COMP_INCR
RELATION
ENDO_ISOT_BETON
CALC_ELEM OPTION "EPSP_ELNO"

7.4
Results of modeling E

For calculation with STAT_NON_LINE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIEF_NOEU_ELGA are null as well as the plastic deformation (EPSP_NOEU) and the variable of damage (VARI_NOEU_ELGA, V1).

Variables Moment Reference
***Aster** %*
difference
xx
3600 6.53
10-4 6.53
10-4 1.33
10-13

3600 6.53
10-4 6.53
10-4 4.98
10-14
yy
p
xx
3600 0.
2.30
10-8
-

p

3600 0.
-3.30
10-10
-
yy
xx
3600 0.
-4.49
10-19 -

3600 0.
-1.78
10-19 -
yy
D
3600 0.
0.0
-

8 Modeling
F

8.1

Characteristics of modeling

Y
D3
N2
N5
N7
N3
N6
N4
N8
N1
N17
D4
N15
D2
N10 N11
N16
N9
N14
N21
N13 N12
N20
N19 N18
X
D1

The loading and the boundary conditions are modelled by:

FACE_IMPO =_F (GROUP_MA = D1, DY= 0.)
TEMP_CALCULEE=TEMP1
SECH_CALCULEE=SECH1
HYDR_CALCULEE=HYDR1

8.2
Characteristics of the grid

A number of nodes:
21
A number of meshs and types: 4 QUAD8

8.3 Functionalities

tested

Orders

DEFI_MATERIAU ELAS_FO
ALPHA

K_DESSIC

B_ENDOGE

BETON_ECRO_LINE

BETON_UMLV_FP

AFFE_MATERIAU AFFE
SECH_REF
AFFE_CHAR_MECA FACE_IMPO

TEMP_CALCULEE
SECH_CALCULEE
HYDR_CALCULEE
STAT_NON_LINE COMP_INCR
RELATION KIT_DDI
CALC_ELEM OPTION "EPSP_ELNO"

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8.4
Results of modeling F

For calculation with STAT_NON_LINE, one tests the components of the tensor of the deformations EPSI_NOEU_DEPL after 3600 days. It is also checked that constraints SIEF_NOEU_ELGA are null as well as the plastic deformation (EPSP_NOEU) and the variable of damage (VARI_NOEU_ELGA, V1).

Variables Moment Reference
Aster *%*
difference
xx
3600 6.53
10-4 6.53
10-4 1.06
10-12

3600 6.53
10-4 6.53
10-4 8.97
10-13
yy
p
xx
3600 0.
2.46
10-7
-

p

3600 0.
2.38
10-7 -
yy
xx
3600 0.
1.44
10-18 -

3600 0.
7.74
10-19 -
yy
D
3600 0.
0.0
-

9 Summary of the results

The results obtained with Code_Aster are identical to the analytical solution. It was thus validated calculation of thermal dilation and the endogenous withdrawal and desiccation for the elastic model, that it is with STAT_NON_LINE or MECA_STATIQUE, like for the law of Mazars, local version or not-local, for law ENDO_ISOT_BETON and the case of the coupling BETON_UMLV_FP/ENDO_ISOT_BETON. Let us announce that modelings A and B also allow to validate the calculation of the withdrawals for laws VMIS_ISOT_TRAC and VMIS_ISOT_LINE which uses even routine that ELAS.

Date:
01/09/05
Author (S):
***J. LAVERNE,** F. LEBOUVIER Key*
:
V3.06.104-A Page:
1/6

Organization (S): EDF-R & D /AMA, DeltaCAD

Handbook of Validation
V3.06 booklet: Linear statics of the axisymmetric structures
Document: V3.06.104

DEMO005 - Thin cylinder under pressure hydrostatic

Summary:

Case-test DEMO005 is a very simple example of use of Code_Aster. It makes it possible to illustrate them orders "impossible to circumvent" on the calculation of a tank.

The thin cylindrical tank is subjected to a variable pressure with the height corresponding to one hydrostatic pressure.

Since the geometry and the loading are axisymmetric, an axisymmetric modeling 2D is chosen to model the problem, the grid representing a vertical section of the cylinder.

One calculates displacements and the constraints in the vertical section of the cylinder.

1
Problem of reference

1.1 Geometry

R = 1 m
y
X
P
Z
L = 4 m

Appear 1.1-a: Geometrical characteristics and loadings

Selected geometrical dimensions are as follows:

.
height
L = 4 m
.

average radius
R = 1 m
.
thickness
E = 0.02 m

1.2
Properties of material

The cylinder consists of a homogeneous material (steel) which follows an elastic law of behavior linear:

.
Young modulus:

E = 2.1 1011 Pa
.
Poisson's ratio:
= 0.3

1.3
Boundary conditions and loadings

The pressure P is applied to the internal wall of the cylinder. This pressure varies linearly: it 20.000 N/m ² at the base of the cylinder and 0 in the high part is worth.

Following displacements at the base of the cylinder are null there, the cylinder can move radially.

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Code_Aster ®
Version
8.2

Titrate:
DEMO005 - Thin cylinder under hydrostatic pressure

Date:
01/09/05
Author (S):
J. LAVERNE, F. LEBOUVIER Key

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is obtained numerically. It is thus only about one test of not regression.

2.2
Results of modeling

Urgent displacements Reference
DX in A
1
4.6814 10-6
DX out of B
1
4.6528 10-6
DX out of C
1
1.2022 10-6
DY out of C
1
-2.6396 10-6
DX in D
1
3.3102 10-9
DY in D
1
-2.8170 10-6

Displacements are expressed in meters.

2.3
Uncertainty on the solution

---

3 Modeling With

3.1 Characteristics of modeling

The cylinder is modelled in elements axisymmetric 2D.

y
D
C
ldf
Discretization:

- 5 meshs according to X
- 20 meshs following y
charg
lfa
B
In support
X

Appear 3.1-a: Longitudinal section of the cylinder

3.2
Characteristics of the grid

The longitudinal section of the cylinder is represented by a regular grid containing:

.
136 elements (6 POI1, 30 SEG2, 100 QUAD4).
.
126 nodes.

Creations of groups of meshs for the application of the loading and the limiting conditions:

· support: to block vertical displacement
· ldf, lfa: to apply a variable pressure to the part cylinder interns.

Creations of groups of nodes:

· A, B, C, D: used to note displacements in these characteristic nodes.

3.3
Command file Aster

.
BEGINNING: obligatory order to start

•

Reading of grid (PRE_GMSH) and generation of grid (LIRE_MAILLAGE).

•

Definition of groups of nodes and meshs for the assignment of the loading and of limiting conditions (DEFI_GROUP).

•

Definition of the finite elements used (AFFE_MODELE).
One assigns to all the meshs grid modeling AXIS.

•

Definition and assignment of material (DEFI_MATERIAU and AFFE_MATERIAU).
The mechanical characteristics are identical on all the structure.

· Affectation of the loading: Definition of a function representing the pressure P on the face intern of cylinder (DEFI_FONCTION), then assignment of the pressure on the internal edges cylinder represented by the groups of meshs LDF and LFA (AFFE_CHAR_MECA_F).

· Affectation of the boundary conditions (AFFE_CHAR_MECA).
Displacements following there are blocked at the base of the cylinder on the level of the group of meshs SUPPORT.

•

Resolution of the linear elastic problem (MECA_STATIQUE).
Calculation of displacements and the constraints at the points of Gauss of each element to be left displacements.

•

Calculation of the constraints to the nodes.
One calculates the stress field to the nodes of each element from displacements (CALC_ELEM).

•

Impression of results (IMPR_RESU).
One prints in form listing the displacement and the constraints of all the grid.
One also prints the field of displacement to format GMSH, for a visualization results with GMSH.

•

Tests relating to the values of displacements to nodes A, B, C, D. (TEST_RESU)
These tests make it possible to check nonthe regression of the code.

•

END: obligatory order to close an execution.

3.4 Notice

For modeling “AXIS”, the axis of revolution is always axis Y.
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4
Results of modeling A

4.1 Values
tested

Identification unit Reference Aster %
difference
DX in A
m
4.6814 10-6 4.6814
10-6 0.
DX out of B
m
4.6528 10-6 4.6528
10-6 0.
DX out of C
m
1.2022 10-6 1.2022

10-6 0.
DY out of C
m
-2.6396 10-6 -2.6396
10-6 0.
DX in D
m
3.3102 10-9 3.3102
10-9 0.
DY in D
m
-2.8170 10-6 -2.8170
10-6 0.

5
Summary of the results

Following displacements X are relatively important at the base of the cylinder, where the loading is highest. One can note that following displacements there of the high part of the cylinder are negative, which was foreseeable with the sight of the problem.

Organization (S): EDF/IMA/MMN

Handbook of Validation

V3.90 booklet: Theoretical references of tests in linear statics

Document: V3.90.001

Calculation of an elastic hyperstatic plane gantry

Summary:

The goal of this note is to expose the method of calculation used to determine the reference solution of case-test SSLL 14, entitled: "Plane Gantry articulated in foot".

One uses the method of the forces (hyperstaticity 1), by taking account only of the energy of inflection: assumption
slim beams.

One considers four loading cases separately.

Contents

Handbook of Validation
V3.90 booklet: Theoretical references of tests in linear statics
HI-75/96/037 - Ind A

Code_Aster ®
Version
4.0
Titrate:

---

y
C
One considers the gantry opposite,
p
subjected to various loads.

has

C
C
1

2
Hyperstaticity of degree 1.
F
Hyperstatic unknown factor: *X*:
1
F

2
moment out of *C*.

Top-load distributed *p* on

H
C1 C.
Two forces *F1*, *F2*, and a couple
With
in *C1*.
B
X
"

tg
= 2a = 0,4 cos

() - 1 = 1,16 =1, 077033
(
)
"

C
tg
=
"
=
1
2 *A*
(+ *H*)
1,2
GOES
VB
B
=
"
With
B

2cos
; sin
= *B has*
H
H
With
B
1
Isostatic requests under real load distributed *p* on
C C
1
1.1
Isostatic reactions of supports
p "
p 2
"
H + *H*

= 0; *V* + *V*
=
;
“*V*
=
With
B
With
B
B
2 cos
8 cos
Part *CB* is articulated and charged only at its ends:
H
B

BC = **0**

H = - *V*

tg
V
B
B

B
From where isostatic reactions:
p "
3 *p* "
p "
p "
H
=
tg; *V*
=
;
H
= -
tg; *V*
=
With
With
B
B

8 cos
8cos
8cos
8 cos
Note:
“tg
"
=
B
.
8 cos
(
8 *A* + *H*)

1.2 Requests
Beam
In C1
M
NR

3 *p* "
NR
= -
Iso

y

8 cos
+

"
V
p
V

=

With
Viso
tg

8 cos
0

p "
H
M
= -
y tg
With
Iso

8 cos
Beam *C B*
2
M
NR

p "
NR
= -

+
Iso
8 cos
y

"
V
p
V
= -
tg

V
Iso
B

8 cos
0

p "
H
= -

B
M
y
Iso
tg

8 cos
Beam *C C*
1
M

px
= -
cos -
sin +

V
NR
H
V
Iso
With
With
sin

cos
p

"
X
NR
= -
tg + 3 tg - 8 tg

+
p

y

8

"

px

V
= *H* sin - *V* cos +

Iso
With
With

cos

cos

p "

=
(tg tg -3+8 *X*/“)
GOES

8
2
H

px
With
M
= -
+ *V* *X* - *H* *y*
Iso
With
With
2 cos
X

p
x2 3 “*X* “*y* tg

=
-
+
-
(= 0 in *C)*!

cos
2
8
8

p "
2 *A* + *H*

M
= -
Iso
(
2 *S*
S 2a
H
3
bh
8 *A* + *H*)
(
)

B -
+
+
with
S
X
= cos [
0, *B*]
Handbook of Validation
V3.90 booklet: Theoretical references of tests in linear statics

Beam *C C2*

NR

NR

= *H* cos - *V*

Iso

B

B sin

p

"

= -

(tg + tg)

y

M

8

+

V

V

= *H* sin + *V*

Iso

B

B

cos

p "

= -

(tg .tg -) 1

8
M

= *H y* + *V* (“- *X*)
V
Iso
B
B
B

p "
H

= -
(*y* tg - (“- *X*)) (= 0 *C*
in
)!
B

8

X
cos
"
1.3 Diagrams

"
B =

2 cos
+
+
p
"
-
- *H* tg

pH "
tg

8cos
8

cos
p “
"
p
=
"
p
"
p “
- *pbh*
- 3
-
tg

- tg

8 *(a+h)*

8 cos
8cos

8cos

8cos

NR
V
M
Iso
Iso
Iso
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Code_Aster ®
Version
4.0
Titrate:
Calculation of an elastic hyperstatic plane gantry
Date:

2 Requests under concentrated force *F1* (downwards)

2.1 Reactions of support

F1
H + *H*
=
With
B
0 ;
C
V + *V*
= *F*
With
B
1
;
C
C
1
2
H
H
With
B

AC = **0** =

BC
V
V
With
B
V
V

With

B
With
B
H
H
With
B
From where:
1
1
1
1
H
=
F tg
; *V*

1
=
F
;
H
1
= - *F* tg
;
V
1
=
F
With
With
B
B
2
2
2
2 1

2.2 Requests

Beam

*In C1***:**

1
NR

= - *F*
Iso
1

2

1
tg
V
=
F

Iso

2 1

1
M
= - *F y* tg
Iso

2 1
Beam *C B*
2
:

1
NR
= - *F*
Iso
1

2

1
tg
V
= - *F*

Iso

2 1

1

M
= - *F y* tg
Iso

2 1
Beam *C C*
1
:

1
NR
= - *F*

1
+
Iso
(tg cos sin)

2

1
V
=
F

1
-
Iso
(tg sin cos)

2

1
M
= - *F*

1
-
Iso
(*y* tg *X*)

2
Beam *C C2***:**

1
NR
= - *F*

1
+
Iso
(tg cos sin)

2

1
V
= - *F*

1
-
Iso
(tg sin cos)

2

1
M
= - *F*
"
1
- -
Iso
(*y* tg (*X*))

2
Handbook of Validation
V3.90 booklet: Theoretical references of tests in linear statics
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2.3 Diagrams
(*F1* downwards)

F1
- *H* tg
2
- *F1h* tg
= - *F lh*
1
2
4 *(a+h)*
- *F1* /2
- *F1/2*
NR
V
M
Iso
Iso
Iso

3
Requests under the concentrated force *F2* (towards the left)

3.1 Reactions
of support

· *Ha* + *HB* = *F2*;
C
C
+ *VB GOES* = 0;
1
C
"*V*
2
B + *H F2*

= 0
F

2
HB

.
BC =
V
V

0
With
V
B
B
With
B
H
H
With
B
From where:

H
H
H
H
H
= *F*

1 1 -
tg
;
V
F
;
H
F
tg
;
V
F

With
With
2
B
1
B

"

=
=
= - 2
"
"
"
Note:
H
H

H
2a + *H*
=
1 -

“tg
(
;
tg
2 *A* + *H*)

"

=
(
2 *A* + *H*)
2
2
H "
" - (
4 *A* + *ah*)

tg sin - cos
= - 2 (
-
=
B has + *H*)
;
tg cos sin
4 (
B has + *H*)

3.2 Requests

Beam *A C1*:

NR
= - *F H*/"
Iso

2

H
V
= *F*

2 1 -
tg
Iso

"

H
M
= - *F y*

2
1 -
tg
Iso

"

Beam *C B*
2
:

NR
= *F H*/“
Iso

2

H
V
= *F*
tg
Iso

2 “*H*
M
= - *F*
y tg
Iso

2 "
Beam *C C*
1
:

H
H

NR
= - *F*

2
1 -
tg
cos
sin
Iso

"

+ "

H
H

V
= *F*

2
1-
tg
sin
cos
Iso

"

- "

H

H

M

= *F*
X

2
- 1 - tg
y
Iso

"

"

Beam *C C2***:**

H
NR
= *F*

2
+
Iso
(tg cos sin)

"

H

V
= *F*

2
-
Iso
(tg sin cos)

“*H*
M
= *F*
"
2

- -
Iso
(*y* tg (*X*))

"
3.3 Diagrams
(
)
- *H* 2a + *H*
F2
+
2 *A*
(+ *H*)
-
- *H*
H2
F
F
2
2
"
2 (+ *H has*)
M
NR
Iso
Iso
Viso

---

4 Requests under the concentrated couple (positive)

4.1 Reactions of support

· *HA* + *HB* = 0;
V
C
WITH + *VB*
= 0 ;

"
C
V

2
B +
= 0
H

B
·
BC =

0
V
V
V
With

B
B
With
B
H
H
With
B
From where:
H
= - tg “; *V*
= "
With
With
H
= tg “; *V*
= - "
B
B
Note:
tg
=
1
"
(
2 *A* + *H*)
4.2 Requests
Beam *A C1*:
NR
= - "
Iso

V
= - tg “
Iso
M
=
y

tg “
Iso
Beam *C B*
2

:
NR
= "
Iso

V
= tg “
Iso
M
=
y

tg “
Iso
Beam *C C*

1
:
NR
=
tg cos -

Iso
(
sin)

"

V
= -
tg sin +

Iso
(
cos)

"

M
=
+ tg -

"
Iso
(*X y*
)

"
Beam *C C2***:**

NR
=
tg cos +

Iso
(
sin)

"

V
=
tg sin -

Iso
(
cos)

"

M
=
tg - “-
Iso
(*y*
(*X*))

"

4.3 Diagrams
(positive)
(
)
- *H* +2a
2 (+ *H has*)
-
H
H
2 *A*
(+h)
2 (+ *H has*)
- tg
- /
/
"
"
"

NR
M
Iso
Viso
Iso

5 Requests under moment *X* hyperstatic

5.1 Reactions of support

X
X
+
H + *H*
=
With
B
0 ;
C
V + *V*
=
C
C2
With
B
0 ;
1
“*V*
=
B
0 ;
V
V
H (+ *H has*) - *X*
=
With
B
B
0
With

B
H
HB
With
From where reactions:
X
X
H
= -
;
V
= 0
; *H*
=
;
V
=
With
0
+ *H has*
With
B
+ *H has*
B

5.2 Requests

Beam *A C1*:

NR
=
X
0

X
V
= -
X
+ *H has*

X
M
=
y
X

+ H has
Beam *C B*
2
:

NR
=
X
0

X
V
=
X
+ H has

X
M
=
y
X

+ H has
Beam *C C*
1
:

X
NR
=
cos

X
+ H has

X
V
= -
sin
X
+ H has

X
X
M
=
y
=
+

X
(*H X* tg)

+ *H has*
+ *H has*
Beam *C C2***:**

X
NR
=
cos

X
+ *H has*

X
V
=
sin
X
+ *H has*

X
M
=
y
X

+ *H has*

5.3 Diagrams

X
X
X sin
X cos
+ *H has*
+
+ *H has*
X H
X H
has
has
+ *H*
+ *H*
O
O
X
+ *H has*
NR
V
M
X
X
X

6

Requests under specific dummy loads out of *C*

In order to calculate displacement out of *C*, using the Principle of Virtual work (cf.

paragraph [§8]), it is necessary to establish the diagrams of requests under the action of two "fictitious" forces *F* and *G* applied out of *C*.

6.1 Reactions

of support
H + *H*
= - *F*
G
With
B
;
V + *V*
= - *G*
F
With
B
;
H
H
C
With
B

AC = **0** =

BC
C
C
V
V
2
With
B
1
V
V

With
B
With
B
H
H
With
B
From where:
1

1
H
= -
+

;
= -
+ cot G
With
(*F G tg*)
GOES
(*G F*
)
2
2
1
1
H
= -
-

;
= -
- cot G
B
(*F G tg*)
VB
(*G F*
)
2
2

6.2 Requests

Beam *A C1*:

1
N
=

(*g*+ *F* cotg)

2

1
v = - (*F* + *G* tg)

2

1
m
=
(*F* +g tg) *y*

2

Beam *C B*
2
:

1
N
=

(*G F* cotg)

2

1
v = - (*F* - *G* tg)

2

1
m
= - (*F* - *G* tg) *y*

2
Beam *C C*
1
:

1
1
N
=

(*F* +g tg) cos + (*g*+ *F* cotg) sin

2
2

1
1
v = - (*F* + *G* tg) sin + (*G* + *F* cot G) cos

2
2

1
1
m
= + (*F* + *G* tg) *y* - (*G* + *F* cot G) *X*

2
2
Beam *C C2***:**

1

1
N
= -

(*F* - *G* tg) cos + (*G F* cotg) sin

2
2

1
1
v = - (*F* - *G* tg) sin - (*G* - *F* cot G) cos

2
2

1
1
m
= - (*F* - *G* tg) *y* - (*G* - *F* cot G) (“- *X*)

2
2

6.3 Diagrams

Here diagrams of requests under the action of the two “fictitious” forces *F* and *G*. One considers here: *F* 0, *G F*
cotg.
G
+
F
- *fh* /2
fh
gh “
2
+
"
4

has
(+ *H*)
+ *gh*
4 *A*
(+ *H*)

N
v
m
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7
Determination of moment *X* hyperstatic

One places oneself in elasticity; one considers only the energy of inflection, the beams being slim. The state
naturalness is supposed to be virgin (not prestressings nor of displacement of support).
The complementary potential is then:

(
2
2
M
+ *M1 X*

+ 1
Iso
)
(*MR. MR. X*
Iso
)
F * (*X*) =

+
I.E.(internal excitation)

I.E.(internal excitation)

1

2
posts
frames
It is stationary with balance, from where:

M2

2
M
1
1

M1 Miso
M1

M
X
=

+
X = -
Iso
S

I.E.(internal excitation)
pot
1

I.E.(internal excitation)
charp
2

-
I.E.(internal excitation)
pot
1

=
I.E.(internal excitation)
charp
2
.
.
.
.
The coefficient of flexibility is the sum of:

M2
2 *H H*
2
1
I.E.(internal excitation)
3 *I.E.(internal excitation)*

has
H

=
+
posts
1
1

M2
2 *B*
H2 1 *has* 2
ah

1

I.E.(internal excitation)
I.E.(internal excitation)

has
H + 3

has

+ *H*
2

=
+

+
2
2
(*has*

+ *H*)
frames

that is to say:
3
2
2

2
H
(*B h3* +a + *a3h*)
E
=

(
+
+ *H*) 2 *has* 3I
3I
1
2

Numerical application:
In the example considered:
-
I = 2I
4
= 5 0
, 10
m4
1
2

"
H = 2 *A* = 8 *m*; “= 20 *m*; *B* =
1 1
, 6
2
From where:
2
=
2
H
19 *B*
H
E (

+
+ *H*) 2 *has I*
3

2
1

2353 45347
3
.
m
One studies one after the other the various loadings to calculate the second members *S*.
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7.1 Charge
distributed
p **on** *C C*
1
The second member *S* due to *p* is:
MR. M
2 *H*
H
3
"
"
1
Iso
Pb H
-

2
pH B

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*

has
2
1
1
+ *H* (
8 *A* + *H*)
= *E*
24
posts
(+ *H has*) *I1*
MR. M
pb2h
2
"
"
1
Iso
1 *H*

1 *A*

1
phb (*H*
3 + *has*)
-

=
I.E.(internal excitation)
(
8 *A*
2
2
+ *H*) *I.E.(internal excitation)* 2

has
2
+ *H* + 6

+ *H has*
= *E*
48
C C
(+ *H has*) *I*
2
2
"

+

-
MR. M
1
p

1
Iso
B
has
H
has

2 2
S
S (2a 3h) *bh*
H
S
ds

=

I.E.(internal excitation)
I.E.(internal excitation)
(
8 *A* + *H*) 2 0

B -
+
+

B
C C
2
2

+
1
1
2
p " *B*
2
2
=

H - *ah* - *has*
2
(2
)
E (+ *H has*) *I*
48

2
From where:
3
2
2
2
2
p " *B* 4h
(
hb H
3 + *has*)
(*bh* - *ah*-*a*)
S
=

+
+

E (+ *H has*) 2
96 *I*
I
I
1
2
2

Numerical application:
I = 2I
;
H = 2 *A*;
p = 3.000 *NR*/*m*
1
2
(downwards)
2
p " *bh2*
13
S
=

4h +
B

E (+ *H has*) 2 *I*
96

2

1

43.946 02189
.
NR m4

From where:
· moment out of *C*:
X
= **18.672.994**
.
NR m
· reaction in *a:*
B "
X
Pb " 8 - *X*
H
= *p*
-
=
With
(
8 *A* + *H*)
+ *H has*
(+ *H has*)
H
=
With
5.175 37
.
NR
3pb
V
=
-

With
0
4
V
=
With
24.233 24
.
NR

7.2 Charge
specific
F1 **out of** *C*

The second member is obtained using:

MR. M
2 *H*
H
3
"
"
1
Iso
F H
1

-

2
F H

1

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*

has
2
1
1
+ *H* 4 (+ *H has*) = *E*
12
posts
(+ *H has*) *I1*
MR. M
2b
F “
1
Iso
1 *H*
1
H
1
has

-

=

I.E.(internal excitation)
I.E.(internal excitation)
4 (*has*
2
2
+ *H*) 2

+ *H has* + 6

+ *H has*
frames
2
F B " (
H H
1
3 + *has*)
= *E* (

+ *H*) 2 *has I*
24
2
From where:
2
F “*H* 2h2
(
B H
3
1
+ *has*)
S
=

+

E (+ *H has*) 2
24
I
I

1
2

Numerical application:
I = 2I
;
H = 2 *A*; *F* = 20.000 *NR*
1
2
1
(downwards)

2
F “*H2*
S
1
=

2 + 7
2
[*H B*]
E (+ *H has*) *I*
24
1

97.485.127 76
,
NR m4

From where
· moment out of *C*:
X
= **41.422.161**
.
NR m
· reaction in *a:*
1
"
X
F “4
1
- *X*
H
=
F1
-
=
With
4
+ *H has*
+ *H has*
(+ *H has*)

H
=
With
4.881 4866
.
NR
1
V
=
F1 -
With
0
2
V
=
With
10.000 0
. **NR**

7.3
Concentrated loading *F2* **in** *C1*

The second member is obtained using:

MR. M
H
3
1
Iso
H

F
(
H 2a
2
+ *H*)
2
F H (2a
2
+ *H*)
-
=

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*

has
2
1
1
+ *H2* (+ *H has*)
E
12
WITH C
(+ *H has*) *I1*
1
2
MR. M
H
4
1
H
(- *F H*
2
)
2
-
-
=

F H
Iso
2

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*

has
2
1
1
+ *H* (
2 *A* + *H*)
E
12
C B
(+ *H has*) *I*
2
1
MR. M
B
F H2
1
Iso
2
(*a*+ *H*) 1 *H*
1
has

-

=
I.E.(internal excitation)
I.E.(internal excitation)
(
2 *A*

2
2
+ *H*)
2

6
C C

+ *H has* +

+ *H has*
1
2
F bh
2
2
2
(*h3* +7ah+2a)
= *E* (

+ *H*) 2 *has I*
24
2
MR. M
B
2
2
1
Iso
- *F H*
2
1 *H*
1 *A*

2
- *F bh* (*H*
2
3 + *has*)
-

=

I.E.(internal excitation)
I.E.(internal excitation)
(
2 *A*
2
2
2
+ *H*) 2

6
24
C C

+ *H has* +

+ *H has* = *E* (+ *H has*) *I2*
2
From where:
2
F ha 2h2
B

S
=
2

+
(*H*
3 + *has*)
E (+ *H has*) 2
12 *I*
I
1
2

Numerical application:
I = 2I
;
H = 2 *A*; *F* = 10.000 *NR*
1
2
2
(towards the left)

2
F H2 has
S
=
2
(2h + 7b)
E (+ *H has*) 2 *I*
12
1

19.497.025 55 *NR m*
4
.
From where:
· moment out of *C*:
X
= **8.284 4321**
.
NR m
· reaction in *a:*
2a + *H*
X
F (*has*
2
+ *H*/2) - *X*
H
= *F2*
-
=
With
(
2 *A* + *H*)
+ *H has*
(+ *H has*)
H
=
With
5.976.297
.
NR

V
= *F H*
With
2
/ "
V
=
With
4.000 00
.
NR

7.4 Couples specific in *C1*

The second member is obtained using:

MR. M
3

1
- 2h
H
H
2
-
-

=

H
Iso

=
I.E.(internal excitation)
3 *I.E.(internal excitation)*

has
2
1
1
+ *H* (
2 *A* + *H*)
E
6
posts
(+ *H has*) *I1*
MR. M
B
(*H*
1
Iso
+ 2a) 1
H
1
has

-

=
I.E.(internal excitation)
I.E.(internal excitation)
(
2 *A*
2
2
+ *H*) 2

6
C C

+ *H has* +

+ *H has*
1
2
(*H* + 2a) (*H*
3 + *has*)
=
B
E (

+ *H*) 2 *has I*
24
2
MR. M
B

1
Iso
- *H* 1 *H*
1 *A*

2
- *hb* (*H*
3 + *has*)
-

=
I.E.(internal excitation)
I.E.(internal excitation)
(
2 *A*
2
2
2
+ *H*) 2

6
24
C C

+ *H has* +

+ *H has* = *E* (+ *H has*) *I*
2
2
From where:
2
- 2h3
(
ab H
3 + *has*)
S
=

-

E (+ *H has*) 2 12 *I*
I
1
2

Numerical application:
I = 2I
;
H = 2 *A*; = -100 000 *NR m*
1
2
(direction hands clock)
2
-
S
=

3
2
[*H* - *has* (*B h3*+*a*)]
E (+ *H has*) *I*
6

1

11.571.281 93
.
NR m
4
From where
· moment out of *C*:
X
= **4.916 7243**
.
NR m
· reaction in *a:*
-
X
- 2 - *X*
H
=
-
=
With
(
2 *A* + *H*)
+ *H has*
(+ *H has*)
H
=
With
4.576.394
.
NR

V
=
With
"
V
=
With
5.000.000
.
NR

7.5 Summary

CASE
Moment out of *C*
Reactions of *A* **(NR)**
(N.m)
Ha
GOES
p on *C C*
18672.994
5175.37
24233.240
1
F1 out of *C*
41422.161
4881.487
10000.000
F
8284.432
5976.297
4000.000
2 in *C1*
out of *C*
4916.724
4576.394
5000.000
1
TOTAL

22033.31
43233.24

Notice

Recall: in post *A C1*: normal effort = - *GOES*, shearing action = *ha*.

8

Calculation of displacement out of *C*

One considers also only the elastic energy of inflection (slim beams). By applying the Principle virtual Work on the structure subjected to the fictitious forces of the paragraph [§6], working in sought displacements, one calculates the numbers *W* and *D* depending linearly on *F* and *G*:

m (*M* + *X M1*

+
Iso
)
m (*M*
X M
Iso
1)
F U + *G v*
=
W
Xd

+
=
+
, (
F, *G*
C
C
)
I.E.(internal excitation)
I.E.(internal excitation)

1

pot
charp
2
.
.

8.1 Charge

distributed
p **on** *C C*
1

m M
2h
gh "
- *pbh* "
2
- *gpbh3* 2
"
Iso

=

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*
(
4 *A*
2
1
1
+ *H*) (
8 *A* + *H*)
E
+
96
posts
(*H has*) *I1*

m M
2
- *p* " *hb2*
Iso

2
"
2
(*F* (*a*+*h*) +g) (*ha*)

=
EI2
E
+
384
C C
(*H has*) *I*
1
2

M
B
pbh "
fh
G H
"

2
- *pb2* " *H2* “- 2
+
Iso
(*G*
F (*H has*))

-

=

I.E.(internal excitation)
I.E.(internal excitation)
3
(
8 *A* + *H*) 2
(
4 *A* + *H*) =
E
2
+
192
C C
2

2
(*H has*) *I*
2
2
From where:
2
- *pbh* " 4g *H2*
"
G " (
B H
3 - *has*) - 2 *Bfrs* (+ *H has*) 2
W
=

+
2

E (+ *H has*)
384
I
I
1
2

Numerical application:
I = 2I
;
H = 2 *A*;
p = 3.000 *NR*/*m*
1
2
(downwards)
2

5
9

- *p bh2* "
W
=
G " 2h + *B*

fbh
E (+ *H has*) 2 *I*

2 - 2

192
1

- 2154065922
.
NR m
3
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8.2 Charge specific

F1 **out of** *C*

m M
H
gh "
- *F H*
3 2
2
"
"

1
2
- *F gh*
Iso

=

1

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*
(
4 *A*
2
1
1
+ *H*) (
4 *A* + *H*)
E
+
48
posts
(*H has*) *I1*

m M
B
gh "
- *F H*
2 2
2
"
"
1
2
- *F gbh*
Iso

=

1

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*
(
4 *A*
2
.
2
2
+ *H*) (
4 *A* + *H*)
E
+
48
charp
(*H has*) *I2*
From where (it is noted that *W* does not depend on *F* for this loading):
2
- *F gh2* 2
“*H*
B
W
=

1
+
E (+ *H has*) 2
48
I
I
1
2
Numerical application:
I = 2I
;
H = 2 *A*; *F* = 20.000 *NR*
1
2
1
(downwards)
2g
- *F H2* 2

"
W
=

1
(*H* + 2b)
E (+ *H has*) 2 *I*
48
1

315.100.365 0
. *NR m*
5
8.3 Charge
specific
F2 **in** *C1*

m M
H
F H

"
"
2
fh
gh

- *fh*
gh

Iso
- 2a + *H*
+
H
+

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*

(
2 *A*
1
1
+ *H*)
(
) 2 (4a

+ *H*) + 2
(
4 *A* + *H*)
posts

2
- *F*
3
2 *H*
=

2
“2
2
(*Ag* + *F* (*a*+*h*))
E (+ *H has*) *I*
24
1

m M
2
- *F bh2*
Iso

2
2
“2
2
(*Ag* + *F* (*a*+*h*))

=
I.E.(internal excitation)
.
2
E

+
24
charp
(*H has*) *I2*
From where:
2
- *F H2*
H
B
W
=

2
2
"
2
(*Ag* +2f (*a*+*h*)) +
E (+ *H has*)
24
I
I
1
2
Numerical application:
I = 2I
;
H = 2 *A*; *F* = 10.000 *NR*
1
2
2
(towards the left)
2
-
3
2
+
=
"
2
(
F H H 2b
G + 9gh)
(

)
W
E (+ *H has*) *I*
48
1

- 315100365
.
NR m
4

8.4 Couples
specific
in *C1*

m M
H
H

fh
G H
"
fh
G " H
Iso

+

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*
(
2 *A*
1
1
+ *H*) 2
(
4 *A*

+ *H*) + -
+

2 (4a+h)
posts

2
h3 " *G*
=

E (+ *H has*) 2 *I*
24
1

m M
B

fh
G " *H*
fh
G " *H*
Iso
- 2a + *H*
+
H

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*
(
2 *A*
.
2
2
+ *H*)
(
)

2
(
4 *A* + *H*) +
-
+

2 (4a+h)
charp

- 2
bh
=

2
“2
2
(*Ag* + *F* (*a*+*h*))
E (+ *H has*) *I*
24
2
Numerical application:
I = 2I
;
H = 2 *A*; = - 100.000 *Nm*
1
2
2
H2
W
=

"
2
(*G* (*h*-*b*) - 9 *fhb*)
E (+ *H has*) *I*
24
1

- 266.666.667
.
NR m
3
m M
8.5 Calculation
of
D =
1
I.E.(internal excitation)

m M
2h
G " *H*
H
2
G " *h3*
1

=

=

I.E.(internal excitation)
3 *I.E.(internal excitation)*
(
4 *A*
2
1
1
+ *H*) *has* + *H*
E
+
12

posts
(*H has*) *I1*

m M
2b
"
"
1
1 *H*
1 *A*
G H
2
G B (
H H
3 + *has*)
=

=
I.E.(internal excitation)
I.E.(internal excitation)
2

has
2
2
2

+ *H* + 6

+ *H has* (
4 *A* + *H*)
E
+
24
frame
(*H has*) *I2*
From where (it is noted that *D* does not depend on *F*):
2
G H
“2h2
(
B H

3 + *has*)
D
=

+

E (+ *H has*) 2 24 *I*
I
1
2

Numerical application:
I = 2I
;
H = 2 *A*
1
2
2
“*H2*
D
=
G
(2h + 7b)
E (+ *H has*) 2 *I*
24
1

4.874 2564
.
m4

8.6
Summary of displacements *CPU* **and** *vC*
-
I
4
= 5 0
, 10
m4
1
E
= 210.000 *MPa*
CASE
X
X D
wV
pressure on *C C*
18672.994
91016960.3
184930109.4
1
F1 out of *C*
41422.161
201902233.4
315100365.0
F
8284.432
40380445.6
63020073.0
2 in *C1*
out of *C*
4916.724
23965373.4
14775091.25
1
CASE
W
U
(*m*)

v
(*m*)
H
C
C
pressure on *C C*
83519999.94
0.0110476
0.012422374
1
F1 out of *C*
0.00
0.00
0.01497330
F
226872262.8
0.03000956
0.00299466
2 in *C1*
out of *C*
206790328.5
0.0273532
0.001215646
1
Note:
2
D
=
G D
4
, with: *D*
= 4.874 2564
.
m
E (+ *H has*) 2 *I1*
2
W
=

2
(*G W* + *F W*
V
H) to see higher

E (+ *H has*) *I1*
2
2
U
=
W
;
v
=
2
2
(*W* + *Xd*
C
H
C
V
)
E (+ *H has*) *I*
E (*has*
1
+ *H*) *I1*
2
10
-
1
-
-4
= .

NR m
E (+ *H has*)
1 32275132 10
2
1
I

Comparison Aster - reference analytical (R.)
CASE
Moment out of *C*
Reaction
Reaction *V*
Displacement
With
Displacement *vC*
(N.m)
HA **(NR)**
(NR)
CPU **(m)**
(m)
p on
R:
18672.994
5175.37
24233.24
0.0110476
0.012422374
C C
Aster:
18673.20
5175.36
24233.2
0.0110472
0.0124233
1
F
41422.161
4881.487

10000.00
0.00000
0.01497330
1 out of *C*
R:
Aster:
41422.40
4881.47
10000.0
0.0000
0.0
F
R:
8284.432
5976.297
4000.00
0.03000956
0.00299466
2 in *C1*
Aster:
8284.34
5976.31
4000.0
0.0300098
0.00299450
out of *C*
R:
4916.724
4576.394
5000.00
0.0273532
0.001215646
1
Aster:
4916.62
4576.38
5000.0
0.0273536
0.00121583
Foot-note:
Aster calculation was carried out by taking very slim elements, so that: *S* " 2 << *I*. Thus,
the energy of inflection is prevalent. The values of Aster calculation result from case-test VPCS called SSLL14,

with the following data:
-
-
I
4
=
.
m4
;
I
4
=
.
m4
5 0 10
2 5 10
;
E
= 210.000 *MPa*
1
2
,
"
H = 2 *A* = 8 *m*; “= 20 *m*; *B* =
11
. 6 ,
2
p = 3.000 *NR*/*m* (downwards),
F =
NR
1
20 000
(downwards),
F =
NR
2
10 000
(towards the left),
= - 100.000 *Nm*.
Handbook of Validation
V3.90 booklet: Theoretical references of tests in linear statics
HI-75/96/037 - Ind A

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
Document: V4.01.001

TPLA01 - Infinite hollow roll in balance thermics

Summary:

Linear stationary thermics.

Axisymmetric model; 3 modelings.

Analytical solution.

Interest of the test:

· all axisymmetric elements: triangles and quadrangles, degrees 1 and 2,
· boundary conditions varied: exchange, imposed temperature, imposed flow,
· validation partial of the matrix of thermal "mass" because one makes "a false" transient.

The results are not affected by the distortion of the meshs h/l = 40.

1
Problem of reference

1.1 Geometry

Z
IH
Re
Interior ray
IH = 0.300 m
External ray

Re = 0.35 m
Not F

R = 0.32 m
R
Z
D
C
E
F
With
B
R

1.2
Material properties

= 1 W/m °C

CP = 2. J/m3 °C (voluminal heat)

1.3
Boundary conditions and loadings

· [CD.] [AB]:
= 0 W/m2
· [EA]:
T = Ti = 100°C
· [ED]:
= I = 1729.9091 W/m2 (returning flow)
· [CB]: exchange
H = He = 500 W/m2 °C

T = Te = 17.03444 °C

1.4 Conditions
initial

To make this stationary calculation, a transitory calculation is made for which the boundary conditions are
constants in time. This makes it possible to test elementary calculations of mass intervening in
the first member as well as the second member.
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures

2 *Reference solution*

2.1 *Method of calculation used for the reference solution*

R
T (R) = Ti + Log
IH

T - T
T
E
I
I: temperature in skin "interns"
=
;
R
T

E
E: temperature in "external" skin
Log

IH

T

with: "radial" flows
on the walls of the cylinder are:
R

I
= + ,
R

I

E
= +
.
R

E

2.2
Results of reference

Temperatures and flow at the points A, B, D, F.

2.3
Uncertainty on the solution

Analytical solution.

Titrate:
TPLA01 - Infinite hollow roll in thermal balance

Date:
30/08/02
Author (S):
J.** Key **PELLET
:
V4.01.001-C Page:
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3 Modeling
With

3.1
Characteristics of modeling

axis (TRIA3, QUAD4)

y
L = 2.5 10-3
D
C
X y

H = 0.1
In 0.3.0.0 N1
B 0.35
0.0
N41
E
G
D
0.30 0.10 N43
E
0.30 0.05 N2
F 0.32
0.0
N17
J
0
X

I
With
F
B

3.2 Characteristics of the grid

A number of nodes: 63.

A number of meshs and types: 40 TRIA3, 20 QUAD4

3.3 Functionalities tested

Orders

AFFE_MODELE
THERMICS
AXIS

THER_LINEARE
TEMP_INIT
STATIONARY

EXCIT
CHARGE

AFFE_CHAR_THER
TEMP_IMPO
FLUX_REP
EXCHANGE

4
Results of modeling A

4.1 Values
tested

Identification	***Reference***	***Aster***	*%* ***difference***
T (A)	*100*	*100.000*	*0.00*
T (B)	*20*	*20.002*	*0.01*
T (F)	*66.506*	*66.507*	*0.00*
T (D)	*100*	*99.933*	*0.07*
(A)	*1729.91*	*1722.62*	*0.42*
(B)	*1482.78*	*1487.98*	*0.35*
(D)	*1729.91*	*1723.26*	*0.38*
(F)	*1621.79*	*1628.17*	*0.39*
(F)	*1621.79*	*1615.50*	*0.39*

---

5 Modeling
B

5.1
Characteristics of modeling

axis (TRIA6, QUAD8)

y
L = 2.5 10-3
D
C
X y

H = 0.1
In 0.3.0.0 N180
B 0.35
0.0
N10
E
D
0.30 0.10 N178
E
0.30 0.05 N183
F 0.32
0.0
N112
0
X
With
F

B

5.2
Characteristics of the grid

A number of nodes: 185.

A number of meshs and types: 40 TRIA6, 20 QUAD8

5.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
AXIS

THER_LINEARE
TEMP_INIT
STATIONARY

EXCIT
CHARGE

AFFE_CHAR_THER
TEMP_IMPO
FLUX_REP
EXCHANGE

---

6 Results of modeling B

6.1 Values tested

Identification	***Reference***	***Aster***	*% **difference***
T (A)	*100*	*100.00*	*0.00*
T (B)	*20*	*20.00*	*0.00*
T (F)	*66.506*	*66.506*	*0.00*
T (D)	*100*	*100.00*	*0.00*
(A)	*1729.91*	*1729.89*	*0.00*
(B)	*1482.78*	*1482.77*	*0.00*
(D)	*1729.91*	*1729.88*	*0.00*
(F)	*1621.79*	*1621.77*	*0.00*
(F)	*1621.79*	*1621.78*	*0.00*

7 Modeling
C

7.1
Characteristics of modeling

axis (TRIA6, QUAD9)

y
L = 2.5 10-3
D
C
X y

H = 0.1
In 0.3.0.0 N199
B 0.35
0.0
N10
E
D
0.30 0.10 N197
E
0.30 0.05 N203
F 0.32
0.0
N124
0

X
With
F
B

7.2 Characteristics of the grid

A number of nodes: 205.

A number of meshs and types: 40 TRIA6, 20 QUAD9

7.3 Functionalities tested

Orders

AFFE_MODELE
THERMICS
AXIS

THER_LINEARE
TEMP_INIT
STATIONARY

EXCIT
CHARGE

AFFE_CHAR_THER
TEMP_IMPO
FLUX_REP
EXCHANGE

Titrate:
TPLA01 - Infinite hollow roll in thermal balance

Date:
30/08/02
Author (S):
J.** Key **PELLET
:
V4.01.001-C Page:
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8
Results of modeling C

8.1 Values
tested

Identification	Reference	Aster	% difference
T (A)	100	100.00	0.00
T (B)	20	20.00	0.00
T (F)	66.506	66.506	0.00
T (D)	100	100.00	0.00
(A)	1729.91	1729.89	0.00
(B)	1482.78	1482.77	0.00
(D)	1729.91	1729.88	0.00
(F)	1621.79	1621.77	0.00
(F)	1621.79	1621.77	0.00

HT-66/02/001/A

9
Summary of the results

This problem is correctly solved:

· with the various types of elements whatever the degree of interpolation,
· is not affected by the shape of the elements h/l = 40.

Titrate:
TPLA04 Release of power in a hollow roll

Date:
20/09/02

Author (S):
***C. DURAND**, E. SCREW, F. LEBOUVIER Clé*
:
V4.01.004-A Page:
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Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
Document V4.01 004

TPLA04 - Release of power in one
hollow roll

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It comprises an axisymmetric modeling 2D which tests the axisymmetric elements in thermics, them boundary conditions in imposed temperature and the boundary conditions of the heat source type.

This test aims to validate the taking into account of the heat source by comparing the results obtained with those provided by VPCS.

Titrate:
TPLA04 Release of power in a hollow roll

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.01.004-A Page:
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1
Problem of reference

1.1 Geometry

Z
Re
IH
Interior ray IH = 1m
External ray Re = 2 m
Length L
Q
R

1.2
Properties of material

= 1.0 W/m°C
Thermal conductivity

1.3
Boundary conditions and loadings

· Imposed Températures:
-
Interior surface: Ti = T (R = IH) = 20°C,
-
External surface: Te = T (R = Re) = 20°C,
· Released Puissance uniform Q = 100 W/m3.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLA04/89 of guide VPCS.

· Température according to R:

R

ln (
)
Q
R

T (R) = T +

(R2 - R2
I
)
- (r2 - R2)
I
E
I
4

R
I
E

ln (
)

R

I

· Density flux according to R:

dT
Q (R2 - R2)

(R) = -
E
I
= -

- 2r2
Dr.
4r
R

ln (E)

R

I

The cylinder is supposed infinitely long (l>>Re)

2.2 Results of reference

Temperature and density flux for R = 1.0, 1.2 and 1.5

2.3 Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

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3 Modeling
With

3.1
Characteristics of modeling

AXIS (QUAD9)

y (Z)
0.1 m
D
C
m20
m17 m16
m11 m10
m1
X (R)
With
E
F
B
IH = 1.m
1.2m
1.5m
Re = 2.m
Limiting conditions:
Not
R
Z
Node
With
1.0
0.0
N1
- dimensioned AD, BC T = 20 °C
D
1.0
0.1
N3
- all
Q = 100 W/m3
E
1.2

0.0
N25
- dimensioned AB, CD = 0. W/m2
F
1.5
0.0
N61
B
2.0
0.0
N121
C
2.0
0.1
N123

3.2
Characteristics of the grid

A number of nodes:
123
A number of meshs and types: 20 QUAD9

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
AXIS
ALL

AFFE_CHAR_THER
TEMP_IMPO
SOURCE

THER_LINEAIRE
EXCIT

CHARGE

RECU_CHAMP
NUME_ORDRE

CALC_CHAM_ELEM
FLUX_ELNO_TEMP

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must obligatorily be declared. One CP = 2.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference

tolerance
Temperature (°C)

Node n1 (a: R = 1.0)
20.00
20.0000
0.000%*
1%
Node n25 (E: R = 1.2)
28.73
28.7276
-0.008%
1%
Node n61 (F: R = 1.5)
32.62
32.6222
0.007%
1%

Density flux (W/m ²)

Net m20 n1 (R = 1.0)
-58.20
-58.1592
-0.070%
1%
Net m17 n25 (R = 1.2)

-30.17
-30.1412
-0.095%
1%
Net m16 n25 (R = 1.2)
-30.17
-30.1434
-0.088%
1%
Net m11 n61 (R = 1.5)
2.87
2.8791
0.316%
1%
Net m10 n61 (R = 1.5)
2.87
2.8782
0.285%
1%

4.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
64 Mo
Time CPU To use: 1.98 seconds

5
Summary of the results

The results obtained are very satisfactory. The maximum change is -0.008% in temperature and of 0.316% in flow.

This test made it possible to test the taking into account of a source term within meshs QUAD9 with one
modeling AXIS (AFFE_CHAR_THER associated with the key word SOURCE).

Titrate:
TPLA05 Bars cylindrical with density flux

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
Document V4.01 005

TPLA05 - Cylindrical bar with density flux

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It includes/understands two modelings, the first which tests the voluminal elements, the second, the elements 2D
axisymmetric.

Boundary conditions in imposed temperature and of density flux are taken into account.
The results resulting from this case test are compared with those provided by VPCS.

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLA05 Bars cylindrical with density flux

Date:

20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.01.005-A Page:
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1
Problem of reference

1.1 Geometry

R
Z
O
L

R = 0.01 m (ray of the cylinder)
L = 1 m

1.2
Properties of material

= 33.33 W/m °C
Thermal conductivity

1.3
Boundary conditions and loadings

· Imposed Températures,
- T = 0°C in Z = 0. ,
- T = 500°C in Z = 1. ,
· Constant Density flux on cylindrical surface: = 200 W/m2 (outgoing flow).

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLA05/89 of guide VPCS

R
Z
O
L

-
Z
· Température according to Z: T (Z) =
Z (Z - L) + T. ,
R

1 L

· T (z=0) =0 T (z=L) = T1.

The cylinder is supposed infinitely long (L>>r)

The temperature minimum is of -4.17 °C in Z = 0.083 m

2.2
Results of reference

Temperature in Z = 0. , 0.1,…, 0.8, 0.9, 1.0

2.3
Uncertainty on the solution

< 1%
Approximate analytical solution (approximation: T = cte, for any R)

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

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3 Modeling With

3.1 Characteristics of modeling

3D (PENTA15, HEXA20)

X (R)
Limiting conditions:
= 30°
- faces ABCD, ABEF = 0
- face DFEC
= -200 w/m ²
- face AFD
T= 0°C
D
C
- face NOZZLE
T= 500°C
F
E
Cutting:
Z
- 80 elements
according to Z
- 2 elements according to

With
- 2 elements according to X
y
B

3.2
Characteristics of the grid

A number of nodes:
1937
A number of meshs and types: 160 PENTA15, 160 HEXA20 (and 160 QUAD8)

3.3 Functionalities
tested

Orders

AFFE_MODELE
AFFE
THERMICS

3D

AFFE_CHAR_THER
TEMP_IMPO

FLUX_REP

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must be declared for Code_Aster. One

CP = 1.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
tolerance
Temperature (°C)

Z = 0.0 R = .0 (n1: With)

0.00
0.000
0.0000*
.00001
R = .01 (n17: D)
0.00
0.000
0.0000*
.00001
Z = 0.1 R = .0 (n193)
-4.00
-3.991
-0.234%
1%
R = .01 (n209)
-4.00
-4.021
0.517% 1%
Z = 0.2 R = .0 (n385)
4.00
4.005
0.123%
1%
R = .01 (n401)
4.00
3.975
-0.627%
1%
Z = 0.3 R = .0 (n577)
24.00
24.002
0.007%
1%
R = .01 (n593)
24.00
23.972
-0.118%
1%
Z = 0.4 R = .0 (n769)
56.00
56.000
0.000
1%

R = .01 (n785)
56.00
55.970
-0.054%
1%
Z = 0.5 R = .0 (n961)
100.00
99.999
-0.001%
1%
R = .01 (n977)
100.00
99.969
-0.031%
1%
Z = 0.6 R = .0 (n1153)
156.00
156.000
0.000%
1%
R = .01 (n1169)
156.00
155.970
-0.019%
1%
Z = 0.7 R = .0 (n1345)
224.00
224.002
0.001%
1%
R = .01 (n1361)
224.00
223.972
-0.013%
1%
Z = 0.8 R = .0 (n1537)
304.00
304.005
0.002%
1%
R = .01 (n1553)
304.00
303.975

-0.008%
1%
Z = 0.9 R = .0 (n1729)
396.00
396.009
0.002%
1%
R = .01 (n1745)
396.00
395.979
-0.005%
1%
Z = 1.0 R = .0 (n1921: B)
500.00
500.000
*0.0000**
.00001
R = .01 (n1937: C)
500.00
500.000
*0.0000**
.00001

(: Imposed temperature)*

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 3.21 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

AXIS (TRIA6)

Limiting conditions:
X (R)
- dimensioned CD
= -200.W/m ²
- dimensioned AD
T =
0°C
D
C
- dimensioned BC
T =
500°C
Cutting:
y (Z)
- 80 elements
according to y
With
B
- 2 elements according to X

5.2

Characteristics of the grid

A number of nodes:
805
A number of meshs and types: 320 TRIA6 (and 80 SEG3)

5.3 Functionalities tested

Orders

AFFE_MODELE
AFFE
THERMICS

AXIS

AFFE_CHAR_THER
TEMP_IMPO

FLUX_REP

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

5.4 Remarks

Voluminal heat CP does not intervene in this test, but must be declared for Code_Aster. One CP = 1.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

6
Results of modeling A

6.1 Values
tested

Identification Reference
Aster %
difference
tolerance
Temperature (°C)

Z = 0.0 R = .0 (n1: With)
0.00
0.000
*0.0000**
00001
R = .01 (n5: D)
0.00
0.000
*0.0000**

00001
Z = 0.1 R = .0 (n81)
-4.00
-3.990
-0.257%
1%
R = .01 (n85)
-4.00
-4.021
0.513% 1%
Z = 0.2 R = .0 (n161)
4.00
4.006
0.152%
1%
R = .01 (n165)
4.00
3.976
-0.618%
1%
Z = 0.3 R = .0 (n241)
24.00
24.003
0.013%
1%
R = .01 (n245)
24.00
23.972
-0.116%
1%
Z = 0.4 R = .0 (n321)
56.00
56.001
0.002
1%
R = .01 (n325)
56.00
55.970
-0.053%
1%
Z = 0.5 R = .0 (n401)
100.00
100.001

0.001%
1%
R = .01 (n405)
100.00
99.970
-0.030%
1%
Z = 0.6 R = .0 (n481)
156.00
156.001
0.001%
1%
R = .01 (n485)
156.00
155.970
-0.019%
1%
Z = 0.7 R = .0 (n561)
224.00
224.003
0.001%
1%
R = .01 (n565)
224.00
223.972
-0.012%
1%
Z = 0.8 R = .0 (n641)
304.00
304.006
0.002%
1%
R = .01 (n645)
304.00
303.975
-0.008%
1%
Z = 0.9 R = .0 (n721)
396.00
396.010
0.003%
1%
R = .01 (n725)

396.00
395.979
-0.005%
1%
Z = 1.0 R = .0 (n801: B)
500.00
500.000
*0.0000**
00001
R = .01 (n805: C)
500.00
500.000
*0.0000**
00001

(: Imposed temperature)*

6.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.28 seconds
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLA05 Bars cylindrical with density flux

Date:
20/09/02
Author (S):

7
Summary of the results

The results obtained are satisfactory, the maximum change is 0.63%. Modeling 3D (with meshs PENTA15, HEXA20) and modeling AXIS (with meshs TRIA6) give appreciably same results (the grid and the degree of interpolation are identical).

The analytical solution which is an approached solution, supposes that the r/L report/ratio is much higher than
1. For this numerical test, the r/L report/ratio was taken equal to 100.

Titrate:
TPLA06 Bars cylindrical with convection

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.01.006-A Page:
1/8

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
V4.01.006 document

TPLA06 - Cylindrical bar with convection

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about an axisymmetric problem 2D represented by two modelings, the first using of the elements *voluminal, the second of the axisymmetric elements 2D.*
Boundary conditions in imposed temperature and of convection are taken into account.
The results resulting from this case test are compared with those provided by VPCS.

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLA06 Bars cylindrical with convection

Date:
20/09/02
Author (S):

1 Problem of reference

1.1 Geometry

R
Z
O
L

R = 0.01 m (ray of the cylinder)
L = 1 m

1.2 Properties of material

= 33.33 W/m °C
Thermal conductivity

1.3 Boundary conditions and loadings

· Imposed Températures:
-
T = 0°C in Z = 0. ,
-
T = 500°C in Z = 1. ,
· Convection on cylindrical surface,
-
H = 10 W/m2 °C,
- T E = 0 °C (outside temperature).

1.4 Conditions initial

Without object.

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The reference solution is that given in card TPLA06/89 of guide VPCS

R
Z
O
L>> R

sinh (az)
· Température according to Z: T (Z) = T
,
1 sinh (Al)
2h
where has =
R

· T (Z = 0) =0 T (Z = L) = T1.

2.2
Results of reference

Temperature in Z = 0. , 0.1, 0.2,…, 0.8, 0.9, 1.0

2.3
Uncertainty on the solution

< 1%
Approximate analytical solution (approximation: T = cte, for any R)

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

3D (PENTA6, HEXA8)

Limiting conditions:
X (R)
- faces ABCD, ABEF =
0.
= 30°
- face DCEF
H = 10.W/m ² °C
Text = 0°C
D
C
- face ADF
T =
0°C
- face ECB
T = 500°C
F
E
Cutting:
- 100 elements according to Z
Z
- 3 elements according to
With
B
- 3 elements according to X
y

3.2
Characteristics of the grid

A number of nodes:
1313
A number of meshs and types: 300 PENTA6, 600 HEXA8 (and 300 QUAD4)

3.3 Functionalities

tested

Orders

AFFE_MODELE
AFFE
THERMICS

3D

AFFE_CHAR_THER
TEMP_IMPO

EXCHANGE

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must be declared for Code_Aster. One CP = 1.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.01.006-A Page:
5/8

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
tolerance
Temperature (°C)

Z = 0.0 R = .0 (n1: With)
0.0000
0.0000
0.0000*
.00001
R = .01 (n13: D)
0.0000
0.0000
0.0000*
.00001
Z = 0.1 R = .0 (n131)
0.3694
0.3654
-1.084%
1%
R = .01 (n143)

0.3694
0.3648
-1.240%
1%
Z = 0.2 R = .0 (n261)
0.9718
0.9621
-0.998%
1%
R = .01 (n273)
0.9718
0.9606
-1.154%
1%
Z = 0.3 R = .0 (n391)
2.1870
2.1679
-0.875%
1%
R = .01 (n403)
2.1870
2.1644
-1.031%
1%
Z = 0.4 R = .0 (n521)
4.7815
4.7460
-0.743%
1%
R = .01 (n533)
4.7815
4.7385
-0.899%
1%
Z = 0.5 R = .0 (n651)
10.392
10.329
-0.611%
1%
R = .01 (n663)
10.392
10.312
-0.768%

1%
Z = 0.6 R = .0 (n781)
22.555
22.450
-0.468%
1%
R = .01 (n793)
22.555
22.414
-0.625%
1%
Z = 0.7 R = .0 (n911)
48.944
48.782
-0.331%
1%
R = .01 (n923)
48.944
48.705
-0.488%
1%
Z = 0.8 R = .0 (n1041)
106.20
106.00
-0.192%
1%
R = .01 (n1053)
106.20
105.83
-0.349%
1%
Z = 0.9 R = .0 (n1171)
230.44
230.31
-0.056%
1%
R = .01 (n1183)
230.44
229.95
-0.214%
1%
Z = 1.0 R = .0 (n1301: B)
500.00

500.00
*0.0000**
.00001
R = .01 (n1313: C)
500.00
500.00
*0.0000**
.00001

(: Imposed temperature)*

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 3.10 seconds
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

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5 Modeling
B

5.1
Characteristics of modeling

AXIS (TRIA3)

Limiting conditions:
- dimensioned CD
H = 10.W/m ² °C
X (R)
Text = 10°C
D
C
- dimensioned AD
T =
0°C
- dimensioned BC
T = 500°C
Cutting:
y (Z)
- 150 elements following y
- 3 elements according to X
With
B

5.2 Characteristics of the grid

A number of nodes:
604
A number of meshs and types: 900 TRIA3 (and 150 SEG2)

5.3 Functionalities tested

Orders

AFFE_MODELE
AFFE
THERMICS

AXIS

AFFE_CHAR_THER
TEMP_IMPO

EXCHANGE

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

5.4 Remarks

Voluminal heat CP does not intervene in this test, but must be declared for Code_Aster. One CP = 1.0 J/m3 °C takes.

6
Results of modeling A

6.1 Values tested

Identification Reference
Aster %
difference
tolerance
Temperature (°C)

Z = 0.0 R = .0 (n1: With)
0.0000
0.0000
*0.0000**
.00001
R = .01 (n4: D)
0.0000
0.0000
*0.0000**

.00001
Z = 0.1 R = .0 (n61)
0.3694
0.3703
0.254%
1%
R = .01 (n64)
0.3694
0.3697
0.095%
1%
Z = 0.2 R = .0 (n121)
0.9718
0.9741
0.237%
1%
R = .01 (n124)
0.9718
0.9726
0.079%
1%
Z = 0.3 R = .0 (n181)
2.1870
2.1919
0.224%
1%
R = .01 (n184)
2.1870
2.1884
0.065%
1%
Z = 0.4 R = .0 (n241)
4.7815
4.7913
0.205%
1%
R = .01 (n244)
4.7815
4.7837
0.046%
1%
Z = 0.5 R = .0 (n301)
10.392

10.411
0.181%
1%
R = .01 (n304)
10.392
10.394
0.022%
1%
Z = 0.6 R = .0 (n361)
22.555
22.593
0.167%
1%
R = .01 (n364)
22.555
22.557
0.008%
1%
Z = 0.7 R = .0 (n421)
48.944
49.015
0.145%
1%
R = .01 (n424)
48.944
48.937
-0.013%
1%
Z = 0.8 R = .0 (n481)
106.20
106.33
0.126%
1%
R = .01 (n484)
106.20
106.16
-0.033%
1%
Z = 0.9 R = .0 (n541)
230.44
230.68
0.103%
1%

R = .01 (n544)
230.44
230.31
-0.056%
1%
Z = 1.0 R = .0 (n601: B)
500.00
500.00
*0.0000**
.00001
R = .01 (n604: C)
500.00
500.00
*0.0000**
.00001

(: Imposed temperature)*

6.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.60 seconds
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLA06 Bars cylindrical with convection

Date:
20/09/02

7
Summary of the results

The modeling A, carried out in 3D with linear meshs (PENTA15, HEXA8), gives results whose four values (out of 22) exceed the tolerance fixed initially. The maximum change obtained is 1.24% for a tolerance of 1%. This going beyond of the tolerance is observed for values of the temperature close to 0.

By account modeling B, carried out in AXIS with linear meshs (TRIA3), gives satisfactory results, the maximum change obtained is 0.25%.

Modeling AXIS is adapted to model this cylindrical bar than modeling 3D. Cutting circonférenciel in 3D is not enough dense to represent the cylinder, and one finer cutting would improve the results.

The results obtained by modeling 3D are regarded as acceptable taking into account grid used.

The analytical solution which is an approached solution, supposes that the r/L report/ratio is much higher than 1. For this numerical test, the r/L report/ratio was taken equal to 100.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
V4.01.007 document

TPLA07 - Orthotropic hollow roll

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about an axisymmetric problem 2D represented by two modelings, the first three-dimensional one,
second axisymmetric 2D.

The interest of this case test is to test an orthotropic material subjected to various boundary conditions (flow
imposed, convection, linear variation of the outside temperatures).

The results resulting from this case test are compared with those provided by VPCS.

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
Orthotropic TPLA07 Hollow roll

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.01.007-A Page:
2/6

1
Problem of reference

1.1 Geometry

Z
Re
IH
Interior ray IH = 0.03 m
External ray Re = 0.05 m
Height L = 0.40 m
L
R

1.2
Properties of material

R = 2.89 W/m.°C
thermal conductivity along the axis R
Z = 40.0 W/m.°C

thermal conductivity along axis Z
circumferential:
unspecified

1.3
Boundary conditions and loadings

· density flux = -500 W/m ² through surface Z = 0. (outgoing flow),
· density flux = +500 W/m ² through surface Z = 0.4 (entering flow),

· convection on interior surface: H = 377.0 W/m2 °C,
· convection on external surface: H = 339.3 W/m2 °C,

· linear variation of the outside temperatures:
-
on surface R
E
E
E
I: Ti = 130°C in Z = 0. ; Ti = 135°C in Z = 0.4 (Ti = 130 + 12.5z),
-
on surface R
E
E
E
E: Te = 20°C in Z = 0. ; Ti = 25°C in Z = 0.4 (Te = 20 + 12.5z).

1.4 Conditions
initial

Without object.

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.01.007-A Page:
3/6

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLA07/89 of guide VPCS.

Temperature: T (R, Z) = -117.46 Log R + 12.5z -311.87

2.2
Results of reference

· temperature in R = 0.03, 0.035, 0.04 and 0.05 and for Z = 0. , 0.2 and 0.4,
· density flux on interior and external surface,
· density flux following axis Z.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures

3 Modeling With

3.1 Characteristics of modeling

AXIS (TRIA3)

y (Z)
Limiting conditions:
D
C
- dimensioned AB
=
500. W/m ²
- dimensioned CD
=
-500. W/m ²
- dimensioned DA
H =
377. W/m ² °C
Tei = 130+12.5z
- dimensioned BC
H =
339.3 W/m ² °C
Tee = 20+12.5z

Cutting:
X (R)
- 40 elements
according to y
- 4 elements
according to X
With
B

z=0.
z=0.2
M42
N201 N202 z=0.4 N204 N205
M282
M2
M242
M41
M281
M80
M320
N101
N102
N104
N105
M1
M241
M40
R
M280
M79
M319
N1
N2
N4
N5
M39
M279

r=0.03 r=0.05 r=0.03 r=0.05 r=0.03 r=0.05

3.2
Characteristics of the grid

A number of nodes:
205
A number of meshs and types: 408 TRIA3 (and 88 SEG2)

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS

AXIS

DEFI_MATERIAU
THER_ORTH

AFFE_CARA_ELEM
SOLID MASS
ANGL_REP

AFFE_CHAR_THER_F
EXCHANGE

FLUX_REP

THER_LINEAIRE
CARA_ELEM

CALC_CHAM_ELEM
CARA_ELEM

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must obligatorily be declared. One .cp = 1.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
tolerance
Temperature (°C)

Z = 0. R = 0.030 (N1)
100.01
99.829
-0.181%
1.%
R = 0.035 (N2)
81.90
81.867
-0.040%
1.%
R = 0.040 (N3)
66.22
66.229

0.014%
1.%
R = 0.045 (N4)
52.38
52.422
0.081%
1.%
R = 0.050 (N5)
40.01
40.095
0.212%
1.%
Z = 0.2 R = 0.030 (N101)
102.51
102.469
-0.040%
1.%
R = 0.035 (N102)
84.40
84.388
-0.014%
1.%
R = 0.040 (N103)
68.72
68.718
-0.003%
1.%
R = 0.045 (N104)
54.88
54.892
0.021%
1.%
R = 0.050 (N105)
42.51
42.521
0.025%
1.%
Z = 0.4 R = 0.030 (N201)
105.01
105.111
0.096%
1.%
R = 0.035 (N202)

86.90
86.909
0.010%
1.%
R = 0.040 (N203)
71.22
71.207
-0.018%
1.%
R = 0.045 (N204)
57.38
57.361
-0.033%
1.%
R = 0.050 (N205)
45.01
44.946
-0.142%
1.%
Density flux (W/m ²)

Z (z=0.) M1/N1
-500.
-511.97
2.395
1.%
Z (z=0.) m2/N1
-500.
-824.47
64.894
1.%
Z (z=0.) M241/N5
-500.
-346.66
-30.668
1.%
Z (z=0.2) M40/N101
-500.
-499.95
-0.009
1.%

Z (z=0.2) M41/N101
-500.
-499.93
-0.013
1.%
Z (z=0.2) M280/N105
-500.
-499.93
-0.014
1.%
Z (z=0.4) M80/N201
-500.
-828.51
65.701
1.%
Z (z=0.4) M319/N205
-500.
-345.65
-30.869
1.%
Z (z=0.4) M320/N205
-500.
-468.64
-6.271
1.%
IH (z=0.) M1/N1
11310.
10381.98
-8.205
1.%
IH (z=0.2) M40/N101
11310.
10450.74
-7.597
1.%
IH (z=0.4) M80/N201
11310.
10520.67
-6.979
1.%
IH (z=0.) M241/N5
6786.
7125.41

5.002
1.%
IH (z=0.2) M280/N105
6786.
7150.5
5.371
1.%
IH (z=0.4) M320/N205
6786.
7175.83
5.745
1.%

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.56 seconds
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

5
Summary of the results

The results obtained are satisfactory in temperature but far away from the reference solution to level of flows (especially for flow along axis Z). The maximum departures obtained are as follows:

· 0.212% in temperature,
· 65.701% for flow along axis Z,
· -8.205 for flow according to the ray.

Flow following the axis: the flow of reference is constant, the variations observed are more important with
ends of the cylinder, on the other hand with semi height these variations are very weak (lower than the tolerance).

Flow following the ray: The variations according to the ray are higher than the tolerance, but they could
to be minimized by increasing the discretization along axis R.

Following these results, an anomaly software was emitted under the n° 96-176.

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
V4.01.300 document

TPLA300 - Plate circular subjected to a source of voluminal heat

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

The interest of this case test plane 2D is to validate a thermal element under various boundary conditions (imposed temperature, heat source).

This case test includes/understands two modelings 2D, one axisymmetric, the other planes.

The results are compared with an analytical solution.

1
Problem of reference

1.1 Geometry

R=5.0
With
O
Q

1.2
Properties of material

= 0.04 W/m.°C thermal Conductivity

1.3
Boundary conditions and loadings

· voluminal heat source Q = 1W/m3,
· temperature imposed on surface outside (R = 5): T = 0°C.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution:

T (R) = 6.25 (25 - r2)

2.2
Results of reference

Temperature for R = 0. , 0.625, 1.25, 1.875, 2.5, 3.125, 3.75, 4.375, 5.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
W.K. Liu, T. Belytschko, "Efficient linear and nonlinear heat conduction with has quadrilateral element ", Int. J. num. Meth. Engng, flight 20, n°5, pp 931-948, 1984.
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

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3 Modeling
With

3.1
Characteristics of modeling

PLAN (QUAD4)

y
C
N17
N15
N13
N184
N168
N11
N151
Limiting conditions:
N9

N133
- dimensioned AB = 0
N7
N108
- dimensioned CA = 0
- dimensioned BC T = 0°C
N5
N3
B
N1
In N45 N116 N171 N207
X
N79 N146 N191 N217

3.2
Characteristics of the grid

A number of nodes:
217
A number of meshs and types: 192 QUAD4

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
PLAN
ALL

AFFE_CHAR_THER
TEMP_IMPO
SOURCE

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
tolerance
temperatures (°C)

R = 0.000 (N1)
156.25
156.07

-0.114
1%
R = 0.625 (N3)
153.81
153.63
-0.116
1%
R = 0.625 (N45)
153.81
153.63
-0.116
1%
R = 1.250 (N5)
146.48
146.31
-0.117
1%
R = 1.250 (N79)
146.48
146.31
-0.117
1%
R = 1.875 (N7)
134.28
134.10
-0.131
1%
R = 1.875 (N116)
134.28
134.10
-0.131
1%
R = 2.500 (N9)
117.19
116.98
-0.182
1%
R = 2.500 (N108)
117.19
116.82
-0.313
1%
R = 2.500 (N146)

117.19
116.98
-0.182
1%
R = 3.125 (N11)
95.21
95.04
-0.178
1%
R = 3.125 (N133)
95.21
95.00
-0.216
1%
R = 3.125 (N171)
95.21
95.04
-0.178
1%
R = 3.750 (N13)
68.36
68.23
-0.191
1%
R = 3.750 (N151)
68.36
68.21
-0.214
1%
R = 3.750 (N191)
68.36
68.23
-0.191
1%
R = 4.375 (N15)
36.62
36.55
-0.194
1%
R = 4.375 (N168)
36.62
36.54
-0.211

1%
R = 4.375 (N207)
36.62
36.55
-0.194
1%
R = 5.000 (N17)
*0.00**
0.00
0.00
1%
R = 5.000 (N217)
*0.00**
0.00
0.00
1%
R = 5.000 (N184)
*0.00**
0.00
0.00
1%

** Condition limiting*

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 1.98 seconds

5
Summary of the results

The results obtained are very satisfactory, the maximum change is 0.313%.

Among the points of observation, the most important variation is noted with the N108 node which belongs to
the element more deformed grid.

The grid used is that proposed in the reference. A radial grid with the same cutting and
with the same meshs should give better results.

This test made it possible to test the taking into account of a source term within meshs QUAD9 with one
modeling AXIS (AFFE_CHAR_THER associated with the key word SOURCE).

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
V4.01.301 document

TPLA301 - Distribution of temperature in a cylinder runs

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

The axisymmetric problem 2D aims to validate the axisymmetric thermal elements under temperature imposed in the case of a cylinder court on radial and axial behavior.

It comprises only one modeling (axisymmetric).

The results are compared with a solution based on a graphic estimate.

1
Problem of reference

1.1 Geometry

Z
Tsup
Z
E
J
L
r1
D
I
I
Tcyl
C
H
H
Y
L
B
G
G
R
X
With
F

K
Tinf
Points
Z
Points
Z
(r=0)
(x10-3)
(r=r1/2)
(x10-3)
With
0.0
F
0.0
B
38.1
G
38.1
r1 = L = 0.1524 m
C
76.2
H
76.2
D
114.3
I
114.3
E
152.4
J
152.4

1.2
Properties of material

= 1.7307 W/m.°C thermal Conductivity

1.3
Boundary conditions and loadings

Imposed temperatures:

· Tinf = Tcyl = 17.778°C,
· Tsup = 4.444°C.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The original reference solution given in the book [bib1] is based on a graphic estimate.
This reference is quoted in the handbook of checking of ANSYS [bib2]

2.2
Results of reference

Temperature at points A B C D E F G H I J

2.3
Uncertainty on the solution

Unknown factor, it was not possible to get the original reference (delivers old, more published).

2.4 References
bibliographical

[1]
Schneider, P.J., "Conduction Heat Transfer", Addison-Wesley Publishing Co., Inc. Reading, Mass., 2nd Printing, 1957.
[2]
ANSYS: "Checking manual", 1st edition, June 1, 1976

---

3 Modeling
With

3.1
Characteristics of modeling

AXIS (QUAD4)

y (Z)

Limiting conditions:
- dimensioned AE
= 0. W/m2
- dimensioned AK, KL T =-17.778°C n5 (E)
n15 (J)
n25 (L)
- dimensioned IT
T = 4.444°C
n4 (D)
n14 (I)
Not
X
y
Node
With
0.000 0.000
N1
B
0.000 0.381
N2
n3 (C)
n13 (H)
C
0.000 0.762
N3
D
0.000 1.143
N4
E
0.000 1.524
N5
F
0.762 0.000
N11
N2 (B)
n12 (G)
G
0.762 0.381
N12
H
0.762 0.762
N13
X (R)

I
0.762 1.143
N14
J
0.762 1.524
N15
n1 (A)
n11 (F)
n21 (K)

3.2
Characteristics of the grid

A number of nodes:
25
A number of meshs and types: 16 QUAD4

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
AXIS
ALL

AFFE_CHAR_THER
TEMP_IMPO

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must obligatorily be declared. One CP = 2.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.

Limiting conditions, T = -17.778°C on KL, and T = 4.444 on, are incompatible at the point L (node n25).

Code_Aster applies a "law of overload" which, in this case, consists in taking into account last condition limits entered. The order of assignment of the imposed temperatures thus has large influence on the results obtained.

In the case treated, the temperature on the higher face (IT) is affected after that on the blank of roll (KL).
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

4
Results of modeling A

4.1 Values
tested

Identification Reference Aster
% difference
NISA
Front KL
Front KL
Temperature (°C)

Nodes

n1 T (A)
-17.778
-17.778
0.00%* -17.778
N2 T (B)
-14.000
-13.79
-1.50%
-13.953
n3 T (C)
-9.111
-8.908
-2.27%
-9.151
n4 T (D)
-2.889
-2.713
-6.10%
-2.892
n5 T (E)
4.444
4.444
0.00%*
4.444

n11 T (F)
-17.778
-17.778
0.00%* -17.778
n12 T (G)
-14.889

-14.999
0.74% -15.179
n13 T (H)
-10.667
-11.005
3.16% -11.499
n14 T (I)
-4.444
-4.412
-0.72%
-4.854
n15 T (J)
4.444
4.444
*0.00%**
4.444

(: Imposed temperature)*

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.06 seconds
Handbook of Validation
V4.01 booklet: Stationary thermics of the axisymmetric structures
HT-66/02/001/A

5
Summary of the results

Modeling gives results whose value (on 10) exceeds the tolerance fixed initially
(5%). The maximum change obtained is -6.10%, it is on the smallest value of reference.

In this test, Code_Aster applies a "law of overload" which in this case consists in taking in
count the last condition limits entered. The order of assignment of the imposed temperatures, thus has
a great influence on the results obtained.

Calculations were carried out in °C. Determination of the variation, by considering the temperatures in °F,
give a maximum value very different from that obtained in °C.

A calculation carried out with software NISA gives identical results has those of Aster (checked in
case where the temperature imposed on the point L is of 4.44°C).

The quality of the results could be improved by carrying out a finer grid, the problem of
overload would be always present, but the zone of influence of the temperature imposed on the point L would be
weaker. The results are regarded as acceptable taking into account modeling
carried out (grid and system of unit, law of overload).

Titrate:
TPLL01 - Infinite plane wall in linear thermics

Date:
13/09/02
Author (S):
***O. BOITEAU,** J. Key PELLET*
:
V4.02.001-E Page:
1/16

Organization (S): EDF/SINETICS, AMA

Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
Document: V4.02.001

TPLL01 - Infinite plane wall in linear thermics

Summary:

This case test relates to a calculation of stationary thermics linear. It includes/understands 10 modelings which test them
elements 2D and 3D.

This case test is of several interests:

· for modelings of A with I, it tests on almost all the elements 3D and 2D (except 2D_AXIS, Lumpés PYRAM and), the calculation of the basic options of linear thermics: “rigidity”, “mass”, exchange,
imposed flow, imposed temperature,
· in modeling J, one calculates a cartography of space error via option ERTH_ELEM_TEMP CALC_ELEM on which will rest, in a loop PYTHON, the tool of refinement/déraffinement LOBSTER encapsulated in MACR_ADAP_MAIL.
· The orientation of the wall is unspecified compared to the axes of co-ordinates,
· It is one of the rare case-tests to test elements TETRA10 and QUAD9 in linear thermics, with to combine orders AFFE_CHAR_THER/LIAISON_DDL, and to test INTE_MAIL_3D.

1
Problem of reference

1.1 Geometry

E
S
B
The problem corresponds to an infinite wall:
and unspecified
CF
OF
D

G

F
L = 0.05 m
m

C = {0.03, 0.0, 0.0}
y
With
F = {0.0, 0.04, 0.0}
L
With = {0.015, 0.02, 0.0}
.
X
C
Z

1.2
Material properties

= 0.75 W.m °C thermal Conduction

CP = 2. Voluminal J.m3 °C Heat

1.3
Boundary conditions and loadings

· [FE] and [CD]: null flow
· [F]: free convection (H = 30 W/m2 °C, Te= 140°C)
· [AC]: imposed temperature Ti = 100°C
· [ED]: density flux imposed i= - 1.200 W/m2, (outgoing flow)

1.4 Conditions
initial

To make this stationary calculation, one makes a transitory calculation (except for modelings A and G) for
which the boundary conditions are constant in time. This makes it possible to test calculations elementary of mass intervening in the first member as well as the second member.
Handbook of Validation

2
Reference solution

2.1
Method of calculation used for the reference solution

S
T (S) = MT + (T - T
B
With)
S = AM M not running
L

T
R
- T
B
With
= -
Mr.

L

2.2
Results of reference

Temperatures and flow at the points A, B, G.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References

Case test VPCS TPLL01.
Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
HI-23/02/017/A

---

3 Modeling
With

3.1
Characteristics of modeling

Plan (QUAD4, TRIA3)

One nets part of the infinite wall, such as the field is a square OF = CF = L with 4 meshs TRIA3 and 2 meshs QUAD4.

E
B
X
y
y
N1
C
0.03
0
D
0.07
0.03
G
F
D
E
0.04
0.07
N3
F
0
0.04
With
0.015 0.02
N5
B
0.055 0.05
N1
With
G
0.035 0.035 N3
N5
C
X
0

3.2
Characteristics of the grid

A number of nodes: 9

A number of meshs and types: 2 QUAD4, 4 TRIA3

3.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument

AFFE_CHAR_THER
FLUX_REP
EXCHANGE
TEMP_IMPO

LIAISON_DDL

AFFE_MODELE
PLAN
THERMICS

MACRO_MATR_ASSE
SOLVEUR
"MULT_FRONT"

MATR_ASSE
RIGI_THER
CALC_VECT_ELEM
CHAR_THER

ASSE_VECT

FACT_LDLT

RESO_LDLT

CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

3.4 Remarks

To test the key word factor LIAISON_DDL, the linear relation was introduced (checked by the

solution):
T (G) - T (B) = 40.

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
T (A) °C 100.
100.00
0.00
T (B)°C 20.
20.00
0.00
T (G) °C 60.
60.00
0.00
R (R
m) .i (m
)

2
W/m
960. 960.00
0.00
R (R
m). J (m
)
2
W/m
720. 720.00
0.00

---

5 Modeling
B

5.1
Characteristics of modeling

Plan (QUAD8, TRIA6)

E
B
X y

y

N6
C 0.03
0
G
D 0.07
0.03
F
D
E 0.04
0.07
N13
F 0 0.04
To 0.015
0.02
N22
With
B 0.055
0.05
N6
N22
G
0.035 0.035 N13
C
X
0

5.2
Characteristics of the grid

A number of nodes: 23

A number of meshs and types: 4 TRIA6, 2 QUAD8

5.3 Functionalities
tested

Orders
Key word factor
Simple key word
Argument
AFFE_CHAR_THER_F

FLUX_REP
EXCHANGE
TEMP_IMPO
LIAISON_DDL
AFFE_MODELE
PLAN
THERMICS
THER_LINEAIRE
CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

5.4 Notice

To test the key word factor LIAISON_DDL, the linear relation was introduced (checked by the solution)
T (G) T (B) = 40.

6
Results of modeling B

6.1 Values
tested

Identification Reference
Aster %
difference
T (A) °C 100.
100.00
0.00
T (B)°C 20.
20.00
0.00
T (G) °C 60.
60.00
0.00
R (R
m) .i (m
)
2
W/m
960. 960.00
0.00

R (R
m). J (m
)
2
W/m
720. 720.00
0.00

---

7 Modeling
C

7.1
Characteristics of modeling

Plan (QUAD8, TRIA6)

E
X
y
B
y
C
0.03
0

N6
D
0.07
0.03
G
E
0.04
0.07
F
D
F
0
0.04
N14
With
0.015 0.02
N24
B
0.055 0.05
N6
With
G
0.035 0.035 N14
N24
C
X
0

7.2
Characteristics of the grid

A number of nodes: 25

A number of meshs and types: 4 TRIA6, 2 QUAD9

7.3 Functionalities
tested

Orders
Key word factor
Simple key word
Argument
AFFE_CHAR_THER_F

FLUX_REP
EXCHANGE
TEMP_IMPO
AFFE_MODELE
PLAN
THERMICS
THER_LINEAIRE
CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

8
Results of modeling C

8.1 Values
tested

Identification Reference
Aster %
difference
T (A) °C
100.
100.00
0.00
T (B) °C
20.
20.00
0.00
T (G) °C
60.
60.00
0.00
R (R
m) .i (m
)
2
W/m
960. 960.00
0.00
R (R
m). J (m
)

2
W/m
720. 720.00
0.00

---

9 Modeling
D

9.1
Characteristics of modeling

Voluminal (HEXA8)

E
X y Z
N6

y
B
C 0.03
0 0
D
0.07 0.03 0
E

0.04 0.07 0
F
G
N16
D
F 0 0.04
0
To 0.015
0.02
0 N20
B 0.055
0.05
0 N6
N20
With
G
0.035 0.035 0
N16
C
X
Z 0

9.2
Characteristics of the grid

A number of nodes: 21

A number of meshs and types: 4 HEXA8 + 20 QUAD4

9.3 Functionalities
tested

Orders
Key word factor
Simple key word
Argument
AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE
TEMP_IMPO
AFFE_MODELE
3D
THERMICS

THER_LINEAIRE
CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP
INTE_MAIL_3D
POSt_RELEVE

10 Results of modeling D

10.1 Values tested

Identification Reference
Aster %
difference
T (A) °C
100.
100.00
0.00
T (B) °C
20.
20.00
0.00
T (G) °C
60.
60.00
0.00
R (R
m) .i (m
)
2
W/m
960. 960.00
0.00
R (R
m). J (m
)
2
W/m
720. 720.00
0.00

---

11 Modeling E

11.1 Characteristics of modeling

Voluminal (PENTA6)

E
X y Z
N10

y
B
C 0.03
0 0
D
0.07 0.03 0
E
0.04 0.07 0
F
G
N11
D
F 0 0.04

0
To 0.015
0.02
0 N12
B 0.055
0.05
0 N10
N12
With
G
0.035 0.035 0
N11
C
X
Z 0

11.2 Characteristics of the grid

A number of nodes: 21

A number of meshs and types: 8 PENTA6 + 8 TRIA3 + 16 QUAD4

11.3 Functionalities tested

Orders
Key word factor
Simple key word
Argument

AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE
TEMP_IMPO

AFFE_MODELE
3D
THERMICS

THER_LINEAIRE

CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

12 Results of modeling E

12.1 Values tested

Identification	*Reference*	*Aster*	*% difference*
T (A) °C	*100.*	*100.00*	*0.00*
T (B) °C	*20.*	*20.00*	*0.00*
T (G) °C	*60.*	*60.00*	*0.00*
R (R m) .i (m) W/m^2	*960.*	*960.00*	*0.00*
R (R m). J (m) W/m^2	*720.*	*720.00*	*0.00*

13 Modeling F

13.1 Characteristics of modeling

Voluminal (HEXA20)

E
X
y
Z
N16
y
B
C
0.03
0
0
N45
D
0.07
0.03
0
E
0.04
0.07
0

F
G
D
F
0
0.04
0
With
0.015 0.02
0
N57
N57
B
0.055 0.05
0
N16
With
G
0.035 0.035 0
N45
C
X
Z 0

13.2 Characteristics of the grid

A number of nodes: 59

A number of meshs and types: 4 HEXA20 + 20 QUAD8

13.3 Functionalities tested

Orders
Key word factor
Simple key word
Argument

AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE
TEMP_IMPO

AFFE_MODELE
PLAN
THERMICS

THER_LINEAIRE

CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

14 Results of modeling F

14.1 Values tested

Identification Reference
Aster %
difference
T (A) °C
100.
100.00
0.00
T (B) °C
20.
20.00
0.00
T (G) °C
60.
60.00
0.00
R (R
m) .i (m
)
2
W/m
960. 960.00
0.00
R (R
m). J (m
)
2

W/m
720. 720.00
0.00

---

15 Modeling G

15.1 Characteristics of modeling

Voluminal (PENTA15)

E
X y Z
N28

y
B
C 0.03
0 0
D
0.07 0.03 0
E
0.04 0.07 0
F

G
N52
D
F 0 0.04
0
To 0.015
0.02
0 N61
B 0.055
0.05
0 N28
N61
With
G
0.035 0.035 0
N52
C
X
Z 0

15.2 Characteristics of the grid

A number of nodes: 65

A number of meshs and types: 8 PENTA15 + 8 TRIA6 + 16 QUAD8

15.3 Functionalities tested

Orders
Key word factor
Simple key word
Argument
AFFE_CHAR_THER
FLUX_REP
EXCHANGE
TEMP_IMPO
AFFE_MODELE
3D
THERMICS
CALC_MATR_ELEM
OPTION
“RIGI_THER”

NUME_DDl
ASSE_MATRICE
CALC_VECT_ELEM
OPTION
“CHAR_THER”
ASSE_VECTEUR
FACT_LDLT
RESO_LDLT
PRE_GIBI
CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

16 Results of modeling G

16.1 Values tested

Identification Reference
Aster %
difference
T (A) °C
100.
100.00
0.00
T (B) °C
20.
20.00
0.00
T (G) °C
60.
60.00
0.00
R (R
m) .i (m
)
2
W/m
960. 960.00
0.00
R (R
m). J (m
)

2
W/m
720. 720.00
0.00

---

17 Modeling
H

17.1 Characteristics of modeling

Voluminal (TETRA4)

E
X y Z
N2

y
B
C 0.03
0 0
D
0.07 0.03 0
E
0.04 0.07 0

F
G
N13
D
F 0 0.04
0
To 0.015
0.02
0 N7
B 0.055
0.05
0 N2
N7
With
G
0.035 0.035 0
N13
C
X
Z 0

17.2 Characteristics of the grid

A number of nodes: 18

A number of meshs and types: 20 TETRA4 + 6 TRIA3 + 16 QUAD8

17.3 Functionalities
tested

Orders
Key word factor
Simple key word
Argument
AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE
TEMP_IMPO
AFFE_MODELE
3D
THERMICS
THER_LINEAIRE
PARM_THETA

1
CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

18 Results of modeling H

18.1 Values tested

Identification	*Reference*	*Aster*	*% difference*
T (A) °C	*100.*	*100.00*	*0.00*
T (B) °C	*20.*	*20.00*	*0.00*
T (G) °C	*60.*	*60.00*	*0.00*
R (R m) .i (m) W/m^2	*960.*	*960.00*	*0.00*
R (R m). J (m) W/m^2	*720.*	*720.00*	*0.00*

19 Modeling I

19.1 Characteristics of modeling

Voluminal (TETRA10)

E
B
X
y
y
N09
C
0.03
0
D
0.07
0.03
G
F
D
E
0.04
0.07
N04
F

0
0.04
With
0.015 0.02
N01
B
0.055 0.05
N09
With
G
0.035 0.035 N04
N01
C
X
0

19.2 Characteristics of the grid

A number of nodes: 125

A number of meshs and types: 48 TETRA10 + 16 TRIA6

19.3 Functionalities tested

Orders
Key word factor
Simple key word
Argument
AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE
TEMP_IMPO
AFFE_MODELE
3D
THERMICS
THER_LINEAIRE
PARM_THETA
1.0
CALC_CHAM_ELEM
FLUX_ELNO_TEMP
FLUX_ELGA_TEMP

20 Results of modeling I

20.1 Values tested

Identification	Reference	Aster	% difference
T (A) °C	100.	100.00	0.00
T (B) °C	20.	20.00	0.00
T (G) °C	60.	60.00	0.00
R (R m) .i (m) 2 W/m	960.	960.00	0.00
R (R m). J (m) 2 W/m	720.	720.00	0.00

21 Modeling J

21.1 Characteristics of modeling

It is about a case functional test and of data-processing not-regression of the calculation of the indicator of error has established posteriori in thermics (cf [R4.10.03]). It exhumes a cartography of space error on which will rest, in a loop PYTHON, the tool of refinement/déraffinement LOBSTER encapsulated in MACR_ADAP_MAIL (cf [U7.03.01]).
The calculation of this chart of indicator of error is carried out, via option "ERTH_ELEM_TEMP" of the operator of postprocessing CALC_ELEM, on a EVOL_THER (provides to the key word RESULT) coming from one former thermal calculation (linear or not, transient or stationary, isotropic or orthotropic, via THER_LINEAIRE or THER_NON_LINE, cf environment necessary, parameter setting and perimeter of use [R4.10.03] §6.2/4).
This calculation requires as a preliminary the recourse to option "FLUX_ELNO_TEMP" of CALC_ELEM which determines values of the vector heat flux to the nodes (cf example of use [R4.10.03] §6.5).
The indicator consists of fifteen components per element and for a given moment. In this case test, one calculates the fifteen components but the procedure of refinement/déraffinement does not rest that on the component ERTABS which represents the absolute total space error (cf [R4.10.03] §6.3).
In order to be able post-to treat via POST_RELEVE or GIBI, one needs to extrapolate fields by element in fields with the nodes by element. The addition of option "ERTH_ELNO_ELEM" (afterwards the call to "ERTH_ELEM_TEMP") makes it possible to carry out this purely data-processing transformation. For one

moment and a given finite element, it does nothing but duplicate the fifteen components of the indicator on each node of the element.
This modeling thus constitutes as much an example of use, in a loop PYTHON, possible couplings "calculation of indicator"/"refinement/déraffinement of grid", that a case test of not-regression of options "ERTH_ELEM_TEMP" and "ERTH_ELNO_ELEM" and of their adherence with the process of mending of meshes.
This case test takes again the characteristics of modeling I and its grid (TETRA10 + TRIA6) associated.

21.2 Functionalities tested

Orders

AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE
TEMP_IMPO

AFFE_MODELE
3D
THERMICS

THER_LINEAIRE

CALC_ELEM
FLUX_ELNO_TEMP
ERTH_ELEM_TEMP
ERTH_ELNO_ELEM

MACR_ADAP_MAIL
REFINEMENT

22 Results of modeling J

22.1 Values tested

One tests the data-processing not-regression of component ERTREL (relative total space error) of

the indicator of error compared to the V6.2.1 versions of platforms SGI and SUN of Code_Aster and of
the V4.3 version of the software LOBSTER. The relative tolerance is thus severe: 5.10 6%.

Identification
Aster
Tolerance
Value of ERTREL on mesh MA1
4.15918735 10-5 5.10-8
before mending of meshes
Value of ERTREL on node NO4
4.15918735 10-5 5.10-8
before mending of meshes
Value of ERTREL on the M1 mesh
5.48408914 10-6 5.10-7
after mending of meshes
Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
HI-23/02/017/A

---

23 Summary of the results

The field solution (linear) belongs to the space of interpolation of all the elements tested.
results are thus naturally excellent.

Intentionally white left page.

Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
Document: V4.02.100

TPLL100 - Anisotropic plane wall in thermics
stationary

Summary:

This test the purpose of which relates to it thermal linear stationary and transitory be to validate the anisotropy
Cartesian.

Two modelings are carried out:

· a first into voluminal,
· a second in plan.

The results obtained are in perfect agreement with the analytical values.
Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLL100 - Anisotropic plane wall in stationary thermics

Date:
23/09/02
Author (S):
C. Key DURAND
:
V4.02.100-B Page:
2/6

1
Problem of reference

1.1 Geometry

Z 0
J
I
Y 0
K
E
B

H
Z 1
D
X 1
Y
G 1
F
X
With
0
C

In the reference mark (X0, Y0, Z0), the points have as co-ordinates:

C (0.03; 0; 0)
D (0.07; 0.03; 0)
E (0.04; 0.07; 0)
F (0; 0.04; 0)
To (0.015; 0.02; 0)
B (0.055; 0.05; 0)
G (0.035; 0.035; 0)

FK = CH = DI = EJ = 0,05.Z0
(

,
CD X = rad

Z //Z
1)
0
1
4

1.2
Material properties

Anisotropic material, direction privileged along the axes of the reference mark (X1, Y1, Z1):

X = 1 W/°
m C

Y = 0.5 W/°
m C
Z = 2 W/°
m C
C = 2 J/m3

° C
p

1.3
Boundary conditions and loadings

face FEJK: Outgoing flow of 400 W/m2.

face CDIH: Entering flow of 400 W/m2.

face EDIJ: Outgoing flow of 1.200 W/m2.

face FCHK: Imposed temperature 100°C.

Others faces: condition of Neumann.

1.4 Conditions
initial

To make this stationary calculation, a transitory calculation is made for which the boundary conditions are
constants in time. This makes it possible to test elementary calculations of mass and rigidity intervening in the first member as well as the second member.

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution.
Temperature varying linearly according to CD.

Isotherms parallel with faces CHKF and DIJE.

CD CH CF
:
locate

In

,
,

:
has

one
,
CD CH

CF

- (
2
2
T

X cos

+ Y

sin

)

X
X

T
= - -

y
( )
cos

sin

X

Z
0

:
with
X = 1200 y = 400 = (X, 1CD) -
T (X)
X
=
X + T (A)

2
2
X cos + Y
sin
1
:

that is to say T (X) = -

1600 X + 20
. X = cos X - sin y
720

that is to say
O

if = (CD, Xo). =sin +
cos
720

that is to say
Y
X
Z
O

2.2
Results of reference

Temperature at the points A, B, G.

Flow following the directions Xo and Yo.

T (A) = 100
T (B) = 20
T (G) = 60
X = 720
Y
O
O = 1040

2.3 References
bibliographical

[1]
NR. RICHARD: Note technical HM-18/94/0011, "Development of the thermal anisotropy in the software Aster ".

Handbook of Validation

V4.02 booklet: Stationary thermics of the linear structures
HT-66/02/001/A

---

3 Modeling With

3.1 Characteristics of modeling

diagram in time, forced on 1 to test the calculation of the second member.
4 elements 3D, HEXA8.

3.2 Characteristics of the grid

4 Hexa 8.

3.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
DEFI_MATERIAU
THER_ORTH
AFFE_CARA_ELEM
--

ANGL_REP
--
NET
AFFE_MODELE
AFFE
MODELING
“3D”
THER_LINEAIRE
TEMP_INIT
STATIONARY
“YES”
INCREMENT
LIST_INST
--
PARM_THETA
1.
--
CARA_ELEM
CALC_NO
--
OPTION
“FLUX_ELNO_TEMP”
CALC_CHAM_ELEM
--
CARA_ELEM
--
OPTION
“FLUX_ELNO_TEMP”
--
OPTION
“FLUX_ELGA_TEMP”

4 Results of modeling A

4.1 Values tested

Identification Reference
Aster *%*
difference
*T (A) N7 **

100°
100°
0.
T (B) N2
20°C
20°C
0.
T (G) N13
60°C
60°C
0.
Xo
720 720 0.
Yo
1040 1040
0.

**: imposed temperature*

4.2 Remarks

The analytical solution being of order 1 and the field represented by the discretization, the code finds, with the errors rounding close, this solution.

---

5 Modeling
B

5.1
Characteristics of modeling

Similar to the modeling A, but solved in 2D in plan CDEF.

5.2
Characteristics of the grid

4 QUAD 4.

5.3 Functionalities
tested

Orders
Key word factor
Single-ended spanner word
Argument
DEFI_MATERIAU
THER_ORTH
AFFE_CARA_ELEM
--
ANGL_REP
--
NET
AFFE_MODELE
AFFE
MODELING
“PLANE”
THER_LINEAIRE
TEMP_INIT
STATIONARY
“YES”
INCREMENT
LIST_INST
--
PARM_THETA
1.
--
CARA_ELEM

CALC_NO
--
OPTION
“FLUX_ELNO_TEMP”
CALC_CHAM_ELEM
--
CARA_ELEM
--
OPTION
“FLUX_ELNO_TEMP”
--
OPTION
“FLUX_ELGA_TEMP”

6
Results of modeling B

6.1 Values
tested

Identification Reference
***ASTER** %*
difference
*T (A) N5 **
100°
100°
0.
T (B) N2
20°C
20°C
0.
T (G) N8
60°C
60°C
0.
Xo
720 720 0.
Yo
1040 1040
0.

**: imposed temperature*

6.2 Remarks

The analytical solution being of order 1 and the field represented by the discretization, the code finds, with the errors rounding close, this solution.

7
Summary of the results

Key word ANGL_REP introduced into order AFFE_CARA_ELEM is thus tested in 3D and plane 2D on an anisotropic problem of thermics.

Key ***S. TAHERI***
:
V4.02.101-B Page:
1/6

Organization (S): EDF/MTI/MMN

Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
Document: V4.02.101

TPLL101 - Joule effect heating of a cylinder hollow

Summary:

One imposes electrical currents inside and outside a hollow roll finite length, then one calculate the temperature established under the effect of a heat source produced by Joule effect. The solution of reference is analytical.

The applicability is it thermal linear stationary.

The model is axisymmetric.

The test is carried out on elements QUAD8 and TRIA6.

1
Problem of reference

1.1 Geometry

Axisymmetric

Z
D
C
R1
R0
+ M
R
With
B

WITH B
C
D
M
R 1.
2.7182

2.7182
1.
1.8591
Z 0.
0.
0.1 0.1
0.025

1.2 Properties
of
materials

Electric characteristic: electric conductivity = 1.
1 1
m

Thermal characteristics: = 2. 102W/m°C CP = 0.

1.3
Boundary conditions and loadings

Electric calculation:

j.n = 10.
on DA
j.n =.
3 6787944 on BC

Thermal calculation

T = 0. on DA

T = 0. on BC

FLOW = 0. on AB

FLOW = 0. on CD

1.4 Conditions
initial

Stationary calculation.
Handbook of Validation

2
Reference solution

2.1
Method of calculation used for the reference solution

· Problème elastostatic V potential electric

In volume V = 0.

j.n =.
0
on CD and AB

Boundary conditions NEUMANN j.n = 10.
on AD

j.n

= .
3 6787944 on BC

electric conductivity = 1.

j.n = V

Axisymmetric solution

1
V

R
R
= 0 V = 0
V L

R R R
og

With

The boundary conditions on AD and BC impose:

V0 = 10.

Note:

The knowledge of A is not necessary for thermal calculation.

· Thermal Problème T the temperature

T = S with a voluminal source S = (V) 2

Boundary conditions: T = 0. on DA and BC.
T N = 0 on cd. and AB

Axisymmetric solution:

1
2
T
v0
R
= -
Taking into account the boundary conditions
R R R
1 2
R

2
v
R

R
T (R)
1
0
= -
L
L

2
og
og

0
R
1
R

2.2
Results of reference

T = 5.889313 102 (temperature at the point M).

2.3
Uncertainty on the solution

Analytical solution.

---

3 Modeling
With

3.1
Characteristics of modeling

Element THAXTR6

Not M: N200

3.2 Characteristics

grid

A number of nodes: 305

A number of elements: 120

3.3 Functionalities
tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE
AFFE
MODELING AXIS
% calculation electric

AFFE_CHAR_THER FLUX_REP

THER_LINEAIRE

CALC_CHAM_ELEM OPTION "SOUR_ELGA_ELEC"

% calculation thermal

AFFE_CHAR_THER TEMP_IMPO

FLUX_REP

SOURCE
SOUR_CALCULEE

THER_LINEAIRE

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
Temperature at the point Mr. N200
5.889313 102 5.891298
102
0.034

4.2 Remarks

The boundary conditions of the electric problem are all of the conditions of NEUMANN.
Nevertheless, the analytical solution is found.

4.3 Parameters
of execution

Version: 5.4.17

Machine: SGI O-2000

System:

IRIX 64
Obstruction memory:
32 Mo
Time CPU To use:
2.0 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

Element THAXQU8

Not M: N186

5.2 Characteristics

grid

A number of nodes: 245

A number of elements: 60

5.3 Functionalities

tested

Orders
Key word factor
Single-ended spanner word
Argument
AFFE_MODELE
AFFE
MODELING AXIS
% calculation electric

AFFE_CHAR_THER FLUX_REP

THER_LINEAIRE

CALC_CHAM_ELEM OPTION
"SOUR_ELGA_ELEC"

% calculation thermal

AFFE_CHAR_THER TEMP_IMPO

FLUX_REP

SOURCE
SOUR_CALCULEE

THER_LINEAIRE

6
Results of modeling B

6.1 Values
tested

Identification Reference Aster %
difference
Temperature at the point Mr. N186
5.889313 102 5.892292
102
0.051

6.2 Parameters
of execution

Version: 5.4.17
Machine: SGI O-2000

System:
IRIX 64
Obstruction memory:
64 Mo
Time CPU To use:
2.00 seconds
Handbook of Validation
V4.02 booklet: Stationary thermics of the linear structures
HI-75/01/010/A

7
Summary of the results

In addition to the test presented, one carried out a calculation on structure (COTHAA). The results obtained have *summer compared with those obtained using Code CASTEM 2000. One obtains results very close relations.*

Author (S)
:
P. MASSIN, F. VOLDOIRE, A.M. DONORE

Organization (S): EDF/IMA/MMN

Document: V4.03.100

TPLS100 - Infinite plate subjected to flows antisymmetric

Summary:

The purpose of this test is to test the model of thermal hull linear with three fields (MODELING: "HULL" or "COQUE_PLAN") by comparison with an analytical solution, for an infinite plate subjected to one couple stationary antisymmetric heat flows on its two half-faces, in stationary regime.

The equation of heat is solved in hover, with a linear, isotropic, homogeneous conduction.

Two modelings: With for the finite elements of surface hull (triangles) and B for the linear elements (segments).

One simultaneously tests in each modeling the elementary orders and the total order THER_LINEAIRE [U4.33.01].

---

1 Problem of reference

1.1 Geometry

Z
y
F
E
D
O
X
B
With
B
C
L

Length: L = 20mm
Width: B = 2mm
Thickness: H = 4mm

1.2 Material properties

Conductivity = 4.5 W/mm/°C
Voluminal heat: (CP = 0.) J (°C. mm3)

1.3 Boundary conditions and loadings

Null temperature on the average layer of the plate:
TEMP = 0.
Flow imposed on the upper surface (ABEF) +
flux+ = 30. W/mm2/°C
Flow imposed on the upper surface (ABEF) -
flow = 30. W/mm2/°C

---

2 Reference solution

2.1 Method of calculation used for the reference solution

Analytical

For more details to refer to the document [R3.11.01] and the note [bib1].

2.2 Results of reference

· Température in higher skin,
· Flux in nodes placed on axis OX in higher skin.

2.3 Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
S. ANDRIEUX, F. VOLDOIRE HI-71/7131 - Formulation of a model of thermics for thin hulls (7/12/90).

Code_Aster ®
Version
4.0
Titrate:
TPLS100 Plates infinite subjected to antisymmetric flows
Date: 01/12/98

3 Modeling
With

3.1
Characteristics of modeling

y
X
N176
N161
N1
N32
N46
X

Cutting:
28 elements in length,
8 elements in width.

Boundary conditions - loading:
TEMP_IMPO (ALL: “yes”, TEMP: 0.)
FLUX_REP (Group_Ma: GRSD2,
FLUN_INF: - 30.
FLUN_SUP: 30.)

3.2
Characteristics of the grid

A number of nodes: 969
A number of meshs and types: 448 meshs TRIA6

3.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
DEFI_MATERIAU
THER
[U4.23.01]
AFFE_MATERIAU
ALL

[U4.23.02]
AFFE_MODELE
“THERMAL”
“HULL”
ALL
[U4.22.01]
AFFE_CHAR_THER_F
TEMP_IMPO
FLUX_REP
[U4.25.02]
CALC_MATR_ELEM
RIGI_THER
[U4.41.01]
CALC_MATR_VECT
CHAR_THER
[U4.42.01]
NUME_DDL
[U4.42.02]
ASSE_MATRICE
[U4.41.02]
ASSE_VECTEUR
[U4.42.03]
FACT_LDLT
[U4.51.01]
RESO_LDLT
[U4.52.02]
AFFE_CHAR_THER
TEMP_IMPO
ALL
[U4.25.02]
FLUX_REP
GROUP_MA
THER_LINEAIRE
CARA_ELEM
[U4.33.01]
CALC_ELEM
RESULT
[U4.61.02]
NIVE_COUCHE
CARA_ELEM

4 Results of modeling A

4.1 Values tested

Identification	Reference	Aster	% difference
TEMP_SUP:			
node N201 (10. , 0)	13.3321	13.3310	0.008
node N176 (5.15, 0)	13.2565	13.2564	0.001
node N161 (2.8, 0)	12.7462	12.7458	0.003
node N1 (0. , 0.)	6.6666	6.6666	0.001
node N32 (28, 0.25)	0.5870	0.5872	0.027
node N46 (5.15, 0)	0.07679		

0.07693
0.177
Flow component X:
N176 node
net M297
0.2992
0.2907
2.84
net M289
0.2992
0.2780
7.09
net M290
0.2992
0.2799
6.44
average value
0.2992
0.283
5.46
N161 node
net M265
2.287
2.186
4.43
net M266
2.287
2.197
3.92
net M273
2.287
2.242
1.96
average value
2.287
2.208
3.44
N1 node
net M1
25.98
25.94
0.15
net M225

25.98
25.94
0.14
net M337
25.98
25.94
0.14
average value
25.98
25.94
0.14

Contents of the file results

· Températures with the nodes,
· heat flow to the nodes in higher wall,
· values tested deferred above.

4.2 Parameters
of execution

Version: 3.06
Machine: CRAY C90
System UNICOS:
8.4
Obstruction memory:
8 megawords
Time CPU To use:
37.68 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

y
N201
N1
N71
X
10
+10
0

Cutting: 28 linear elements in length, (even progression of meshs that in the grid modeling A).

Boundary conditions - loading:
TEMP_IMPO (ALL: “yes”, TEMP: 0.)
FLUX_REP (Group_Ma: GRSD2,
FLUX_INF: - 30.
FLUX_SUP: 30.)

5.2
Characteristics of the grid

A number of nodes: 57
A number of meshs and types: 28 meshs SEG3

5.3 Functionalities
tested

Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
DEFI_MATERIAU
THER
[U4.23.01]
AFFE_MATERIAU
ALL
[U4.23.02]
AFFE_MODELE
“THERMAL”
“COQUE_PLAN”
ALL
[U4.22.01]
AFFE_CHAR_THER
TEMP_IMPO
ALL

[U4.25.02]
FLUX_REP
GROUP_MA
AFFE_CHAR_THER_F
TEMP_IMPO
ALL
[U4.25.02]
FLUX_REP
GROUP_MA
CALC_MATR_ELEM
RIGI_THER
[U4.41.01]
CALC_MATR_VECT
CHAR_THER
[U4.42.01]
NUME_DDL
[U4.42.02]
ASSE_MATRICE
[U4.41.02]
ASSE_VECT
[U4.42.03]
FACT_LDLT
[U4.51.01]
RESO_LDLT
[U4.52.02]
THER_LINEAIRE
CARA_ELEM
[U4.33.01]
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

---

6 Results of modeling B

6.1 Values tested

Identification	Reference	Aster	% difference
TEMP_SUP:			
node N201 (10. , 0)	13.3321	13.331	0.008
node N176 (5.15, 0)	13.2565	13.2565	-
node N161 (2.8, 0)	12.7462	12.7462	-
node N1 (0. , 0.)	6.6666	6.6666	0.001
node N46 (5.15, 0)	0.07679	0.07683	0.05

Contents of the files results

· Températures with the nodes on the upper surface,

· values tested deferred above.

6.2 Parameters of execution

Version: 3.06

Machine: CRAY C90

System UNICOS: 8.4

Obstruction memory: 8 megawords

Time CPU To use: 5.2 seconds

---

7 Summary of the results

In modeling A with meshs TRIA6, one notes that the variations on flows are lower than 1%, except in the zones where those are very weak.

Organization (S): EDF/IMA/MMN

Handbook of Validation

V4.03 booklet: Stationary thermics of the plates and the hulls

Document: V4.03.101

TPLS101 - Infinite plate subjected to an exchange symmetrical thermics with outside

Summary:

The purpose of this test is to test the model of thermal hull linear with three fields per comparison with analytical solution, for an infinite plate subjected to a couple of conditions of heat exchange with outside, symmetrical compared to the average layer. The equation of heat is solved in hover, with a linear, isotropic, homogeneous conduction.
The results are presented for the finite elements available of thermal surface hull triangles and quadrangles.
Compared to test TPLS100 [V4.03.100], this one makes it possible to check the contribution of the coefficients of exchange to
thermal rigidity, like various methods of assignment of the boundary conditions. Moreover, the solution is such as the temperature is uniform in the thickness.
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

1
Problem of reference
1.1 Geometry
Z
y
F
E
D
O
X
B
With
B
C
L
Length: L = 20mm
Width: B = 2mm

Thickness: H = 4mm

1.2

Material properties

Conductivity = 1000 W/mm/°C

1.3

Boundary conditions and loadings

· Null Température at the point O, on all the thickness.
· On the higher faces (ABEF) + and lower (ABEF):
coefficient of exchange: H = 10 W/mm2/°C
outside temperature: Text = 50°C
· On the faces higher (BCDE) + and lower (BCDE):
coefficient of exchange: H = 10 W/mm2/°C
outside temperature: Text = 50°C

2

Reference solution

2.1

Method of calculation used for the reference solution

Analytical

For more details to refer to the document [R3.11.01] and the note [bib1].

2.2

Results of reference

Temperature in higher, lower skin and average layer.

2.3

Uncertainty on the solution

Analytical solution.

2.4 References

bibliographical

[1]
S. ANDRIEUX, F. VOLDOIRE HI-71/7131 - Formulation of a model of thermics for thin hulls (7/12/90).

Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

---

3 Modeling With

3.1 Characteristics of modeling

y
N201
X
Cutting:
28 elements in length,
8 elements in width.
Boundary conditions - loading (three calculations for three choices):
· calculation a: scalar loadings and dualisation of the condition of Dirichlet:
TEMP_IMPO (NODE: N1, TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)
EXCHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)
· calculation b: loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.
· calculation C: scalar loadings and "kinematic" loading:
THER_IMPO: (NODE: N1, TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)

3.2 Characteristics of the grid

A number of nodes: 969
A number of meshs and types: 448 meshs TRIA6

3.3 Functionalities tested

Orders
Keys
AFFE_CARA_ELEM
HULL

ALL
[U4.24.01]
DEFI_MATERIAU
THER
[U4.23.01]
AFFE_MODELE
“THERMAL”
“HULL”
ALL
[U4.22.01]
AFFE_CHAR_THER
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_THER_F
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_CINE
THER_IMPO
NODE
[U4.25.05]
CALC_CHAR_CINE
[U4.41.03]

5/14

4

Results of modeling A

4.1 Values

tested

Identification

Reference

Aster

Aster

Aster

% difference

calculation has

calculation B

calculation C

N201 node

Temp_sup

49.999

49.9999

49.9999

49.9999

0.002

(-10.,0.)

Temp

49.999

49.9999

49.9999

49.9999

0.002

Temp_inf

49.999

49.9999

49.9999

49.9999

0.002

N176 node

Temp_sup

49.9658

49.9655

49.9655

49.9655

0.001

(-5.15,0.)

Temp

49.9658
49.9655
49.9655
49.9655
0.001
Temp_inf
49.9658
49.9655
49.9655
49.9655
0.001
N171 node
Temp_sup
49.8888
49.8879
49.8879
49.8879
0.002
(-4.32,0.)
Temp
49.8888
49.8879
49.8879
49.8879
0.002
Temp_inf
49.8888
49.8879
49.8879
49.8879
0.002
N166 node
Temp_sup
49.6631
49.6611
49.6611
49.6611
0.008
(-3.53,0.)
Temp
49.6631
49.6611
49.6611

49.6611
0.008
Temp_inf
49.6631
49.6611
49.6611
49.6611
0.008
N161 node
Temp_sup
49.0542
49.0500
49.0500
49.0500
0.008
(-2.8,0.)
Temp
49.0542
49.0500
49.0500
49.0500
0.008
Temp_inf
49.0542
49.0500
49.0500
49.0500
0.008
N156 node
Temp_sup
47.556
47.5482
47.5482
47.5482
0.016
(-2.13,0.)
Temp
47.556
47.5482
47.5482
47.5482
0.017
Temp_inf

47.556
47.5482
47.5482
47.5482
0.016
N141 node
Temp_sup
26.700
26.6833
26.6833
26.6833
0.062
(-0.54,0.)
Temp
26.700
26.6828
26.6828
26.6828
0.064
Temp_inf
26.700
26.6833
26.6833
26.6833
0.062
N136 node
Temp_sup
11.830
11.8212
11.8212
11.8212
0.074
(-0.19,0.)
Temp
11.830
11.8206
11.8206
11.8206
0.079
Temp_inf
11.830
11.8212
11.8212

11.8212
0.074
N11 node
Temp_sup
26.700
26.6833
26.6833
26.6833
0.062
(0.54,0.)
Temp
26.700
26.6828
26.6828
26.6828
0.064
Temp_inf
26.700
26.6833
26.6833
26.6833
0.062
N26 node
Temp_sup
47.556
47.5482
47.5482
47.5482
0.016
(2.13,0.)
Temp
47.556
47.5481
47.5481
47.5481
0.017
Temp_inf
47.556
47.5482
47.5482
47.5482
0.016

Contents of the file results

· Températures with the nodes of calculation has,
· heat flow on the average layer (calculation has),
· values tested deferred above (calculations has, B, c).

4.2 Parameters
of execution

Version: NEW 4.00.02
Machine: CRAY C90
System UNICOS:
9.0
Obstruction memory:
16 megawords
Time CPU To use:
54.7 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

y
N387
X

Cutting:
68 elements in length,
2 elements in width.

Boundary conditions - loading (three calculations for three choices):
· scalar loadings and dualisation of the condition of Dirichlet:
TEMP_IMPO (NODE: N1, TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)
EXCHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,

TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)
· loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.
· scalar loadings and “kinematic” loading:
THER_IMPO: (NODE: N1,
TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)

5.2

Characteristics of the grid

A number of nodes: 456
A number of meshs and types: 136 meshs QUAD4

5.3 Functionalities
tested

Orders
Keys

AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
DEFI_MATERIAU
THER
[U4.23.01]
AFFE_MODELE
“THERMAL”
“HULL”
ALL
[U4.22.01]
AFFE_CHAR_THER
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_THER_F
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_CINE
THER_IMPO
NODE

[U4.25.05]
CALC_CHAR_CINE
[U4.41.03]
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
TPLS101 Plates infinite subjected to a symmetrical heat exchange
Date: 01/12/98
Author (S)
:
P. MASSIN, F. VOLDOIRE
Key:
V4.03.101-C Page:
7/14
6
Results of modeling B
6.1 Values
tested
Identification
Reference
Aster
Aster
Aster
% difference
calculation has
calculation B
calculation C
N387 node
Temp_sup
49.999
49.9999
49.9999
49.9999
0.002
(-10.,0.)
Temp
49.999
49.9999

49.9999
49.9999
0.002
Temp_inf
49.999
49.9999
49.9999
49.9999
0.002
N397 node
Temp_sup
49.9658
49.9669
49.9669
49.9669
0.002
(-5.15,0.)
Temp
49.9658
49.9669
49.9669
49.9669
0.002
Temp_inf
49.9658
49.9669
49.9669
49.9669
0.002
N401 node
Temp_sup
49.8888
49.8913
49.8913
49.8913
0.005
(-4.32,0.)
Temp
49.8888
49.8913
49.8913
49.8913
0.005

Temp_inf
49.8888
49.8913
49.8913
49.8913
0.005
N405 node
Temp_sup
49.6631
49.6661
49.6661
49.6661
0.006
(-3.53,0.)
Temp
49.6631
49.6661
49.6661
49.6661
0.006
Temp_inf
49.6631
49.6661
49.6661
49.6661
0.006
N409 node
Temp_sup
49.0542
49.0594
49.0594
49.0594
0.011
(-2.8,0.)
Temp
49.0542
49.0594
49.0594
49.0594
0.011
Temp_inf
49.0542
49.0594

49.0594
49.0594
0.011
N412 node
Temp_sup
47.556
47.5657
47.5657
47.5657
0.020
(-2.13,0.)
Temp
47.556
47.5657
47.5657
47.5657
0.020
Temp_inf
47.556
47.5657
47.5657
47.5657
0.020
N420 node
Temp_sup
26.700
26.7559
26.7559
26.7559
0.209
(-0.54,0.)
Temp
26.700
26.7553
26.7553
26.7553
0.207
Temp_inf
26.700
26.7559
26.7559
26.7559
0.209

N422 node
Temp_sup
11.830
11.8119
11.8119
11.8119
0.153
(-0.19,0.)
Temp
11.830
11.8106
11.8106
11.8106
0.164
Temp_inf
11.830
11.8119
11.8119
11.8119
0.153
N426 node
Temp_sup
26.700
26.7559
26.7559
26.7559
0.209
(0.54,0.)
Temp
26.700
26.7553
26.7553
26.7553
0.207
Temp_inf
26.700
26.7559
26.7559
26.7559
0.209
N434 node
Temp_sup
47.556

47.5657
47.5657
47.5657
0.020
(2.13,0.)
Temp
47.556
47.5656
47.5656
47.5656
0.020
Temp_inf
47.556
47.5657
47.5657
47.5657
0.020

6.2 Parameters of execution

Version: NEW 4.01.13
Machine: CRAY C90
System UNICOS:
8.0
Obstruction memory:
16 megawords
Time CPU To use:
8.666 seconds

---

7 Modeling
C
7.1
Characteristics of modeling

Cutting:
30 elements in length,
2 elements in width.
Boundary conditions - loading (three calculations for three choices):
· scalar loadings and dualisation of the condition of Dirichlet:
TEMP_IMPO (NODE: N1, TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)
EXCHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)
· loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.
· scalar loadings and “kinematic” loading:
THER_IMPO: (NODE: N1,
TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)

7.2
Characteristics of the grid

A number of nodes: 410
A number of meshs and types: 60 meshs QUAD8

7.3 Functionalities
tested

Orders		Keys	
AFFE_CARA_ELEM	HULL	ALL	[U4.24.01]
DEFI_MATERIAU	THER		[U4.23.01]
AFFE_MODELE	“THERMAL”	“HULL” ALL	[U4.22.01]
AFFE_CHAR_THER	TEMP_IMPO	NODE	[U4.25.02]

EXCHANGE
GROUP_MA
AFFE_CHAR_THER_F
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_CINE
THER_IMPO
NODE
[U4.25.05]
CALC_CHAR_CINE
[U4.41.03]
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

8
Results of modeling C
8.1 Values
tested
Identification
Reference
Aster
Aster
Aster
% difference
calculation has
calculation B
calculation C

N227 node
Temp_sup
49.999
49.9999
49.9999
49.9999
0.002
(-10.,0.)
Temp
49.999
49.9999
49.9999
49.9999
0.002
Temp_inf
49.999
49.9999
49.9999
49.9999
0.002
N233 node
Temp_sup
49.9658
49.9656
49.9656
49.9656
0.001
(-5.15,0.)
Temp
49.9658
49.9656
49.9656
49.9656
0.001
Temp_inf
49.9658
49.9656
49.9656
49.9656
0.001
N235 node
Temp_sup
49.8888

49.8887
49.8887
49.8887
0.001
(-4.32,0.)
Temp
49.8888
49.8887
49.8887
49.8887
0.001
Temp_inf
49.8888
49.8887
49.8887
49.8887
0.001
N237 node
Temp_sup
49.6631
49.6598
49.6598
49.6598
0.007
(-3.53,0.)
Temp
49.6631
49.6598
49.6598
49.6598
0.007
Temp_inf
49.6631
49.6598
49.6598
49.6598
0.007
N238 node
Temp_sup
49.0542
49.0459
49.0459
49.0459

0.017
(-2.8,0.)
Temp
49.0542
49.0459
49.0459
49.0459
0.017
Temp_inf
49.0542
49.0459
49.0459
49.0459
0.017
N239 node
Temp_sup
47.556
47.5403
47.5403
47.5403
0.033
(-2.13,0.)
Temp
47.556
47.5403
47.5403
47.5403
0.033
Temp_inf
47.556
47.5403
47.5403
47.5403
0.033
N242 node
Temp_sup
26.700
26.7039
26.7039
26.7039
0.015
(-0.54,0.)
Temp

26.700
26.7034
26.7034
26.7034
0.013
Temp_inf
26.700
26.7039
26.7039
26.7039
0.015
N243 node
Temp_sup
11.830
11.7826
11.7826
11.7826
0.401
(-0.19,0.)
Temp
11.830
11.7818
11.7818
11.7818
0.407
Temp_inf
11.830
11.7826
11.7826
11.7826
0.401
N246 node
Temp_sup
26.700
26.7039
26.7039
26.7039
0.015
(0.54,0.)
Temp
26.700
26.7034
26.7034

26.7034
0.013
Temp_inf
26.700
26.7039
26.7039
26.7039
0.015
N249 node
Temp_sup
47.556
47.5403
47.5403
47.5403
0.033
(2.13,0.)
Temp
47.556
47.5402
47.5402
47.5402
0.033
Temp_inf
47.556
47.5403
47.5403
47.5403
0.033

8.2 Parameters
of execution

Version: NEW 4.01.13
Machine: CRAY C90
System UNICOS:
8.0
Obstruction memory:
16 megawords
Time CPU To use:
9.585 seconds

9 Modeling D

9.1 Characteristics of modeling

Cutting:
30 elements in length,
2 elements in width.

Boundary conditions - loading (three calculations for three choices):

· scalar loadings and dualisation of the condition of Dirichlet:
TEMP_IMPO (NODE: N1, TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)
EXCHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)

· loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.

· scalar loadings and “kinematic” loading:
THER_IMPO: (NODE: N1,
TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)

9.2 Characteristics of the grid

A number of nodes: 470
A number of meshs and types: 60 meshs QUAD9

9.3 Functionalities tested

Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
DEFI_MATERIAU

THER
[U4.23.01]
AFFE_MODELE
“THERMAL”
“HULL”
ALL
[U4.22.01]
AFFE_CHAR_THER
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_THER_F
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_CINE
THER_IMPO
NODE
[U4.25.05]
CALC_CHAR_CINE
[U4.41.03]

10
Results of modeling D

10.1 Values
tested
Identification
Reference
Aster
Aster
Aster
% difference
calculation has
calculation B
calculation C
N227 node
Temp_sup
49.999
49.9999
49.9999
49.9999
0.002
(-10.,0.)
Temp
49.999
49.9999
49.9999
49.9999
0.002
Temp_inf
49.999
49.9999
49.9999
49.9999
0.002
N233 node
Temp_sup
49.9658
49.9656
49.9656
49.9656
0.001
(-5.15,0.)
Temp
49.9658
49.9656
49.9656

49.9656
0.001
Temp_inf
49.9658
49.9656
49.9656
49.9656
0.001
N235 node
Temp_sup
49.8888
49.8887
49.8887
49.8887
0.001
(-4.32,0.)
Temp
49.8888
49.8887
49.8887
49.8887
0.001
Temp_inf
49.8888
49.8887
49.8887
49.8887
0.001
N237 node
Temp_sup
49.6631
49.6598
49.6598
49.6598
0.007
(-3.53,0.)
Temp
49.6631
49.6598
49.6598
49.6598
0.007
Temp_inf

49.6631
49.6598
49.6598
49.6598
0.007
N238 node
Temp_sup
49.0542
49.0459
49.0459
49.0459
0.017
(-2.8,0.)
Temp
49.0542
49.0459
49.0459
49.0459
0.017
Temp_inf
49.0542
49.0459
49.0459
49.0459
0.017
N239 node
Temp_sup
47.556
47.5403
47.5403
47.5403
0.033
(-2.13,0.)
Temp
47.556
47.5403
47.5403
47.5403
0.033
Temp_inf
47.556
47.5403
47.5403

47.5403
0.033
N242 node
Temp_sup
26.700
26.7039
26.7039
26.7039
0.015
(-0.54,0.)
Temp
26.700
26.7034
26.7034
26.7034
0.013
Temp_inf
26.700
26.7039
26.7039
26.7039
0.015
N243 node
Temp_sup
11.830
11.7826
11.7826
11.7826
0.401
(-0.19,0.)
Temp
11.830
11.7818
11.7818
11.7818
0.407
Temp_inf
11.830
11.7826
11.7826
11.7826
0.401
N246 node

Temp_sup
26.700
26.7039
26.7039
26.7039
0.015
(0.54,0.)
Temp
26.700
26.7034
26.7034
26.7034
0.013
Temp_inf
26.700
26.7039
26.7039
26.7039
0.015
N249 node
Temp_sup
47.556
47.5403
47.5403
47.5403
0.033
(2.13,0.)
Temp
47.556
47.5402
47.5402
47.5402
0.033
Temp_inf
47.556
47.5403
47.5403
47.5403
0.033

10.2 Parameters of execution

Version: NEW 4.01.13
Machine: CRAY C90

---

11 Modeling E

11.1 Characteristics of modeling

Cutting:
30 elements in length,
2 elements in width.

Boundary conditions - loading (three calculations for three choices):

· scalar loadings and dualisation of the condition of Dirichlet:
TEMP_IMPO (NODE: N1, TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)
EXCHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)

· loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.

· scalar loadings and “kinematic” loading:
THER_IMPO: (NODE: N1,
TEMP_SUP: 0. , TEMP: 0. , TEMP_INF: 0.)

11.2 Characteristics of the grid

A number of nodes: 590
A number of meshs and types: 120 meshs TRIA7

11.3 Functionalities
tested
Orders
Keys
AFFE_CARA_ELEM
HULL
ALL
[U4.24.01]
DEFI_MATERIAU
THER
[U4.23.01]
AFFE_MODELE
“THERMAL”
“HULL”
ALL
[U4.22.01]
AFFE_CHAR_THER
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_THER_F
TEMP_IMPO
NODE
[U4.25.02]
EXCHANGE
GROUP_MA
AFFE_CHAR_CINE
THER_IMPO
NODE
[U4.25.05]
CALC_CHAR_CINE
[U4.41.03]
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

Code_Aster ®
Version
4.0
Titrate:
TPLS101 Plates infinite subjected to a symmetrical heat exchange

12
Results of modeling E
12.1 Values
tested
Identification
Reference
Aster
Aster
Aster
% difference
calculation has
calculation B
calculation C
N227 node
Temp_sup
49.999
49.9999
49.9999
49.9999
0.002
(-10.,0.)
Temp
49.999
49.9999
49.9999
49.9999
0.002
Temp_inf
49.999
49.9999
49.9999
49.9999
0.002
N233 node
Temp_sup
49.9658

49.9659
49.9659
49.9659
0.001
(-5.15,0.)
Temp
49.9658
49.9659
49.9659
49.9659
0.001
Temp_inf
49.9658
49.9659
49.9659
49.9659
0.001
N235 node
Temp_sup
49.8888
49.8886
49.8886
49.8886
0.001
(-4.32,0.)
Temp
49.8888
49.8886
49.8886
49.8886
0.001
Temp_inf
49.8888
49.8886
49.8886
49.8886
0.001
N237 node
Temp_sup
49.6631
49.6572
49.6572
49.6572

0.012
(-3.53,0.)
Temp
49.6631
49.6572
49.6572
49.6572
0.012
Temp_inf
49.6631
49.6572
49.6572
49.6572
0.012
N238 node
Temp_sup
49.0542
49.0428
49.0428
49.0428
0.023
(-2.8,0.)
Temp
49.0542
49.0428
49.0428
49.0428
0.023
Temp_inf
49.0542
49.0428
49.0428
49.0428
0.023
N239 node
Temp_sup
47.556
47.5377
47.5377
47.5377
0.038
(-2.13,0.)
Temp

47.556
47.5376
47.5376
47.5376
0.039
Temp_inf
47.556
47.5377
47.5377
47.5377
0.038
N242 node
Temp_sup
26.700
26.7178
26.7178
26.7178
0.067
(-0.54,0.)
Temp
26.700
26.7172
26.7172
26.7172
0.064
Temp_inf
26.700
26.7178
26.7178
26.7178
0.067
N243 node
Temp_sup
11.830
11.7974
11.7974
11.7974
0.275
(-0.19,0.)
Temp
11.830
11.7965
11.7965

11.7965
0.283
Temp_inf
11.830
11.7974
11.7974
11.7974
0.275
N246 node
Temp_sup
26.700
26.7178
26.7178
26.7178
0.067
(0.54,0.)
Temp
26.700
26.7172
26.7172
26.7172
0.064
Temp_inf
26.700
26.7178
26.7178
26.7178
0.067
N249 node
Temp_sup
47.556
47.5377
47.5377
47.5377
0.038
(2.13,0.)
Temp
47.556
47.5376
47.5376
47.5376
0.039
Temp_inf

47.556
47.5377
47.5377
47.5377
0.038

12.2 Parameters of execution

Version: NEW 4.01.13
Machine: CRAY C90
System UNICOS:
8.0
Obstruction memory:
16 megawords
Time CPU To use:
14.679 seconds

---

13 Summary of the results

It is noted that the variations on the temperature are weak compared to the reference solution (lower than 0.41%).

Meshs QUAD8 and QUAD9 give the same results.

P. MASSIN, F. LEBOUVIER, A. LAULUSA

Organization (S): EDF/IMA/MMN, DELTA CAD, SAMTECH

Handbook of Validation

V4.03 booklet: Stationary thermics of the plates and the hulls

Document: V4.03.302

TPLS302 - Distribution of temperature in one thin section

Summary:

One considers a plate subjected to convection applied to the faces lower and higher and one edge of the plate (width). The temperature is imposed on the opposite edge of the plate.
The goal of this test is to validate the thermal element of hull in conduction in the plan and convection

[R3.11.01] and [U1.01.01]. It also makes it possible to validate the elements of edge (THCOSE2, THCOSE3) in
convection.
Because of the boundary conditions and loadings considered, the distribution of temperature is uniform along the width. The results are compared with a solution based on a graphic estimate.
two types of approach give equivalent results.
This test results from the validation independent of version 3 in thermics.
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

---

1 Problem of reference

1.1 Geometry

Y
L = 101.6 10-3m
Z
D
B = 25.4 10-3m
Tw
H, Text
With
X
C
L
B
B

1.2 Material properties

CP = 1. J/m3°C
= 25.961 W/m °C

1.3
Boundary conditions and loadings
Convection on the lower, higher face:
H = 85.169 W/m2 °C
Text = 37.778 °C
and on the end (X = L, BC) of the plate:
h' = 2.163 W/m °C correspondent with H X B for this test
Temperature imposed on the with dimensions AD: Tw = 593.333 °C

2
Reference solution
2.1
Method of calculation used for the reference solution
The original reference solution given in the book [bib1] is based on a graphic estimate.
Uncertainty on the solution is unknown.
This reference is quoted in the handbook of checking of ANSYS [bib2].
2.2
Results of reference
Temperature at the points of co-ordinates x/L = 0, 0.1, 0.2,… 0.8, 0.9, 1.
2.3 References
bibliographical
[1]
Kreith, F., “Principles of heat transfer”, International Textbook Co., Scranton, Pennsylvania,
2nd Printing, 1959.
[2]
ANSYS: “Checking manual”, 1st edition, June 1, 1976

3 Modeling

With

3.1

Characteristics of modeling

Because of symmetry of the boundary conditions and loadings, modeling is independent
width of the with dimensions AD and BC (the distribution of temperature is uniform in the direction of width).

Modeling: HULL (QUAD8 + SEG3)

y
D
Limiting conditions:
Z
· with dimensions AD
T = 593.33°C
W
· higher, lower face and edge BC
H = 85.169 W m2°C
T
= 37.78 °C
ext.
With
C

Cutting

· Cotés AB, CD: 5 elements
· Cotés AD, BC: 1 element

B
X

3.2

Characteristics of the grid

There are 28 nodes on the whole
5 meshs QUAD8 on the average surface of the hull
1 mesh SEG3 on the with dimensions BC

3.3 Functionalities
tested

Orders
Key word factor
Key word
Argument
Keys
AFFE_CHAR_THER
TEMP_IMPO, EXCHANGE
[U4.25.02]
AFFE_CHAR_THER_F
TEMP_IMPO, EXCHANGE
DEFI_MATERIAU
THER
RHO_CP, LAMBDA
[U4.23.01]
AFFE_MODELE
AFFE
MODELING
“HULL”
[U4.22.01]
AFFE
PHENOMENON
“THERMAL”

4
Results of modeling A

4.1 Values tested

Identification	**Reference**	**Aster**	**% difference**	**Tolerance**
Localization				
T (°C)				
x/L = 0.0	593.333	593.333	0.000	5%
x/L = 0.1	512.778	517.947	1.008	5%
x/L = 0.2	446.111	451.206	1.142	5%
x/L = 0.3	393.333	395.840	0.638	5%
x/L = 0.4	348.889	349.657	0.220	5%
x/L = 0.5	312.778	311.722	0.338	5%
x/L = 0.6	279.444			

280.993
0.554
5%
x/L = 0.7
254.444
256.673
0.876
5%
x/L = 0.8
237.778
238.124
0.146
5%
x/L = 0.9
221.111
224.853
1.693
5%
x/L = 1.0
213.333
216.515
1.492
5%

4.2 Remarks

As envisaged, the distribution of temperature is uniform according to the width. All results obtained are in the interval of allowed tolerance which corresponds to the uncertainty supposed on the results of the graphic estimate.

4.3 Parameters
of execution

Version: 4.01.05
Machine: CRAY C98
Obstruction memory:
8 MW
Time CPU To use:
5.28 seconds

---

5 Modeling
B

5.1
Characteristics of modeling

Because of the boundary conditions and loadings, modeling is independent of the width
with dimensions AD and BC (the distribution of temperature is uniform along the width).

Modeling: HULL (QUAD4 + SEG2)

y
D
Limiting conditions:
Z
· with dimensions AD
T =593.33°C
W
· higher, lower face and edge BC
H = 85.169 W/m ² °C
T = 37.78 °C
ext.
With
C
Cutting
· Cotés AB, CD:
10 elements
· Cotés AD, BC: 1 element
B
X

5.2
Characteristics of the grid

One A 22 nodes on the whole
10 meshs QUAD4 on the average surface of the hull
1 mesh SEG2 on the with dimensions BC

5.3 Functionalities
tested

Orders
Key word factor

Key word
Argument
Keys
AFFE_CHAR_THER
TEMP_IMPO, EXCHANGE
[U4.25.02]
AFFE_CHAR_THER_F
TEMP_IMPO, EXCHANGE
DEFI_MATERIAU
THER
RHO_CP, LAMBDA
[U4.23.01]
AFFE_MODELE
AFFE
MODELING
"HULL"
[U4.22.01]
AFFE
PHENOMENON
"THERMAL"

6
Results of modeling B
6.1 Values
tested
Identification
Reference
Aster

% difference
Tolerance
Localization
T (°C)
x/L = 0.0
593.333
593.333
0.000
5%
x/L = 0.1
512.778
518.146
1.047
5%
x/L = 0.2
446.111
451.267
1.156
5%
x/L = 0.3
393.333
395.633
0.585
5%
x/L = 0.4
348.889
349.428
0.155
5%
x/L = 0.5
312.778
311.457
0.422
5%
x/L = 0.6
279.444
280.715
0.455
5%
x/L = 0.7
254.444
256.390
0.765

5%
x/L = 0.8
237.778
237.839
+0.026
5%
x/L = 0.9
221.111
224.574
1.566
5%
x/L = 1.0
213.333
216.242
1.364
5%

6.2 Remarks

As envisaged, the distribution of temperature is uniform according to the width. All results obtained are in the interval of allowed tolerance which corresponds to the uncertainty supposed on the results of the graphic estimate.

6.3 Parameters of execution

Version: 4.01.05
Machine: CRAY C98
Obstruction memory:
8 MW
Time CPU To use:
5.19 seconds

---

7 Modeling

C

Modeling: HULL (QUAD9 + SEG3)

y
D
Limiting conditions:
Z
- dimensioned AD
T =593.33°C
W
- higher, lower face and edge BC
H = 85.169 W/m ² °C
T = 37.78 °C
ext.
With
C
Cutting
- Dimensioned AB, CD:
5 elements
- Dimensioned AD, BC:
1 element
B
X

7.1

Characteristics of modeling

Because of the boundary conditions and loadings, modeling is independent of the width with dimensions AD and BC (the distribution of temperature is uniform along the largeu).

7.2

Characteristics of the grid

There are 33 nodes on the whole
5 meshs QUAD9 on the average surface of the hull
1 meshs SEG3 on the with dimensions BC

7.3 Functionalities
tested

Orders
Key word factor
Key word
Argument
Keys

AFFE_CHAR_THER
TEMP_IMPO, EXCHANGE
[U4.25.02]

AFFE_CHAR_THER_F
TEMP_IMPO, EXCHANGE
DEFI_MATERIAU
THER
RHO_CP, LAMBDA
[U4.23.01]
AFFE_MODELE
AFFE
MODELING
“HULL”
[U4.22.01]
AFFE
PHENOMENON
“THERMAL”
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

8
Results of modeling C
8.1 Values
tested
Identification
Reference
Aster
% difference
tolerance
Localization
T (°C)
x/L = 0.0
593.333

593.333
0.000
5%
x/L = 0.1
512.778
517.947
1.008
5%
x/L = 0.2
446.111
451.207
1.142
5%
x/L = 0.3
393.333
395.841
0.638
5%
x/L = 0.4
348.889
349.658
0.220
5%
x/L = 0.5
312.778
311.722
-0.338
5%
x/L = 0.6
279.444
280.993
0.554
5%
x/L = 0.7
254.444
256.673
0.876
5%
x/L = 0.8
237.778
238.125
0.146
5%

x/L = 0.9
221.111
224.854
1.693
5%
x/L = 1.0
213.333
216.516
1.492
5%

8.2 Remarks

As envisaged, the distribution of temperature is uniform according to the width. All results obtained are clearly in the interval of allowed tolerance.

8.3 Parameters of execution

Version: 4.01.12
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
5.436 seconds
Handbook of Validation
V4.03 booklet: Stationary thermics of the plates and the hulls
HI-75/98/040 - Ind A

---

9 Modeling D

Modeling: HULL (TRIA7 + SEG3)

y
D
Limiting conditions:
Z
- dimensioned AD
T =593.33°C
W
- higher, lower face and edge BC
H = 85.169 W/m ² °C
T = 37.78 °C
ext.
With
C
Cutting
- Dimensioned AB, CD:
10 elements
- Dimensioned AD, BC:
1 element
B
X

9.1 Characteristics of modeling

Because of the boundary conditions and loadings, modeling is independent of the width with dimensions AD and BC (the distribution of temperature is uniform along the largeu).

9.2 Characteristics of the grid

There are 43 nodes on the whole
10 meshs TRIA7 on the average surface of the hull

1 meshs SEG3 on the with dimensions BC

9.3 Functionalities
tested

Orders
Key word factor
Key word
Argument
Keys

AFFE_CHAR_THER
TEMP_IMPO, EXCHANGE
[U4.25.02]
AFFE_CHAR_THER_F
TEMP_IMPO, EXCHANGE
DEFI_MATERIAU
THER
RHO_CP, LAMBDA
[U4.23.01]
AFFE_MODELE
AFFE
MODELING
"HULL"
[U4.22.01]
AFFE
PHENOMENON
"THERMAL"

10
Results of modeling D

10.1 Values tested

Identification	**Reference**	**Aster**	**% difference**	**tolerance**
Localization	T (°C)			
x/L = 0.0	593.333	593.333	0.000	5%
x/L = 0.1	512.778	517.863	0.992	5%
x/L = 0.2	446.111	451.193	1.139	5%
x/L = 0.3	393.333	395.862	0.643	5%
x/L = 0.4	348.889	349.635	0.214	5%
x/L = 0.5	312.778	311.737	-0.333	5%
x/L = 0.6	279.444	280.981	0.550	

5%
x/L = 0.7
254.444
256.683
0.880
5%
x/L = 0.8
237.778
238.122
0.145
5%
x/L = 0.9
221.111
224.857
1.694
5%
x/L = 1.0
213.333
216.526
1.497
5%

10.2 Remarks

As envisaged, the distribution of temperature is uniform according to the width. All results obtained are clearly in the interval of allowed tolerance.

10.3 Parameters of execution

Version: 4.01.12
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
5.304condes

---

11 Summary of the results

Results obtained for two modelings (QUAD8 + SEG3 or QUAD + SEG2) in
the interval of allowed tolerance (< 2% for a tolerance of 5%) which corresponds to uncertainty on results of the graphic estimate of reference.

The data of the test could retain a tolerance of 2%.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
V4.04.006 document

TPLV06 - Release of power in one hollow sphere

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a three-dimensional problem which aims to validate the voluminal thermal element subjected to
a temperature imposed and on a heat source.

This case test includes/understands a modeling 3D. The results are compared with an analytical solution (VPCS).

1

Problem of reference

1.1 Geometry

Re
IH
Hollow sphere:
- Interior Ray IH = 1 m
- External Ray Re = 2 m
R
O
Q

1.2
Properties of material

=
1. W/m °C
Thermal conductivity

1.3
Boundary conditions and loadings

· Ti = T (R = IH) = 20°C,
· Te = T (R = Re) = 20°C,
· Q = 100 W/m3.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLV06/89 of guide VPCS.

· Température according to R:

1
1

(

R 2 - R 2
-

E
I)
Q
R
R
T = T

I
+
- (R 2 - R 2
I
I)
6

1
1

-

R
R

I
E

· ***Density flux according to R:***

dT
2 Q
2

1
1

= -4
= -
(2
R -
2
R)
-
- 2 3
R
R

E
I

Dr.
3
R
R
I
E

2.2
Results of reference

Temperature in R = 1.25; 1.5 and 1.75 m

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7

---

3 Modeling
With

3.1
Characteristics of modeling

3D (HEXA8)

N101
G
Limiting conditions:
C
N106
N105
- faces ABCD, EFGH,
ABFE, DCGH = 0
N111
N110
- faces ADHE, BCGF T = 20°C
F
N1
N116
N115
N6
X
N120
N121
N11
B
N5
Z
H
N16
N125
D
N10
E
N15
N21
N20
C
With
N25
30°
30°
y

3.2
Characteristics of the grid

A number of nodes:
125
A number of meshs and types: 64 HEXA8

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
3D
ALL

AFFE_CHAR_THER
TEMP_IMPO
SOURCE

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
tolerance
Temperature (°C)

R = 1.25 (N16)
30.625
30.471
-0.504
1%
R = 1.25 (N116)
30.625
30.471
-0.504
1%
R = 1.25 (N20)
30.625
30.462
-0.532
1%
R = 1.25 (N120)

30.625
30.462
-0.532
1%
R = 1.50 (N11)
32.500
32.337
-0.500
1%
R = 1.50 (N111)
32.500
32.337
-0.500
1%
R = 1.50 (N15)
32.500
32.335
-0.507
1%
R = 1.50 (N115)
32.500
32.335
-0.507
1%
R = 1.75 (N6)
28.482
28.379
-0.362
1%
R = 1.75 (N106)
28.482
28.379
-0.362
1%
R = 1.75 (N10)
28.482
28.382
-0.351
1%
R = 1.75 (N110)
28.482
28.382
-0.351

1%

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.00 seconds

5
Summary of the results

The results obtained are satisfactory, the maximum change obtained is 0.53%.

Modeling 3D used to model this sphere is correct.

The quality of the results could be still improved in:

· carrying out a finer grid of the portion of sphere,
· choosing quadratic elements for better approximating the reference solution.

V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
Orthotropic Cubic TPLV07

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.04.007-A Page:
1/6

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
V4.04.007 document

TPLV07 - Cubic orthotropic

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It validates the voluminal thermal elements under conditions of imposed flow, of convection but also of
linear variation of the outside temperature.

The results are compared with an analytical solution (VPCS).

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

has
Cubic of edge = 0.2 m has
Center cube = (0. , 0. , 0.)
Z
y
X
O

1.2
Properties of material

X = 1.0 W/m.°C thermal Conductivity along axis X
y = 0.75 W/m.°C thermal Conductivity along the axis y
Z = 0.50 W/m.°C thermal Conductivity along axis Z

1.3
Boundary conditions and loadings

· density flux normal:
-

N = 60 W/m ² face y = -0.1 (entering flow),
-
N = -60 W/m ² face y = 0.1 (outgoing flow),
-
N = 30 W/m ² face Z = -0.1 (entering flow),
-
N = -30 W/m ² face Z = 0.1 (outgoing flow),

· convection on the faces X = 0.1 and X = 0.1: H = 15 W/m2 °C,

· linear variation of the outside temperatures,
- Text = 30 - 80y - 60z face X = -0.1,
- Text = 15 - 80y - 60z face X =
0.1.

1.4 Conditions initial

Without object.

---

2 Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLV07/89 of guide VPCS.

Analytical solution.

T (X, y, Z) = ax + by + cz + D
= -45x -80y -60z + 22.5

Z
Not T (°C)
L
K
O
22.5
M
With
35.0
B
26.0
I
y
J
C
10.0
G
D
C
D
19.0
E
30.5
H O F X
F
18.0
E
G
14.5
With
B
H
27.0
R

Q
I
29.0
S
J
20.0
K
4.0
L
13.0
NR
P
M
16.5
NR
41.0
P
32.0
X = 45 W/m ² = constant
Q
16.0
R
25.0
y = 60 W/m ² = constant
S
28.5
Z = 30 W/m ² = constant

2.2
Results of reference

Temperature at the points quoted in the table above.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of
Mechanics, AFNOR 1990 ISBN 2-12-486611-7
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

---

3 Modeling
With

3.1
Characteristics of modeling

3D (HEXA8)

Limiting conditions:
Z
- face NPJI
L
K
N = 60 W/m ²
- face RQKL
N = -60 W/m ²
- face NPQR
I

J
N = 30 W/m ²
- face IJKL
N = -30 W/m ²
y
- face NRLI
H = 15 W/m ² °C
T
X
ext. = 30-80y-60z
O
- face PQKJ
H = 15 W/m ² °C
Text = 15-80y-60z
Cutting:
R
Q
- 6 elements according to X
- 6 elements following y
NR
P
- 6 elements according to Z

3.2
Characteristics of the grid

A number of nodes:
343
A number of meshs and types: 216 HEXA8 (and 216 QUAD8)

3.3 Functionalities
tested

Orders

DEFI_MATERIAU
THER_ORTH

AFFE_MODELE

THERMICS
3D
ALL

AFFE_CARA_ELEM
SOLID MASS
ANGLE_REP
0. 0. 0.

DEFI_NAPPE

AFFE_CHAR_THER_F
FLUX_REP
EXCHANGE

THER_LINEAIRE
CARA_ELEM
EXCIT

CALC_CHAM_ELEM
CARA_ELEM
FLUX_ELNO_TEMP

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must be declared for Code_Aster. One CP = 1.0 J/m3 °C takes.

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster
Relative variation (%)
Absolute deviation (°C, W/m2)

difference
tolerance
difference
tolerance
Not

Node
T
(°C)

O

N169
22.5
22.500
0.000% 1.% 2.50E-7 0.5
°C
With
N5
35.0
35.000 0.000%
1.%
1.03E-7
0.5
B
N301

26.0
26.000 0.000%
1.% -7.12E-8
0.5
C

N337
10.0
10.000
0.000%
1.%
-7.72E-8
0.5
D

N49
19.0
19.000
0.000%
1.%
1.00E-7
0.5
E
N151
30.5
30.500 0.000%
1.%
2.54E-7
0.5
F

N316
18.0
18.000
0.000%
1.%
-7.42E-8
0.5
G

N196
14.5
14.500
0.000%

1.%
2.46E-7
0.5
H

N24
27.0
27.000
0.000%
1.%
1.02E-7
0.5
I

N1
29.0
29.000
0.000%
1.%
1.14E-7
0.5
J

N298
20.0
20.000
0.000% 1.% 4.97E-7 0.5
K
N340
4.0
4.000 0.000%
1.% -4.64E-8
0.5
L

N44
13.0
13.000
0.000%
1.%
1.07E-7
0.5
M

N172
16.5
16.500
0.000%
1.%
2.89E-7
0.5
NR

N2
41.0
41.000
0.000%
1.%
9.66E-8
0.5
P
N297
32.0
32.000 0.000%
1.% -8.30E-8
0.5
Q

N338
16.0
16.000
0.000%
1.%
-8.38E-8
0.5
R

N43
25.0
25.000
0.000%
1.%
9.59E-8
0.5
S
N173
28.5
28.500 0.000%

1.%
2.37E-7
0.5
Not maill
Node
(W/m2)

E
X K m211 N340
45.0
45.000
0.000%
1.%
-1.73E-6
0.5 W/m2
X F m201 N316
45.0
45.000
0.000%
1.%
-1.13E-6
0.5
X O m129 N169
45.0
45.000
0.000%
1.%
-1.36E-6
0.5
y K m211 N340
60.0
60.000
0.000%
1.%
-2.43E-6
0.5
y F m201 N316
60.0
60.000
0.000% 1.% 2.96E-8 0.5

y O m129 N169
60.0
60.000
0.000% 1.% 4.49E-8 0.5
Z K m211 N340
30.0
30.000
0.000% 1.% -3.71E-7 0.5
Z F m201 N316
30.0
30.000
0.000%
1.%
-2.40E-7
0.5
Z O m129 N169
30.0
30.000
0.000%
1.%
-2.03E-7
0.5

4.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 3.30 seconds

5
Summary of the results

The results obtained are excellent. The computed values by Aster are identical to the values of reference. That is "a normally awaited" result since the field solution which is linear belongs to the space of interpolation of the element tested.

This test made it possible to test the following orders:

· DEFI_NAPPE allowing to define a variation in the external temperature according to X-coordinate X and of the ordinate y,
· DEFI_MATERIAU associated with key word THER_ORTH, allowing to define the characteristics of one orthotropic material,
· AFFE_CARA_ELEM associated with the MASSIVE key word, allowing to define the axes of orthotropism.

Organization (S): EDF/IMA/MMN

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
Document: V4.04.100

TPLV100 - Roll subjected to conditions with the nonaxisymmetric limits

Summary:

It is about a test in stationary thermics with modeling of Fourier.

This test validates all the elements of Fourier in thermics (5 different modelings) with various types of boundary conditions: imposed temperature, exchange, imposed flow, heat source.

The interest of the test, in addition to the validation of Fourier thermics, lies in the following points:

· comparison between the results and an analytical solution on various harmonics of Fourier (1, 2 and 3),
· homogeneity of the elements between them.

1
Problem of reference

1.1 Geometry

Z
Z
E
G
D
C
R
R
With
B
F

Ray of the cylinder R = 1 Mr.

1.2 Properties
of

materials

= 1 W/m °C

1.3
Boundary conditions and loadings

[EA]: imposed temperature
T = To = 0.°C
[BC]: imposed flow
= O = 2. W/m2 °C
[CD]: exchange
h= 2. W/m2 °C

Text = 2. °C

2
Reference solution

2.1
Method of calculation used for the reference solution

T (R, Z,) = r2 cos L

with L number of the harmonic of Fourier

- T = (l2 - 4) cos L = S
- 2r cos L
R

= -

T = 0.+ (lrsinl)
[
on AB] and [ED]
R R
0
= N = 0.

[
on BC]
0
= 2R = 2.
[
on CD]
2
NR = 2R =
(2R2 - R2) = (hText - T)
R
2
from where H

=
= 2.
R
T
2
ext.
= 2R
= 2.

Only the source term varies according to the harmonic (Sl (R, Z) = l2 - 4).

In following modelings, one will solve the problem on harmonics 1, 2 and 3.

2.2

Results of reference

Temperatures and flow at the points B, C, D, F, G.

---

3 Modeling
With

3.1
Characteristics of modeling

AXIS-FOURIER (TRIA6)

y (Z)
R Z node
To 0. 0. N1
G
B 1. 0. N7
E
D
C 1. 0.5
N8
D 1. 1. N9
C
E 0. 1. N3
F 0.5

0. N4
X (R)
With
G 0.5
1. N6
F
B

The axes of description of the grid are X (R) and y (Z).

Mode - Fourier: 1 T (A) = 0.

S = -3.
on all the field
[BC]:
= 2.
[CD]:
H = 2. Text = 2.

3.2 Characteristics

grid

A number of nodes: 25.
A number of meshs and types: 8 TRIA6

3.3 Functionalities
tested

Orders

Keys
THERMAL AFFE_MODELE
“AXIS_FOURIER”
ALL
[U4.22.01]
AFFE_CHAR_THER TEMP_IMPO
NODE

[U4.25.02]
FLUX_REP
GROUP_MA

EXCHANGE
GROUP_MA

SOURCE
ALL

CALC_MATR_ELEM "RIGI_THER"
MODE_FOURIER
[U4.41.01]
CALC_VECT_ELEM "CHAR_THER"

[U4.41.02]
ASSE_MATRICE

[U4.42.02]
ASSE_VECTEUR

[U4.42.03]
FACT_LDLT

[U4.51.01]
RESO_LDLT

[U4.51.02]
CALC_CHAM_ELEM "FLUX_ELNO_TEMP"
MODE_FOURIER
[U4.61.01]
COMB_CHAM_NO COMB_FOURIER

[U4.53.02]
COMB_CHAM_ELEM COMB_FOURIER

[U4.53.03]
POST_RELEVE CHAM_GD
"EXTRACTION"

[U4.74.03]

3.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM.

The use of orders COMB_CHAM_NO and COMB_CHAM_ELEM key word COMB_R is not one recombination of Fourier but a simple validation of this key word.

4
Results of modeling A

4.1 Values
tested

Identification
Reference
Aster %
difference
= 0
T (B)
1.
0.9981
-0.19
T
(F)
0.25
0.2484

-0.66

R (B)
-2 -1.993
-0.36

R (F)
-1. -0.9924
-0.76

(B)
1. 0.9996
-0.04

(F)
0.5 0.4982
-0.37

Z (B)
0. -5.
10-3 -

Z (F)
0. 7.
10-4 -

= 45
T (B)
0.7071
0.7057
-0.192
T
(F)
0.177
0.1756
-0.65

R (B)
-1.414 -1.4018
-0.87

R (F)
-0.7071 -0.6848 3.15

(B)
-0.707 -0.7069 0.027

(F)
-0.3535 -0.3512 -0.65

Z (B)
0. 0.36
10-3 -

Z (F)
0. 0.12
10-2 -

= 135
T (B)
-0.707
-0.7057
0.19
T
(F)
-0.177
-0.1756
0.65

R (B)
1.414 1.4018
-0.87

R (F)
0.707 0.685
-3.15

(B)
-0.707 -0.7069 0.027

(F)
-0.3535 -0.3533 0.06

Z (B)
0. -0.36
10-3 -

Z (F)
0. -0.12
10-2 -

4.2 Remarks

The values of flows to the nodes are realised on the elements containing this node.

It is noticed that the exact solution is not found. This is with the fact that numerical integration thermal matrix of rigidity is approximate (formula at 3 points of GAUSS). If one were used formulate at 6 points, one would find the solution exactly.

4.3 Parameters
of execution

Version: 4.00.02

Machine: CRAY C90

System UNICOS:
8.04
Obstruction memory:
8 megawords
Time CPU To use:
7.0 seconds
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HI-75/01/010/A

---

5 Modeling *B*

5.1 *Characteristics of modeling*

AXIS-FOURIER (QUAD8)

y (Z)
R Z node
To 0. 0. N1
G
B 1. 0. N4
E
D
C 1. 0.5
N5
D 1. 1. N6
C
E 0. 1. N3
F 0.5
0. N7
X (R)
With
G 0.5
1. N12
F
B

The axes of description of the grid are X (R) and y (Z).

Mode - Fourier: 2 T (A) = 0.
No the term source bus S L (R, Z)

= .
0 for L = 2

[BC]: = 2.
[CD]: H = 2. Text = 2.

5.2 Characteristics

grid

A number of nodes: 13.
A number of meshs and types: 2 QUAD8

5.3 Functionalities
tested

Orders

Keys
“THERMAL” AFFE_MODELE “AXIS_FOURIER”
ALL
[U4.22.01]
AFFE_CHAR_THER TEMP_IMPO
NODE

[U4.25.02]
FLUX_REP
GROUP_MA

EXCHANGE
GROUP_MA

CALC_MATR_ELEM “RIGI_THER”
MODE_FOURIER
[U4.41.01]

CALC_VECT_ELEM "CHAR_THER"

[U4.41.02]
ASSE_MATRICE

[U4.42.02]
ASSE_VECTEUR

[U4.42.03]
FACT_LDLT

[U4.51.01]
RESO_LDLT

[U4.51.02]
CALC_CHAM_ELEM "FLUX_ELNO_TEMP"
MODE_FOURIER
[U4.61.01]

5.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM.

---

6 Results of modeling B

6.1 Values tested

Identification	*Reference*	*Aster*	*% difference*
T (B)	*1.*	*1.*	*0.*
T (C)	*1.*	*1.*	*0.*
T (D)	*1.*	*1.*	*0.*
T (F)	*0.25*	*0.25*	*0.*
T (G)	*0.25*	*0.25*	*0.*
R (B)	*-2.*	*-2.*	*0.*
R (C)	*-2.*	*-2.*	*0.*
R (D)	*-2.*	*-2.*	*0.*
R (F)	*-1.*	*-1.*	*0.*
R (G)	*-1.*	*-1.*	*0.*
(B)	*2.*	*2.*	*0.*
(C)	*2.*	*2.*	*0.*
(D)	*2.*	*2.*	

0.
(F)
1. 1.
0.
(G)
1. 1.
0.
Z (B)
0.
2.10-15
0.
Z (C)
0.
-1.2 10-14
0.
Z (D)
0.
-1.2 10-13
0.
Z (F)
0.
-1.4 10-14
0.
Z (G)
0.
-3.7 10-15
0.

6.2 Remarks

The analytical solution is found exactly.

6.3 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System UNICOS:
8.04

Obstruction memory:
8 megawords
Time CPU To use:
3.8 seconds

---

7 Modeling
C

7.1
Characteristics of modeling

AXIS-FOURIER (QUAD9)

y (Z)
R Z node
To 0. 0. N1
G
B 1. 0. N4
E
D
C 1. 0.5
N5
D 1. 1. N6
C
E 0. 1. N3

F 0.5
0. N7
X (R)
With
G 0.5
1. N12
F
B

The axes of description of the grid are X (R) and y (Z).

Mode - Fourier: 3 T (A) = 0.

S = 5.
on all the field
[BC]:
= 2.
[CD]:
H = 2. Text = 2.

7.2 Characteristics

grid

A number of nodes: 15.
A number of meshs and types: 2 QUAD9

7.3 Functionalities
tested

Orders

Keys
“THERMAL” AFFE_MODELE “AXIS_FOURIER”
ALL
[U4.22.01]
AFFE_CHAR_THER TEMP_IMPO
NODE

[U4.25.02]
FLUX_REP
GROUP_MA

EXCHANGE
GROUP_MA

SOURCE
ALL

CALC_MATR_ELEM "RIGI_THER"
MODE_FOURIER
[U4.41.01]
CALC_VECT_ELEM "CHAR_THER"

[U4.41.02]
ASSE_MATRICE

[U4.42.02]
ASSE_VECTEUR

[U4.42.03]
FACT_LDLT

[U4.51.01]
RESO_LDLT

[U4.51.02]
CALC_CHAM_ELEM "FLUX_ELNO_TEMP"
MODE_FOURIER
[U4.61.01]

7.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM.

TPLV100 Rolls subjected to boundary conditions

8
Results of modeling C

8.1 Values tested

Identification	Reference	Aster	% difference
T (B)	1.	1.	0.
T (C)	1.	1.	0.
T (D)	1.	1.	0.
T (F)	0.25	0.25	0.
T (G)	0.25	0.25	0.
R (B)	-2.	-2.	0.
R (C)	-2.	-2.	0.
R (D)	-2.	-2.	0.
R (F)	-1.	-1.	0.
R (G)	-1.	-1.	0.

(B)
3. 3.
0.
(C)
3. 3.
0.
(D)
3. 3.
0.
(F)
1.5 1.5
0.
(G)
1.5 1.5
0.
Z (B)
0.
1.2 10-14
0.
Z (C)
0.
5.5 10-14
0.
Z (D)
0.
4.6 10-15
0.
Z (F)
0.
-1.1 10-15
0.
Z (G)
0.
1.8 10-14
0.

8.2 Remarks

The analytical solution is found exactly.

8.3 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System UNICOS:
8.04
Obstruction memory:
8 megawords
Time CPU To use:
3.9 seconds
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HI-75/01/010/A

---

9 Modeling
D

9.1
Characteristics of modeling

AXIS-FOURIER (QUAD4)

y (Z)
50 subdivisions in R
R Z node
To 0. 0. N1

G
D
B 1. 0. N151
E
C 1. 0.5
N152
D 1. 1. N153
C
E 0. 1. N3
F 0.5
0. N76
X (R)
G 0.5
1. N78
With
F
B

The axes of description of the grid are X (R) and y (Z).

Mode - Fourier: 2 T (A) = 0.

S = 0.
on all the field
[BC]:
= 2.
[CD]:
H = 2. Text = 2.

9.2 Characteristics

grid

A number of nodes: 153
A number of meshs and types: 100 QUAD4

9.3 Functionalities
tested

Orders

Keys
“THERMAL” AFFE_MODELE “AXIS_FOURIER”
ALL

[U4.22.01]
AFFE_CHAR_THER TEMP_IMPO
NODE

[U4.25.02]
FLUX_REP
GROUP_MA

EXCHANGE
GROUP_MA

SOURCE
ALL

CALC_MATR_ELEM "RIGI_THER"
MODE_FOURIER
[U4.41.01]
CALC_VECT_ELEM "CHAR_THER"

[U4.41.02]
ASSE_MATRICE

[U4.42.02]
ASSE_VECTEUR

[U4.42.03]
FACT_LDLT

[U4.51.01]
RESO_LDLT

[U4.51.02]
CALC_CHAM_ELEM "FLUX_ELNO_TEMP"
MODE_FOURIER
[U4.61.01]

9.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM.

---

10 Results of modeling D

10.1 Values tested

Identification Reference
Aster %
difference
T (B) 1. 0.9998
-2.10-3
T (C) 1. 0.9998
-2.10-3
T (D) 1. 0.9998
-2.10-3
T (F) 0.25
0.2498
-0.02
T (G) 0.25
0.2498
-0.02
R (B)
-2. -1.9800 1.
R (C)
-2. -1.9800 1.

R (D)
-2. -1.9801 1.
R (F)
-1. -1.0000 4. 10-3
R (G)
-1. -1.0000 4. 10-3
(B)
2. 2.0000 4. 10-3
(C)
2. 2.0000 4. 10-3
(D)
2. 2.0001 5. 10-3
(F)
1. 1.0000 4. 10-3
(G)
1. 1.0000 4. 10-3
Z (B)
0.
-2.10-5
-
Z (C)
0.
-2.10-5
-
Z (D)
0.
-2.10-5
-
Z (F)
0.
-2.10-8
-
Z (G)
0.
-2.10-8
-

10.2 Remarks

The bad precision recorded on R (B), R (C), R (D) is explained by the fact why B, C and D are nodes of the edge, therefore flows are not realised on adjacent elements in the direction variation in temperature (direction R).

This phenomenon is not found on, because is balanced by 1/r.

10.3 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System UNICOS:
8.04
Obstruction memory:
8 megawords
Time CPU To use:
5.8 seconds

---

11 Modeling E

11.1 Characteristics of modeling

AXIS-FOURIER (TRIA3)

y (Z)

50 subdivisions in R
R Z node
To 0. 0. N1
G
D
B 1. 0. N151
E
C 1. 0.5
N152
D 1. 1. N153
C
E 0. 1. N3
F 0.5
0. N76
X (R)
G 0.5
1. N78
With
F
B

The axes of description of the grid are X (R) and y (Z).

Mode - Fourier: 2 T (A) = 0.

S = 0.
on all the field
[BC]:
= 2.
[CD]:
H = 2. Text = 2.

11.2 Characteristics

grid

A number of nodes: 153
A number of meshs and types: 200 TRIA3

11.3 Functionalities
tested

Orders

Keys
“THERMAL” AFFE_MODELE “AXIS_FOURIER”
ALL
[U4.22.01]
AFFE_CHAR_THER TEMP_IMPO
NODE

[U4.25.02]
FLUX_REP
GROUP_MA

EXCHANGE
GROUP_MA

SOURCE
ALL

CALC_MATR_ELEM “RIGI_THER”
MODE_FOURIER
[U4.41.01]
CALC_VECT_ELEM “CHAR_THER”

[U4.41.02]
ASSE_MATRICE

[U4.42.02]
ASSE_VECTEUR

[U4.42.03]
FACT_LDLT

[U4.51.01]
RESO_LDLT

[U4.51.02]
CALC_CHAM_ELEM “FLUX_ELNO_TEMP”
MODE_FOURIER
[U4.61.01]

11.4 Remarks

The number of the mode of Fourier not affecting the loading, key word MODE_FOURIER is not necessary in order CALC_VECT_ELEM.

---

12 Results of modeling E

12.1 Values
tested

Identification Reference
Aster %
difference
T (B) 1. 0.9995 0.049
T (C) 1. 0.9999 7.103
T (D) 1. 1.0003 0.033
T (F) 0.25
0.2500 9.10-3
T (G) 0.25
0.2498 -0.077
R (B)
-2. -1.977
-1.14
R (C)
-2. -1.9819

0.90
R (D)
-2. -1.9856
0.72
R (F)
-1. -0.993
0.68
R (G)
-1. -1.007
0.68
(B)
2. 1.9992 -0.04
(C)
2. 2.0000 -
(D)
2. 2.0008 0.04
(F)
1. 1.0004 0.04
(G)
1. 0.9995 -0.05
Z (B)
0.
-4.10-3

Z (C)
0.
-4.10-3

Z (D)
0.
-4.10-3

Z (F)
0.
1.10-3

Z (G)
0.
1.10-3

12.2 Remarks

The bad precision recorded on R (B), R (C), R (D) is explained by the fact why B, C and D are nodes of the edge, therefore flows are not realised on adjacent elements in the direction variation in temperature (direction R).

This phenomenon is not found on, because is balanced by 1/r.

12.3 Parameters of execution

Version: 4.00.02

Machine: CRAY C90

System UNICOS:
8.04
Obstruction memory:
8 megawords
Time CPU To use:
6.1 seconds

---

13 Summary of the results

This problem is correctly solved:

· whatever the number of harmonic of Fourier,
· by the various types of elements (degree 1 or 2).

Organization (S): EDF-R & D /AMA

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
Document: V4.04.101

TPLV101 - Stationary thermics with condition
of exchange between walls in opposite

Summary:

This elementary test makes it possible to deal with stationary problem in thermics bringing into play two fields
separated by imposing a boundary condition of the type exchanges between walls.

For modelings presented here, the results obtained by Code_Aster are identical to the reference calculated analytically.

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/03/008/A

1
Problem of reference

1.1 Geometry

H
G
H
1
1
2
G2
D
D
1
C1
2
C2
L
J1
J2
I
I
1
2
Z
y
F1

F
E
2
1
E2
X
A1
B
With
1
2
B2
L
L
Height L = 3. m
Width I = 1. m

1.2
Material properties

Voluminal heat CP = 0.
Thermal conductivity K = 1.W/m°C

1.3
Boundary conditions and loadings

Outgoing flow through plan B1F1G1C1 identical to flow

entering through plan A2E2H2D2
Temperature imposed in A1
T = 0.°C
Temperature imposed in B2
T = 4.5°C
Normal flow imposed on plan B2F2G2C2
= 3.W/m2
Normal flow imposed on plans C1G1H1D1 and C2G2H2D2
= 6.W/m2
Normal flow imposed on plans E1F1G1H1 and E2F2G2H2
= 2.W/m2
Source imposed in field 1
S

1
Source imposed in field 2
s2

2
Reference solution

2.1
Method of calculation used for the reference solution

One has a simple analytical solution, since it is about exhiber a harmonic function and to adjust the source associated in each field:

· in field 1: T (X, y, Z) = T (1
With)
2
2
2
+ X + y + Z, (in the reference mark of A1 origin),
1
· in field 2: T (X, y, Z) = T (2
With)
2
2
2

+ X + y + Z, (in the reference mark of origin A
2
2).

One deduces the values from them from s1 and s2, s1 = 6. , s2 = 5.W/m3.

2.2
Results of reference

Temperatures at the points of plans B1F1G1C1 and A2E2H2D2

2.3
Uncertainty on the solution

Analytical solution.
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/03/008/A

Code_Aster ®
Version
6.4

Titrate:
TPLV101 - Stationary thermics with exchange between walls
Date:
03/06/03
Author (S):
Key ***J.P. LEFEBVRE***
:
V4.04.101-B Page:
4/8

3 Modeling
With

3.1
Characteristics of modeling

Modeling 2D:

D1

C
D
1
2
C2
N14
N33
N16
N36
N9
N28
N11
N31
N3
N22
N6
N26
N2
N19
With
With
1
B1
2
B

2
3.2
Boundary conditions and loadings

Outgoing flow through wall B1C1 identical to entering flow

through wall A2D2
Temperature imposed in A1
T = 0.°C
Temperature imposed in B2
T = 4.5°C
Normal flow imposed on wall B2C2
= 3.W/m2
Normal flow imposed on plans C1D1 and C2D2
= 6.W/m2
Source imposed in field 1
S
1

Source imposed in field 2
s2

3.3
Characteristics of the grid

6 QUAD8
36 nodes

3.4
Functionalities tested

Order
Key word factor
Simple key word
Argument

DEFI_MATERIAU THER
LAMBDA

CP

AFFE_CHAR_THER SOURCE

TEMP_IMPO

FLUX_REP

ECHANGE_PAROI

LIAISON_GROUP
STATIONARY THER_LINEAIRE TEMP_INIT
“YES”
INCREMENT

4
Results of modeling A

4.1 Values tested

Identification
Reference
Aster *%*
difference
Temperature
node N2 (B1) 1.00
1.00
0.0
N3 node
2.00
2.00
0.0
N6 node
1.25
1.25
0.0
N11 node

3.25
3.25
0.0
N9 node
5.00
5.00
0.0
N16 node
7.25
7.25
0.0
node N14 (C1) 10.00
10.00
0.0
node N19 (A2) 2.00
2.00
0.0
N22 node
3.00
3.00
0.0
N26 node
2.25
2.25
0.0
N31 node
4.25
4.25
0.0
N28 node
6.00
6.00
0.0
N36 node
8.25
8.25
0.0
node N33 (D2) 11.00
11.00
0.0

4.2 Remarks

The functions of form of element QUAD8 being of order 2, it is natural to obtain the solution of reference which is expressed in the form of a polynomial of order 2.

The command file deposited contains a list of moments and calls the order THER_LINEAIRE to carry out a transitory calculation which is not of interest, the coefficient of voluminal heat being taken equal to 0.

---

5 Modeling B

5.1 Characteristics of modeling

Modeling 3D:

B33
A22
A26
B21
B5
B13
A2

A30
B44
B1
A10
A35
B40
A39
B28
A7
A15
B8
A3
B4

5.2
Characteristics of the grid

6 HEXA20
88 nodes

5.3
Functionalities tested

Order
Key word factor
Simple key word
Argument

DEFI_MATERIAU
THER LAMBDA

CP

AFFE_CHAR_THER SOURCE

TEMP_IMPO

FLUX_REP

AFFE_CHAR_THER_F ECHANGE_PAROI

LIAISON_GROUP
THER_LINEAIRE
STATIONARY TEMP_INIT
“YES”
INCREMENT

6
Results of modeling B

6.1 Values
tested

Identification
Reference

Aster
% difference
Temperature
node A2 (B1) 1.00
1.00
0.0
node A3 (F1) 2.00
2.00
0.0
A7 node
3.00
3.00
0.0
A10 node
1.25
1.25
0.0
A15 node
2.25
2.25
0.0
A22 node
5.00
5.00
0.0
A26 node
3.25
3.25
0.0
A30 node
5.25
5.25
0.0
node A35 (G1) 11.00
11.00
0.0
A39 node
8.25
8.25
0.0
node B1 (A2) 2.00
2.00
0.0

node B4 (E2) 3.00
3.00
0.0
B5 node
3.00
3.00
0.0
B8 node
4.00
4.00
0.0
B13 node
2.25
2.25
0.0
B21 node
6.00
6.00
0.0
B28 node
5.25
5.25
0.0
node B33 (D2) 11.00
11.00
0.0
B40 node
9.25
9.25
0.0
B44 node
11.25
11.25
0.0

6.2 Remarks

The functions of form of element HEXA20 being of order 2, it is natural to obtain the solution of reference which is expressed in the form of a polynomial of order 2.

The command file deposited contains a list of moments and calls the order THER_LINEAIRE to carry out a transitory calculation which is not of interest, the coefficient of voluminal heat being taken equal to 0.

7
Summaries of the results

Two modelings with elements of order 2 lead in an exact way to the solution
analytical and the establishment of the boundary conditions of the type ECHANGE_PAROI validates.

Organization (S): EDF-R & D /AMA, CS IF

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
Document: V4.04.102

TPLV102 - Transport of heat by convection
in a parallelepiped

Summary:

This functionality was developed in the code in order to be able to test the nonsymmetrical matrices.

Stationary thermal calculation is carried out on elements of the quadrangle type to 4 nodes.

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V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/03/008/A

---

1 Problem of reference

1.1 Geometry

One considers the plane thermal problem of a square cavity (on side equal to 1) where heat propagate:

- *by convection (i.e the particles constituting the medium of the cavity move at a speed U supposed here constant); speed U is supposed to form an angle of 67.5° with axis X,*
- *by conduction.*

1.2 Material properties

One takes CP = 1
10 6
= -

from where a diffusivity = = -
10 6
CP

U. L
and as one takes U =
one has the Peclet number p =
= +
1
10 6
,

E

(L is the length
characteristic, here L = 1.).

1.3
Boundary conditions and loadings

On segments AB and BC, one imposes a temperature T = 1.

On segment AE, one imposes a temperature T = 0.

On the 2 other sides, one in the condition by defect, namely, one is with null flow.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that recommended by Hughes and Brooks in their article referred to bibliographical [bib1].

One can take as exact solution the field of temperature of the border projected upstream on *the border downstream according to the direction speed.*

2.2 Results of reference

One tests the temperatures on the border between points E and D.

2.3 Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
T.J.R. HUGHES, A. BROOKS "A multidimensional design with No crosswind diffusion" - T.J.R. HUGHES ED., Finite Element Methods for convection doninated flows, AMD vol. 34 (ASME, New York (1979)).

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/03/008/A

---

3 Modeling With

3.1 Characteristics of modeling

Modeling is plane: the grid consists of 100 square elements QUAD4 of equal sizes, and 50 elements SEG2 on the borders.

· the temperature of 0.0 is imposed on the GROUP_NO d2,
· the temperature equal to 1.0 is imposed on the GROUP_NO C1 and C4.

3.2 Characteristics of the grid

50 SEG2, 100 QUA4

3.3 Functionalities tested

Orders

AFFE_MODELE AFFE
MODELING "PLAN"
AFFE_CHAM_NO
SIZE
"DEPL_R"
AFFE_CHAR_THER CONVECTION SPEED
(AFFE_CHAM_NO)
MACRO_MATR_ASS MATR_ASS
OPTION
"RIGI_THER_CONV_D"
CALC_VECT_ELEM
OPTION
"CHAR_THER"

4
Results of modeling A

4.1 Values
tested

Identification Reference

Aster *%*
difference
T (N31) x=1.0
1.
1.0009
0.0009
T (N29) x=0.8
1.
0.9920
0.008
T (N27) x=0.6
1. 1.0495 0.0495
T (N25) x=0.4
1. 0.845 0.155
T (N23) x=0.2
0. 0.055 0.155
T (N1) x=0.
0. 0.
0.155

5
Summary of the results

Good nonsymmetrical matrix installation of for a plane thermal problem.

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
Document: V4.04.103

TPLV103 - Infinite cylinder in stationary thermics anisotropic

Summary:

This test the purpose of which relates to it thermal linear stationary and transitory be to test the anisotropy
cylindrical.

Two modelings are carried out:

· a first into voluminal,
· a second in plane 2D.

The results obtained are in perfect agreement with the analytical values.
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

Z0
Y0
C
B
1/4 of cylinder

G
F
E
With
I
0
H
D
X0

In the reference mark (X0, Y0, Z0), the points have as co-ordinates:

C (0; 2, 1)
D (2; 0; 0)
E (0; 2; 0)
F (1; 0; 1)
O (0; 0; 0)
To (2; 0; 1)
B (2; 2;)
1
G (0; 1; 1)
H (1; 0; 0)
I (0; 1; 0)

1.2
Material properties

Anisotropic material, direction privileged along the axes of the cylindrical reference mark (U, U, U
R

Z).

3
R = 1
= 0.5

Z = 3 W/°
m C

C = 2 J/m °C

1.3

Boundary conditions and loadings

face AFHD:
Temperature imposed on 100 °C
face CGIE:
Temperature with 0 °C
others faces:
Neumann

1.4 Conditions
initial

To make this stationary calculation, a transitory calculation is made for which the boundary conditions are
constants in time. This makes it possible to test elementary calculations of mass and rigidity intervening in the 1st member as well as 2nd.

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution.

Temperature varying linearly in.

in (R, Z)

T () [
= T (C) - T (A)] 2
+ T (A)

(A)
1
Y=-
T
1
2

=-
T C - T A.
R

R (A) [()
( )]

2.2
Results of reference

Temperatures at points A and B, flow following Y to point A.

100
T ()
To = 100
T ()
B = 50
(A) Y =
15.915
2

2.3
Uncertainty on the solution

Analytical solution.

2.4 References bibliographical

[1]
NR. RICHARD: “Development of the thermal anisotropy in the software Aster”, Note technique HM-18/94/0011.

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

---

3 Modeling With

3.1
Characteristics of modeling

diagram in time forced on 1 to test the calculation of the second member in transient.

3.2
Characteristics of the grid

Regulated in 250 HEXA8 (5 elements on the edges HD and DM, 10 elements on DF) by IDEAS.

3.3 Functionalities tested

Orders
Key word factor
Single-ended spanner word
Argument
DEFI_MATERIAU
THER_ORTH
AFFE_CARA_ELEM
SOLID MASS
ANGL_AXE
(0. , 90.)
SOLID MASS
ORIG_AXE
(0. , 0. , 0.)
THER_LINEAIRE
--
PARM_THETA
0.8
--
CARA_ELEM
CALC_CHAM_ELEM
--
CARA_ELEM
--
OPTION
“FLUX_ELNO_TEMP”

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
T (A) * N1
100
100
0
T (B) N133
50

50
0
R () R
WITH Y
15.9155 15.950
0.22

**: imposed temperature*

4.2 Remarks

The symmetry of the grid makes that the solution T with the nodes of the network is exact, but in elements, the extrapolated solution is not exact.

Flow is calculated by Aster at the points of integration of the elements then deferred to the nodes by extrapolation. As flow is not uniform, this extrapolation involves a difference enters calculation and reference.

---

5 Modeling B

5.1 Characteristics of modeling

Similar to the modeling A, but solved in plan HIED.

5.2
Characteristics of the grid

Grid IDEAS with 50 QUAD4 and 66 nodes.

5.3 Functionalities
tested

Orders
Key word factor
Single-ended spanner word
Argument
DEFI_MATERIAU
THER_ORTH
AFFE_CARA_ELEM
SOLID MASS
ORIG_AXE
(0. , 0.)
THER_LINEAIRE
--
PARM_THETA
0.8
--
CARA_ELEM
CALC_CHAM_ELEM
--
CARA_ELEM
--
OPTION
“FLUX_ELNO_TEMP”

6
Results of modeling B

6.1 Values
tested

Identification Reference
Aster %

difference
*T (A) * N6*
100
100
0
T (B) N36
50
50
0
R () R
WITH Y
15.9155 15.950
0.22

**: imposed temperature*

6.2 Remarks

The symmetry of the grid makes that the solution T with the nodes of the network is exact. But in elements, the extrapolated solution is not exact.

Flow is calculated by Aster at the points of integration of the elements then deferred to the nodes by extrapolation. As flow is not uniform, this extrapolation involves a difference enters calculation and reference.

7

Summary of the results

Key words ANGL_AXE and ORIG_AXE introduced into order AFFE_CARA_ELEM are tested in 3D and plane 2D for an anisotropic problem of thermics.
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
Document: V4.04.105

TPLV105 - Stationary nonlinear thermics in

locate mobile: simulation of the Varestrain test

Summary:

This test presents thermal simulation by finite elements of the Varestraint test. This test of weldability is
employee to characterize resistance to the hot cracking of materials.

This test makes it possible to test a nonlinear thermal problem formulated in a pointer under condition of
stationnarity.

In this test only one modeling is carried out, it acts of a thermal modeling PLAN associated with operator THER_NON_LINE_MO allowing to calculate the nonlinear stationary response with one mobile loading.

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
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1
Problem of reference

1.1 Geometry

The studied geometry is a 200 mm length parallelepipedic plate, of 60 mm width and 7 mm thickness.

Torch TIG
Feel displacement
torch

Thickness
Width of
Length of
test-tube
the test-tube
the test-tube
7 mm
60 mm
200 mm

1.2
Properties of material

The material considered is a forged austenitic stainless steel of 316L type (Z2CND17-12).

For nonlinear thermal modeling thermal conductivity and the product density heat-storage capacity C vary according to the temperature. Their values are given in table below:

T

C

Temperature (°C)
Thermal conductivity
(J/(
3
mm C
°))
Enthalpy
(W/(mm C
°))
(
3
J/mm)
20
14.0 E-3
36.00 E-4
0.0

50 14.4
E-3

100
15.2 E-3
39.05 E-4

150 15.8
E-3

200
16.6 E-3
41.63 E-4

250 17.3
E-3

300
17.9 E-3
43.00 E-4

350 18.6
E-3

400
19.2 E-3
43.90 E-4

450 19.9
E-3

500
20.6 E-3
44.50 E-4

550 21.2
E-3

600
21.8 E-3
44.95 E-4

650 22.4
E-3

700
23.1 E-3
45.80 E-4
2.979
750 23.7
E-3

800
24.3 E-3
47.80 E-4

900
26.0 E-3
49.00 E-4

1000
27.3 E-3
49.90 E-4

1200
29.9 E-3
50.40 E-4

1370
32.2 E-3
50.40 E-4
6.232
1400
48.9 E-3
50.40 E-4
8.184
1450 8.444

Thermal conductivity
0.06
)
^{2}
/
°
C
0.05
m
/
m

W
0.04
I
that (
m
0.03
0.02
T
I
v
I
T
é
T
her
0.01
onduc
C
0
0
200
400
600
800
1000
1200
1400
1600
Temperature (°C)

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/04/005/A

Code_Aster ®
Version
6.4

Titrate:
TPLV105 - Stationary nonlinear thermics in pointer
Date:
11/05/04
Author (S):
C. DURAND, F. LEBOUVIER Key

:
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density X specific heat
0.0050
0.0048
)
0.0046
C
/.°
m
0.0044
J
/m
p
(
0.0042
R
H
O
C
0.0040
0.0038
0.0036
0
200
400
600
800
1000
1200
1400
1600
Temperature (°C)

Enthalpy
9
8
7
2

)
m
6
J
/
m
5
E (
pi
4
T
hal
N
3
E
2
1
0
0
200
400
600
800
1000
1200
1400
1600
Temperature (°C)

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1.3
Boundary conditions

The parameters of welding are presented in the table below:

V
I
U
(Tape speed
Diameter of electrode
(Intensity)
(Voltage)
part)
200A
13V
14 cm/min
3 mm

The upper surface of the plate is subjected to the action of a torch. This torch is placed at center plate, to 15 mm of the edge, and parallel to moves its length at constant speed (14cm/min) until 85.5mm of the edge corresponding to the position of extinction of the torch.

1.4 Conditions
initial

None.

2
Reference solution

2.1
Method of calculation

Method of calculation of the density flux constant to impose, boundary conditions imposed, as well as the test results are presented in [bib1].

2.2
Sizes and results of reference

Temperatures on the higher and lower face of the plate close to the torch

2.3 References
bibliographical

[1]
D. BUI: "Thermal Simulations by finite elements of the Varestraint test", Note HI74/97/09

V4.04.105-A Page:
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3 Modeling
With

3.1
Characteristics of modeling

Y Modeling "PLAN" (QUAD8):
WITH LSUP B
I LSUP J X
DC1
DC2

LINF
82. mm

90. mm

Central zone of the grid
Torch

B LZA I

The center of the torch is placed has x=86. mm of the left edge.

Boundary conditions:

· Côté DC1: adiabatic condition (flux=0)
· Côté DC2: imposed temperature 20°C
· Surface upper LSUP: this part is made up on the sides AB and IJ
- Nonlinear Flow imposed QINOX (see table and figure below)
- Convectif Exchange: H = 15x10-6 W (mm ². °C), Text= 20°C.
· Lower Surface: LINF
- Nonlinear Flow imposed QINOX (see table and figure below)
- Convectif Exchange: H = 15x10-6 W (mm ². °C), Text= 20°C.
· Tape speed of the V=-2.33mm/s part

Loading: Density flux brought by the torch
· Density flux imposed Q=19.62 W/mm ² on the with dimensions LZA (B I)

Temperature

QINOX
Temperature
QINOX
(°C)
Nonlinear flow
(°C)
Nonlinear flow
(W/mm ²)
(W/mm ²)
20 0.00E+00
800 -7.96E-02
100 -1.76E-03

900 -1.08E-01
200 -5.04E-03

1000 -1.46E-01
300 -9.80E-03

1100 -1.92E-01
400 -1.63E-02

1200 -2.48E-01
500 -2.59E-02

1300 -3.17E-01
600 -3.89E-02

1400 -3.99E-01
700 -5.64E-02

1500 -4.97E-01

Non-linear flow (QINOX)
0
200
400
600
800
1000 1200 1400 1600
0
-0.1
2
) -0.2
m
/m
W -0.3
X
(
L
U
F -0.4
-0.5
-0.6
Temperature (°C)

3.2
Characteristics of the grid

A number of meshs: 144 (QUAD8)
A number of nodes: 565

3.3 Functionalities
tested

Orders

DEFI_MATERIAU
THER_NL LAMBDA
BETA

AFFE_MODELE AFFE
“THERMAL” PHENOMENON
MODELING
“PLANE”
AFFE_CHAR_THER_F
TEMP_IMPO GROUP_NO
TEMP

FLUX_NL
GROUP_MA

FLUN

EXCHANGE
GROUP_MA

COEF_H

TEMP_EXT

FLUX_REP
GROUP_MA

FLUN

CONVECTION
SPEED

THER_NON_LINE_MO CONVERGENCE
CRIT_TEMP_RELA

CRIT_ENTH_RELA

ITER_GLOB_MAXI

TEMP_INIT

MODEL

CHAM_MATER

EXCIT

3.4
Sizes tested and results

Identification
Size Reference
Aster
% Difference

(°C)
(°C)
N1 (X=82, Y=0)
TEMP
1755.0
1756.11
0.063
N2 (X=83, Y=0)
TEMP
1920.0
1919.29
0.037
N3 (X=84, Y=0)
TEMP
1910.0

1908.63
0.072
N7 (X=88, Y=0)
TEMP
1494.0
1493.46
0.036
N8 (X=89, Y=0)
TEMP
1300.0
1297.51
0.191
N173 (X=46.93, Y=0)
TEMP
1160.0
1155.76
0.365
N174 (X=57.36, Y=0)
TEMP
1215.0
1213.32
0.139
N175 (X=67.79, Y=0)
TEMP
1295.0
1291.86
0.243
N478 (X=10.43, Y=-7)
TEMP
1007.0
1001.09
0.587
N522 (X=52.14, Y=-7) TEMP
989.0
982.39
0.668
N559 (X=0, Y=-7)
TEMP
980.0
973.92
0.621

3.5 Remarks

In the table below we present the position of the nodes in the reference mark (xy) of the torch.

Nodes located
Nodes located on the left of
Nodes located on the left of
under the torch (Zone 1)
torch (Zone 2)
torch and in lower part of
plate (Zone 3)
N1: x=-4 mm, y=0
N173: X = -39.0 mm, y=0
N478: X = -86.0 mm
N2: x=-3 mm, y=0
N174: X = -28.6 mm, y=0
N522: X = -81.0 mm
N3: x=-2 mm, y=0
N175: X = -18.2 mm, y=0
N559: X = -18.2 mm
N7: x= 2 mm, y=0

N8: x= 3 mm, y=0

Y
y
Center torch
Zone 1
Zone 2
X
X
Zone 3

Version
6.4

Titrate:
TPLV105 - Stationary nonlinear thermics in pointer
Date:
11/05/04
Author (S):
C. DURAND, F. LEBOUVIER Key
:
V4.04.105-A Page:
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Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/04/005/A

Code_Aster ®
Version
4.0
Titrate:
Stationary nonlinear Thermal TPLV106 in pointer

Date:
07/12/98
Author (S):
F. WAECKEL, B. NEDJAR
Key:
V4.04.106-A Page:
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Organization (S): EDF/IMA/MMN
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
Document: V4.04.106

TPLV106 - Stationary nonlinear thermics
in pointer

Summary:

This elementary test makes it possible to treat a reducible three-dimensional example with a problem a variable of space in stationary nonlinear thermics in pointer (problem of convection-diffusion).
It also makes it possible to check the taking into account of a solid phase shift/liquid by Code_Aster.
The reference solution is analytical and the variations with the results obtained by Code_Aster are lower to 1%. The problem is modelled in the plane case.

1
Problem of reference

1.1 Geometry

That is to say a bar moving, at the speed V, the right of conditions of temperatures imposed in X = 0 and X = L expressed in a fixed reference frame (compared to the bar moving).

TL = 1000°C
T T

1 = 585° C
T
T = 615°C
2
T0 = 200 °C
liquid phase
solid phase
X = L = 1 m
X = 0
V

1.2 Properties

materials

· thermal conductivity is constant: K = 150 W/m°C
· the function enthalpy is such as:

C
T
;
T T
S

1
(*T*) = *C*
T1 + *C*

-
;
1
1

S
sl (*T*
T)
T
T
T

2
C T1 + *C*
2 - 1 +
-
;
2

S
sl (*T*
T) *Cl* (*T T*)
T
T2
with the following values:
C = *C* = 1
7 *J*/m3°C
S
L
3 10
C = 8 333
.
107 *J*/m3° *C*
sl
T1 =
°
585 *C*
T2 =
°
615 *C*

(T) 8
J/m3
7
6
5
Cl = *Cs*
4
3
Csl
2
1
Cs
0 0
200
400
600
800
1000
1200
1400
1600
T°C
585
615

1.3
Boundary conditions and loadings

Temperatures imposed at the ends
T =
°C
for
X =

0
200
0
T = 1000° C for
X = L = 1m
L
Rate of travel of the solid: V = 104 m/s

---

2 Reference solution

2.1 Method of calculation used for the reference solution

The result of reference is of the semi-analytical type. The equation 1D to be solved is as follows:

V
(T), - KT
=
X
, xx
0

éq 2.1-1

with (T
= 0
=
$x=0$)
T *and* (
T $x=L$)
TL

by integrating the equation [éq 2.1-1] one obtains:
V (
dT
T) -
= *A*
éq 2.1-2
K
dx
V
where *A* is a constant depending on the boundary conditions, of the report/ratio
and of the function
K
enthalpy (*T*).
This constant will be analytically given.
The equation [éq 2.1-2] led to:
(
T X)

dT
X =

éq 2.1-3
V

With +
(*T*)
T0
K
who must check:
TL

dT
L =

éq 2.1-4
V
WITH + (*T*)
T0
K
Knowing *T T*, *L V*
, *T* and (*T*)
0, *L*
, the equation [éq 2.1-4] must give the value of the constant
of integration *A*.

However, it is difficult (even impossible) to determine this constant analytically, from where resort to a numerical resolution of the equation [éq 2.1-4] to determine *A*.

With the facts of the case (*T*, *T*, *T*, *T*, *C* = *C*, *C*…
0
L
1
2
S
L
sl
), we obtained the solution
(physics) of *A* which takes the value *A* = 294,9117.

From this constant, the analytical solution of the problem [éq 2.1-1] is analytical.

2.2 Results of reference

X-coordinate	**Temperature**
0.6	387.98514
0.7	451.51001
0.725	469.72232
0.750	488.97505
0.775	509.32766

0.80
530.84296
0.825
553.58738
0.85
577.63114
0.9
683.71269
0.9125
719.51615
0.925
756.32221
0.9375
794.16795
0.95
833.07971
0.9625
873.08751
0.9750
914.22222
0.9875
956.51557

3 Modeling
With

3.1
Characteristics of modeling

Modeling 2D

3.2
Characteristics of the grid

80 QUAD8

3.3 Functionalities
tested

Orders
Key word factor
Single-ended spanner word
Argument
Keys

DEFI_MATERIAU
THER_NL
LAMBDA
[U4.23.01]
BETA
THER_NON_LINE_MO

CONVERGENCE
CRIT_TEMP_RELA:
1.E-4
[U4.33.04]
CRIT_ENTH_RELA:
1.E-4
ITER_GLOB_MAXI:
130
MODEL
CHAM_MATER
EXCIT
CHARGE

---

4 Results of modeling A

4.1 Values tested

Identification	**Reference**	**Aster**	**% difference**
Temperature			
N80 (X = 0.9875)	956.515	956.884	+0.039
N79 (X = 0.9750)	914.222		

914.888
+0.073
N78 (X = 0.9625)
873.087
873.982
+0.103
N77 (X = 0.9500)
833.079
834.137
+0.127
N76 (X = 0.9375)
794.167
795.326
+0.146
N75 (X = 0.9250)
756.322
757.235
+0.159
N74 (X = 0.9125)
719.516
720.701
+0.165
N73 (X = 0.9000)
683.712
684.834
+0.164
N69 (X = 0.8500)
577.631
576.682
0.164
N67 (X = 0.8250)
553.587
553.507
0.014
N65 (X = 0.8000)
530.842
531.519
+0.128
N63 (X = 0.7750)
509.327
510.657
+0.261
N61 (X = 0.7500)

488.975
490.865
+0.387
N59 (X = 0.7250)
469.722
472.086
+0.503
N57 (X = 0.7000)
451.510
454.270
+0.611
N44 (X = 0.6000)
387.985
391.676
+0.951

4.2 Parameters of execution

Version: 4.0.5
Machine: CRAY C90
Obstruction memory:
8 MW
Time CPU To use:
59 seconds

5 Summary of the results

The results are very satisfactory with variations with the reference solution lower than 1%.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
V4.04.304 document

TPLV304 - Distribution of the temperature in one bar square section

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It aims to validate the voluminal thermal elements under conditions of convection and of imposed temperature.

The reference solution is based on an analytical approach.

1
Problem of reference

1.1 Geometry

Z
L = 203.2 x10-3 m
B = 25.4 x10-3 m
Tw
X
H, Your
B
L
B
Y

1.2
Properties of material

= 43.2675 W/m.°C
Thermal conductivity

1.3
Boundary conditions and loadings

· temperature imposed on the face y =0 Tw = 37.78 °C,
· = 0 on the face y = L,
· convection on the others faces:
-

H = 5.678 W/m2 °C,
- Your = -17.78 0°C.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The original reference solution given in the book [bib1] is based on an analytical approach. This reference is quoted in the handbook of checking of ANSYS [bib2]

2.2
Results of reference

Temperature on the face y = L

2.3
Uncertainty on the solution

Unknown factor, it was not possible to get the original reference (delivers old, more published).

2.4 References
bibliographical

[1]
ANSYS: "Checking manual", 1st edition, June 1, 1976
[2]
Kreith, F., "Principles of heat transfer", International Textbook Co., Scranton, Pennsylvania, 2nd Printing, 1959.

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3 Modeling
With

3.1
Characteristics of modeling

3D (HEXA27)

Z
D
H

y
E
Face BFGC:
With
C
G
N102 N104 N103
N100
N108
N101
Limiting conditions:
B
X
F
N97
N99
N98
- face AEHD
T = 37.78°C
- face BFGC
= 0
- faces ABCD, ABFE,
H = 5.678 W/m ² °C
EFGH, DCGH
Text = -17.78 °C

3.2 Characteristics of the grid

A number of nodes:
153
A number of meshs and types: 8 HEXA27 (and 32 QUAD9)

3.3 Functionalities tested

Orders

AFFE_MODELE

THERMICS
3D
ALL

AFFE_CHAR_THER
TEMP_IMPO

EXCHANGE

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

3.4 Remarks

Voluminal heat CP does not intervene in this test, but must be declared for Code_Aster. One CP = 1.0 J/m3 °C takes.

The condition limits = 0. is implicit on the free edges.

4

Results of modeling A

4.1 Values
tested

Identification Reference
Aster
Relative variation (%)
Absolute deviation (°C)

difference tolerance difference tolerance
Temperature
(°C)

at the end of the bar

Y
=
L
20.329

B N97
20.329
20.295
-0.166
1%
-0.0338
0.5
medium BF
N99

20.329
20.327
-0.010
1%
-0.0021
0.5
F N98
20.329
20.295
-0.166
1%
-0.0338
0.5
medium FG
N101
20.329
20.327
-0.010
1%
-0.0021
0.5
G N103
20.329
20.295
-0.166
1%
-0.0338
0.5
medium GC
N104
20.329
20.327
-0.010
1%
-0.0021
0.5
C N102
20.329
20.295
-0.166
1%
-0.0338
0.5

medium CB
N100
20.329
20.327
-0.010
1%
-0.0021
0.5
medium of the face
N108
20.329
20.359
0.146
1%
0.0297
0.5

4.2 Remarks

The small differences which remain correspond to a variation in temperature in the section observed. What is in conformity with the modelled physical phenomenon.

4.3 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.09 seconds
Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

5
Summary of the results

The results obtained are very satisfactory, the maximum change is -0.166%. Principal interest of it test is to check mesh HEXA27.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
V4.04.305 document

TPLV305 - Heat gradient in a cylinder
(Fourier)

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It validates the thermal axis_fourier and voluminal elements with for boundary conditions of the temperatures
imposed according to a harmonic function (mode 1).

It comprises two modelings, one 3D and the other using of the thermal elements axis_fourier.

The interest of this test is the validation of the thermal elements axis_fourier and the order COMB_CHAM_NO.

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:

TPLV305 Heat gradient in a cylinder (Fourier)

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.04.305-A Page:
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1
Problem of reference

1.1 Geometry

Z
D
J
I
H
C
ro
y
O
1.524
With
E
F
G
B
y
Z
r0 = 6.096 m

1.2
Properties of material

= 1.7307 W/m.°C
Thermal conductivity

1.3 Boundary conditions and loadings

The limiting condition is applied to the external surface of the cylinder, it breaks up into:

· a symmetrical limiting condition of revolution associated with harmonic 0:
CL1: T0 = -17.778°C
· a symmetrical limiting condition compared to associated harmonic 1:
CL2: T1 cos = 44.444 cos (°C)

T0
y
O
y
- T1
O

T1
X
X
T0 T1 cos

1.4 Conditions initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The original reference solution given in the book [bib1] is based on an analytical approach.
This reference is quoted in the handbook of checking of ANSYS [bib2]

2.2
Results of reference

· Température at the points A, E, F, G, B for mode 0 (CL1),
· Température at the points A, E, F, G, B mode 0 and mode 1 recombined (CL1+CL2) for = 0°, 45°, 90° and 180°.

2.3
Uncertainty on the solution

Unknown factor, it was not possible to get the original reference (delivers old, more published).

2.4 References bibliographical

[1]
Kreith, F., "Principles of heat transfer", International Textbook Co., Scranton, Pennsylvania, 2nd Printing, 1959.
[2]
ANSYS: "Checking manual", 1st edition, June 1, 1976

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3 Modeling
With

3.1
Characteristics of modeling

AXIS_FOURIER (QUAD4)

y (Z)
D
J
I
H
C
1.5
X (R)
With
E
F
G
B
Limiting conditions:
Points
X
nodes
With
0.000
N1, N2
- dimensioned AB, CD = 0
E
1.524

N3, N4
- dimensioned BC
F
3.048
N5, N6
. mode 0 T = -17.778
G
4.572
N7, N8
. mode (0 +1) T = -17.778 +44.444 cos
B
6.096
N9, N10

3.2
Characteristics of the grid

A number of nodes:
10
A number of meshs and types: 4 QUAD4

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
AXIS_FOURIER
ALL

AFFE_CHAR_THER
TEMP_IMPO

CALC_MATR_ELEM
RIGI_THER
MODE_FOURIER

CALC_VECT_ELEM

CHAR_THER

NUME_DDL
RENUM
“RCMK”

ASSE_MATRICE
MATR_ELEM
NUME_DDL

ASSE_VECTEUR
VECT_ELEM
NUME_DDL

FACT_LDLT
MATR_ASSE

RESO_LDLT
MATR_FACT
CHAM_NO

COMB_CHAM_NO
COMB_FOURIER
NUME_MODE
TYPE_MODE

ENG

COMB_R

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLV305 Heat gradient in a cylinder (Fourier)

Date:
20/09/02

4
Results of modeling A

4.1 Values
tested

Relative variation %
Absolute deviation
Identification Reference
Aster difference tolerance difference tolerance
Temperature
(°C)

CL1 (mode = 0)

N1, N2
-17.778
-17.778
0.000 1%
-1.14e-12
0.01
N3, N4
-17.778
-17.778
0.000 1%
-9.09e-13
0.01
N5, N6
-17.778
-17.778

0.000 1%
-6.82e-13
0.01
N7, N8
-17.778
-17.778
0.000 1%
-3.41e-13
0.01
N9, N10 *
-17.778
-17.778
0.000 1%
0.000e+0
0.01
CL1+CL2 (mode 0 and 1)

= 0° N1, N2
-17.778
-17.778
0.000 1%
-1.14e-12
0.01
N3, N4
-6.667
-6.667
0.000 1%
1.820e-8
0.01
N5, N6
4.444
4.444
0.000
1%
3.650e-8
0.01
N7, N8
15.556
15.555

-0.006
1%
-1.000e-3
0.01
N9, N10 * 26.667 26.666 -0.004
1%
-1.000e-3
0.01
= 45° N1, N2
-17.778
-17.778
0.000 1%
-1.14e-12
0.01
N3, N4
-9.921
-9.921
0.003 1%
-3.370e-4
0.01
N5, N6
-2.064
-2.065
0.033 1%
-6.730e-4
0.01
N7, N8
5.792
5.792
0.000
1%
-1.040e-5
0.01
N9, N10
13.649
13.649
-0.003
1%
-3.460e-4
0.01
= 90° N1, N2
-17.778
-17.778

0.000 1%
-1.14e-12
0.01
N3, N4
-17.778
-17.778
0.000 1%
-9.09e-13
0.01
N5, N6
-17.778
-17.778
0.000 1%
-5.68e-13
0.01
N7, N8
-17.778
-17.778
0.000 1%
-2.27e-13
0.01
N9, N10
-17.778
-17.778
0.000 1%
2.27e-13
0.01
= 180° N1, N2
-17.778
-17.778
0.000 1%
-1.14e-12
0.01
N3, N4
-28.889
-28.889
0.000 1%
-1.820e-8
0.01
N5, N6
-40.000
-40.000
0.000 1%

-3.650e-8
0.01
N7, N8
-51.111
-51.111
0.000 1%
1.040e-6
0.01
N9, N10
-62.222
-62.222
0.000 1%
2.27e-13
0.01

** imposed temperatures*

4.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory: 8 megawords
Time CPU To use: 3.12 seconds

Handbook of Validation
V4.04 booklet: Stationary thermics of the voluminal structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLV305 Heat gradient in a cylinder (Fourier)

Date:
20/09/02
Author (S):

5 Modeling
B

5.1
Characteristics of modeling

3D (PENTA6, HEXA8)

Z
=180°
N155
=90°
N273
N145
N265
N139
N274
N243
N133
N197
N266
N244
N123
N69
N49
N57
N65
N198
N53
=45°
X
N124
N17
N54
N5
N3
N18

z=0
z=1.524
N6
N70
N69
y
N4
45°
N50
N49
Limiting conditions:
N58
N57
N66
N65
- external face (N8, N155, N273)
N134
N133
T = -17.778 + 44.444 cos
90°
N140
N139

- face interns (N8, N123, N273)
N146
N145

N155
N154
= 0

5.2
Characteristics of the grid

A number of nodes:
274
A number of meshs and types: 128 (16 PENTA6, 112 HEXA8)

5.3 Functionalities
tested

Orders

AFFE_MODELE
AFFE
THERMICS
3D

AFFE_CHAR_THER
TEMP_IMPO

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

5.4 Remarks

Calculations were carried out by considering complete loading CL1+CL2:

Timp = -17.778 + 44.444 cos

6
Results of modeling B

6.1 Values tested

Relative variation %
Absolute deviation
Identification Reference
Aster difference tolerance difference tolerance
CL1+CL2

Temperature (°C)

= 0 N123, N124
-17.778
-17.778
0.000 1%
-3.330e-5
0.01
N53, N54
-6.667
-6.667
0.000 1%
1.330e-7
0.01
N17, N18
4.444
4.444
0.001
1%
2.840e-5
0.01
N5, N6
15.556
15.555
-0.006
1%
-9.730e-4
0.01
N3, N4* 26.667
26.666

-0.004
1%
-1.000e-3
0.01
= 45 N69, N70
-9.921
-9.921
0.003 1%
-3.460e-4
0.01
N49, N50
-2.064
-2.065
0.031 1%
-6.480e-4
0.01
N57, N58
5.792
5.792
0.001
1%
8.240e-5
0.01
N65, N66* 13.649
13.649 0.000 1%
-5.68e-13
0.01
= 90 N133, N134
-17.778
-17.778
0.000 1%
-3.750e-5
0.01
N139, N140
-17.778
-17.778
0.000 1%
-5.030e-5
0.01
N145, N146
-17.778
-17.778
0.000 1%

-6.990e-5
0.01
N155, N156*
-17.778
-17.778
0.000 1%
9.09e-13
0.01
= 180 N197, N198
-2.889
-2.889
0.000 1%
-6.440e-5
0.01
N243, N244
-40.000
-40.000
0.000 1%
-7.680e-5
0.01
N265, N266
-5.1111
-5.1111
0.000 1%
-5.210e-5
0.01
N273, N274*
-62.222
-62.222
0.000 1%
+6.82e-13
0.01

**** imposed temperatures***

6.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.19 seconds

7
Summary of the results

Two modelings carried out (AXIS_FOURIER and 3D) give excellent results, the variation maximum is -0.006% for two modelings

This test made it possible to test in AXIS_FOURIER order COMB_CHAM_NO with the operands following:

- *COMB_FOURIER to calculate the temperature in an angle given,*
- *COMB_R to carry out a linear combination of modes 0 and 1.*

TPLP01 Field in L with geometrical singularity

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.05.001-A Page:
1/8

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
V4.05.001 document

TPLP01 - Field in L with singularity
geometrical

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a problem plane 2D presenting two modelings, one planes, the second voluminal one.

***The objective is to validate, in the presence of a geometrical singularity, the plane thermal elements and 3D with
for boundary condition an imposed temperature.***

The results are compared with those provided by VPCS.

***Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A***

Code_Aster ®
Version
5.0

Titrate:
TPLP01 Field in L with geometrical singularity

Date:
20/09/02
Author (S):
***C. DURAND**, E. SCREW, F. LEBOUVIER Clé*
:
V4.05.001-A Page:
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1
Problem of reference

1.1 Geometry

0.8
F
E
0.4
0.2
0.8
C
D
0.2
With
B
0.4

Dimensions in meters

1.2
Properties of material

=
1. W/m.°C

thermal conductivity

1.3
Boundary conditions and loadings

· side [AF] imposed Temperature Tp = 10°C,
· side [OF] imposed Temperature Tp = 0°C,
· side [AB], [BC], [CD], [EF], flow = 0.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLP01/89 of guide VPCS.

2.2
Results of reference

Temperature at the points of a squaring of with dimensions 0.2m X 0.2m.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7
[2]
G.T. Symm-, National Physical Laboratory Division of Numerical Analysis and Computing, treatment of singularities in solution of Laplace' S equation by integral year equation method, NPL Carryforward NAC Jan 31, 1973.

3 Modeling
With

3.1
Characteristics of modeling

PLAN (QUAD8)

y
F
E
N23
N37
N45
Limiting conditions:
N21
N35
N43
- dimensioned AF:
T=10°C
- dimensioned:
T=0°C
- dimensioned AB, BC, CD, EF: =0
N19
N33
N41
C
D
N17
N31
X
N15
N29
With
B

3.2
Characteristics of the grid

A number of nodes:
53
A number of meshs and types: 12 QUAD8

3.3 Functionalities tested

Orders

AFFE_MODELE
THERMICS
PLAN
ALL

AFFE_CHAR_THER
TEMP_IMPO

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster difference
tolerance
Temperature (°C)

X = 0.2 y = 0.0 (N15)
9.316
9.283
-0.357
1%
y = 0.2 (N17)
9.001
9.108
1.186
1%
y = 0.4 (N19)
8.514
8.519
0.054
1%
y = 0.6 (N21)
8.018
8.015
-0.037
1%
y = 0.8 (N23)
7.869
7.883
0.177

1%

X = 0.4 y = 0.0 (N29)
9.009
8.961
-0.529
1%
y = 0.2 (N31)
8.640
8.669
0.334
1%
y = 0.4 (N33)
6.667
6.667
-0.005
1%
y = 0.6 (N35)
5.680
5.666
-0.254
1%
y = 0.8 (N37)
5.495
5.519
0.443
1%

X = 0.6 y = 0.4 (N41)
2.972
2.963
-0.310
1%
y = 0.6 (N43)
2.881
2.877
-0.132

1%
y = 0.8 (N45)
2.816
2.834
0.650
1%

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.25 seconds
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

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5 Modeling
B

5.1
Characteristics of modeling

3D (HEXA8)

y
L
N19
N30
N35
K
Limiting conditions:
N29
N36
F
N20
E
- face AGLF:
T=10°C
N18
N27
N34
- face DJKE:
T=0°C
- faces ABHG, BHIC:
=0
N17
N28
N33
- faces CDJI, FEKL:
=0
N16
I
N26
N31
J
N15
N25
N32
N13
C N24
D
Thickness = 0.2 m
N14
N23

G
N11
N21
H
N12
N22
X
With
B
Z

5.2
Characteristics of the grid

A number of nodes:
42
A number of meshs and types: 12 HEXA8

5.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
3D
ALL

AFFE_CHAR_THER
TEMP_IMPO

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

6
Results of modeling B

6.1 Values
tested

Identification Reference
Aster difference
tolerance
Temperature (°C)

X = 0.2 y = 0.0 (N11)
9.316
9.294
-0.239
1%
(N12)
9.316
9.294
-0.239
1%

y = 0.2 (N13)
9.001
9.015
0.160
1%
(N14)
9.001
9.015
0.160
1%
y = 0.4 (N15)
8.514
8.505
-0.108
1%
(N16)
8.514
8.505
-0.108
1%
y = 0.6 (N17)
8.018
8.025
0.093
1%
(N18)
8.018
8.025
0.093
1%
y = 0.8 (N19)
7.869
7.861
-0.096
1%
(N20)
7.869
7.861
-0.096
1%
X = 0.4 y = 0.0 (N21)
9.009
8.996

-0.139
1%
(N22)
9.009
8.996
-0.139
1%
y = 0.2 (N23)
8.640
8.661
0.247
1%
(N24)
8.640
8.661
0.247
1%
y = 0.4 (N25)
6.667
6.667
-0.005
1%
(N26)
6.667
6.667
-0.005
1%
y = 0.6 (N27)
5.680
5.669
-0.188
1%
(N28)
5.680
5.669
-0.188
1%
y = 0.8 (N29)
5.495
5.502
0.123
1%
(N30)

5.495
5.502
0.123
1%
X = 0.6 y = 0.4 (N31)
2.972
2.990
0.621
1%
(N32)
2.972
2.990
0.621
1%
y = 0.6 (N33)
2.881
2.959
2.712
1%
(N34)
2.881
2.959
2.712
1%
y = 0.8 (N35)
2.816
2.845
1.024
1%
(N36)
2.816
2.845
1.024
1%

6.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.00 seconds
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

7
Summary of the results

Two modelings give results whose certain values exceed the fixed tolerance
initially (1%):

· for modeling A (PLANE with meshs QUAD8), the maximum change is 1.19%
(going beyond for only one value out of the 13 tested),
· for modeling B (3D with meshs HEXA8), the maximum change is 2.7%
(going beyond for two values out of 26 tested).

The modeling of the geometrical singularity (presence of an important heat gradient close to singularity) is represented better with quadratic elements (modeling A).

For two modelings, the precision should be improved by using a finer grid
(more important refinement in the zone of the geometrical singularity).

The results are regarded as acceptable taking into account modelings carried out.

HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
Orthotropic Square TPLP02

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.05.002-A Page:
1/6

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
V4.05.002 document

TPLP02 - Orthotropic square

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a problem plane 2D represented by only one modeling (plane).

The functionalities tested are the use of plane thermal elements, of an orthotropic material, three limiting types of conditions:
- convection
-
linear variation of the outside temperatures,
- flow
imposed.

The results are compared with an analytical solution (VPCS).

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

has
Cubic of edge = 0.2 m has

Center cube = (0. , 0.)
Y
X
O

1.2
Properties of material

X = 1.0 W/m.°C
thermal conductivity along axis X
y = 0.75 W/m.°C thermal conductivity along the axis y

1.3
Boundary conditions and loadings

· density flux:

y = 60 W/m ²
face y = -0.1 (entering flow)
y = -60 W/m ²
face y = 0.1 (outgoing flow)

· convection on the faces X = -0.1 and X = 0.1: H = 15 W/m ² °C,

· linear variation of the outside temperatures:

- Text = 30 - 80y face X = -0.1,
- Text = 15 - 80y face X = 0.1.

1.4 Conditions
initial

Without object.

Titrate:

Orthotropic Square TPLP02

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.05.002-A Page:
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2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in card TPLP02/89 of guide VPCS

Analytical solution.

T (X, y, Z) = ax + by + D = -45x -80y + 22.5

D
G
C
Not T (°C)
Figure 0.1
O
22.5
With
35.0
Y
Figure 0.2
B
26.0
C
10.0
X
H
F
D
19.0

O
E
30.5
F
18.0
G
14.5
H
27.0
With
E
B
X = 45 W/m ² = constant
y = 60 W/m ² = constant

2.2
Results of reference

Temperature at the points located on the figure above.

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
Guide validation of the software packages of structural analysis. French company of Mechanics, AFNOR 1990 ISBN 2-12-486611-7
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

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3 Modeling With

3.1 Characteristics of modeling

PLAN (QUAD4)

y
D
N66 G
C
Limiting conditions:
N11
N121
m100
m96 m95
m91
- dimensioned AB y = 60 W/m ²
- dimensioned CD y = -60 W/m ²
- dimensioned BC H = 15 W/m ² °C
Text = 15-80y
- dimensioned AD H = 15 W/m ² °C
Text = 30-80y
m60
m56
m51 F

O
X
H
N6
N116
m50
N61 m45
m41
N1
m10
m6
m5
m1 N111
With
N56 E
B

3.2
Characteristics of the grid

A number of nodes:
121
A number of meshs and types: 100 QUAD4

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
PLAN
ALL

DEFI_MATERIAU
THER_ORTH

AFFE_CARA_ELEM
SOLID MASS

DEFI_FONCTION
NOM_PARA: “X”
NOM_PARA: “Y”

AFFE_CHAR_THER_F
EXCHANGE
FLUX_REP

THER_LINEAIRE
EXCIT
CARA_ELEM

CALC_CHAM_ELEM
CARA_ELEM
FLUX_ELNO_TEMP

4
Results of modeling A

4.1 Values tested

Identification Reference

***Aster** difference*
tolerance
Temperature °C

T (O) 22.5
22.5
0.0
1%
T (A) 35.0
35.0
0.0
1%
T (B) 26.0
26.0
0.0
1%
T (C) 10.0
10.0
0.0
1%
T (D) 19.0
19.0
0.0
1%
T (E) 30.5
30.5
0.0
1%
T (F) 18.0
18.0
0.0
1%
T (G) 14.5
14.5
0.0
1%
T (H) 27.0
27.0
0.0
1%
Flow
W/m ^{2}

X (A)
45.0 45.0 0.0 1%
X (H)
45.0 45.0 0.0 1%
X (D)
45.0 45.0 0.0 1%
X (B)
45.0 45.0 0.0 1%
X (F)
45.0 45.0 0.0 1%
X (C)
45.0 45.0 0.0 1%
y (A)
60.0 60.0 0.0 1%
y (E)
60.0 60.0 0.0 1%
y (B)
60.0 60.0 0.0 1%
y (D)
60.0 60.0 0.0 1%
y (G)
60.0 60.0 0.0 1%
y (C)
60.0 60.0 0.0 1%

4.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.40 seconds
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

5
Summary of the results

The results obtained are excellent. The computed values by Aster are identical to the values of reference. That is "a normally awaited" result since the field solution which is linear belongs to the space of interpolation of the element tested.

This test made it possible to test the following orders:

· DEFI_FONCTION associated with operand NOM_PARA, allowing to define a variation of outside temperature according to the X-coordinate or of the ordinate,
· DEFI_MATERIAU associated with key word THER_ORTH, allowing to define the characteristics of an orthotropic material,
· AFFE_CARA_ELEM associated with the MASSIVE key word, allowing to define the axes of orthotropism.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

***Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
V4.05.300 document***

TPLP300 - Rectangular plate: convection, imposed temperature

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a problem plane 2D represented by only one modeling (plane).

The functionalities tested are the use of plane thermal elements under conditions limit temperature imposed and of convection.

The results are compared with those provided by NAFEMS.

1
Problem of reference

1.1 Geometry

D
C
dimensions in meters
1.0
Y
E
X
0.2
With
B
0.6

1.2
Properties of material

= 52 W/m.°C
Thermal conductivity

1.3
Boundary conditions and loadings

· imposed temperature with dimensions [AB]: Tp= 100°C,
· density flux = 0 on the with dimensions one [DA],
· convection on the with dimensions ones [BC] and [CD],
-
H = 750 W/m ² °C,
- Text = 0°C.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The reference solution is that given in the card "TEST n° T4" of the tests of reference published by NAFEMS.

2.2

Results of reference

Temperature at the point E: T = 18.3 °C

2.3
Uncertainty on the solution

Nonavailable on card NAFEMS

2.4 References
bibliographical

[1]
NAFEMS (the National Agency for Finite Element Methods Standard and (the U.K.)): "The standard NAFEMS Benchmarcks ", TNSB rév 3, October 1990.

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3 Modeling
With

3.1
Characteristics of modeling

PLAN (QUAD4)

Boundary conditions:

y

n71 (D)

n77 (C)

- Dimensioned AB:

T

= 100°C

- Dimensioned BA:

=

0.

- Dimensioned BC, CD: Text = 0°C

H

= 750W/m ² °C

Points

X

Y

Nodes

E

0.6

0.2

N21

...

With

0.0

0.0

N1

n28

B

0.6

0.0

N7

n21 (E)

C

0.6

1.0

N77

D

0.0

1.0

N71

n14

X

N2 n3 n4 n5 n6

n1 (A)
n7 (B)

3.2
Characteristics of the grid

A number of nodes:
77
A number of meshs and types: 60 QUAD4 (16 SEG2)

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS
PLAN
ALL

AFFE_CHAR_THER
TEMP_IMPO

EXCHANGE
COEF_H

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster difference
tolerance
Temperature (°C)

At the point E: N21
18.3
17.954
-1.89
1%

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:

8 megawords
Time CPU To use: 1.84 seconds

5
Summary of the results

Modeling gives a result which exceeds the tolerance fixed initially. The maximum change obtained is 1.9%, to compare with the tolerance of 1%.

In this test, the heat gradients are more important close to the point B (imposed temperature and convection), a finer grid in this zone would improve quality of the results.

The results are regarded as acceptable taking into account the type of mesh (QUAD4) and of density of the grid used

The interest of this test is its origin NAFEMS.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
V4.05.301 document

TPLP301 - Square plate with imposed temperature distributed sinusoïdalement

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a problem plane 2D represented by two modelings, one planes, the second hull.

The functionalities tested are as follows:
· plane thermal element,
· thermal element hull,
· limiting conditions: sinusoidal distribution of the imposed temperature

The results are compared with an analytical solution.

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

Y
has = 1 m
D
C
I
H
Poin
Poi ts
T
X
Y
has
B
E
0,0
0. 1
5 0,0
0. 1
00
G
E
F
0,0
0. 1

5 0,0
0. 2
25
F
G
0,0
0. 1
5 0,0
0. 3
50
G
H
0,0
0. 2
5 0,0
0. 1
75
F
H
I
0,0
0. 2
5 0,0
1. 2
00
0,02 0,03
X
With
E
B
0,03 0,04
Tp = sin (X)

1.2
Properties of material

=
1. W/m.°C
Thermal conductivity

1.3
Boundary conditions and loadings

· side [AB]
imposed temperature Tp = sin (X),
· side [BC]
imposed temperature T0 = 0°,
· side [CD]
imposed temperature T0 = 0°,
· side [BA]
imposed temperature T0 = 0°.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

Analytical solution:

T (X, y) = sinh [(1.0 there)] sin (X) /sinh ()

2.2
Results of reference

Temperature at the points E, F, G, H, I

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
W.K. Liu, T. Belytschko, "Efficient linear and nonlinear heat conduction with has quadrilateral element ", Int. J. num. Meth. Engng, flight 20, n°5, pp 931-948, 1984.

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3 Modeling
With

3.1
Characteristics of modeling

HULL (TRIA3)

y
0.5
n17 (D)
n153 (I)
Limiting conditions:
- dimensioned AE
T= sin (X)
n149 (H)
- dimensioned JD, DA T= 0°C
- dimensioned EJ:
= 0
n145 (G)
Not
X
y
Node
E
0.5
0.
n137
F
0.5
0.25
n141
n141 (F)
G
0.5
0.5
n145
H
0.5
0.75
n149
I
0.5
1.
n153
n1 (A)
n137 (E)
n1

n35
n69
n103
n137
X
n18
n52
n86
n120

3.2
Characteristics of the grid

A number of nodes:
153
A number of meshs and types: 256 TRIA3

3.3 Functionalities
tested

Orders

AFFE_MODELE
THERMICS

HULL

AFFE_CHAR_THER
TEMP_IMPO
TEMP_SUP, TEMP
TEMP_INF

AFFE_CARA_ELEM
HULL

THER_LINEAIRE
CARA_ELEM
EXCIT

RECU_CHAMP
NUME_ORDRE

3.4 Remarks

The imposed temperature, distributed sinusoïdalement on AE, entered node by node.

The data of voluminal heat CP is obligatory for Code_Aster (although without influence in this simulation). One takes CP = 1. J/m3 °C.

The condition limits = 0. is implicit on the free edges.

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster difference
tolerance
Temperature (°C)

E Node n137 skin inf.
1.0
1.00000
0.00%*
1%
E Node n137 skin moy.
1.0
1.00000
0.00%*
1%
E Node n137 skin sup.
1.0
1.00000
0.00%*
1%
F Node n141 skin inf.
0.45269
0.45379
0.24%
1%
F Node n141 skin moy.
0.45269
0.45379
0.24%
1%
F Node n141 skin sup.
0.45269
0.45379
0.24%
1%
G Node n145: skin inf.
0.19927
0.20019
0.46%
1%
G Node n145: skin moy.
0.19927
0.20019
0.46%
1%
G Node n145: skin sup.
0.19927

0.20019
0.46%
1%
H Node n149: skin inf.
0.07522
0.07569
0.63%
1%
H Node n149: skin moy.
0.07522
0.07569
0.63%
1%
H Node n149: skin sup.
0.07522
0.07569
0.63%
1%
I Node n153: skin inf.
0.0
0.00000
-2.E17*
1.E4
I Node n153: skin moy.
0.0
0.00000
2.E17*
1.E4
I Node n153: skin sup.
0.0
0.00000
1.E17*
1.E4

4.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:

8 megawords
Time CPU To use: 2.36 seconds
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

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5 Modeling
B

5.1
Characteristics of modeling

PLAN (TRIA3)

y
0.5
n17 (D)
n153 (I)
Limiting conditions:
- dimensioned AE
T= sin (X)
n149 (H)
- dimensioned JD, DA T= 0°C
- dimensioned EJ:
= 0
n145 (G)
Not
X
y
Node

E
0.5
0.
n137
F
0.5
0.25
n141
n141 (F)
G
0.5
0.5
n145
H
0.5
0.75
n149
I
0.5
1.
n153
n1 (A)
n137 (E)
n1
n35
n69
n103
n137
X
n18
n52
n86
n120

5.2
Characteristics of the grid

A number of nodes:
153
A number of meshs and types: 256 TRIA3

5.3 Functionalities tested

Orders

AFFE_MODELE
THERMICS
PLAN
ALL

AFFE_CHAR_THER
TEMP_IMPO

THER_LINEAIRE
EXCIT
CHARGE

5.4 Remarks

The data of voluminal heat CP is obligatory for Code_Aster (although without influence in this simulation). One takes CP = 1. J/m3 °C.

The condition limits = 0. is implicit on the free edges.

6
Results of modeling B

6.1 Values
tested

Identification Reference
Aster difference
tolerance
Temperature (°C)

E: Node n137
1.0
1.00000
0.00%*
1%
F: Node n141
0.45269
0.45379
0.24%
1%
G: Node n145
0.19927
0.20019
0.46%
1%
H: Node n149
0.07522
0.07569
0.63%
1%
I: Node n153
0.0
0.00000
-1.E17*
1.E4

6.2 Parameters of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.05 seconds

---

7 Summary of the results

2 modelings carried out, HULL and PLAN with meshs TRIA3 give results satisfactory, the maximum change obtained is 0.63%. Results found for two modelings are identical. The interest of this test is to compare the results obtained with an analytical solution.

Titrate:
TPLP302 Plates rectangular with imposed temperature

Date:
20/09/02
Author (S):
C. DURAND, E. SCREW, F. LEBOUVIER Clé
:
V4.05.302-A Page:
1/6

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
V4.05.302 document

TPLP302 - Rectangular plate with temperature
imposed

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a problem plane 2D represented by a modeling hull.

The functionalities tested are as follows:
· thermal element hull,
· limiting conditions: imposed temperature.

The results are compared with an analytical solution.
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

1
Problem of reference

1.1 Geometry

Y
L
D
C
L = 0.2 m
L = 2 m
has
= 0.05m has
has
Points
X
Y
E

0.05 0.05
K
L
F
0.05 0.10
G
J
G
0.05 0.15
H
0.10 0.05
F
I
I
0.10 0.10
J
0.10 0.15
E
H
K
0.10 0.20
X
With
B

1.2
Properties of material

=
1 W/m °C
Thermal conductivity

1.3
Boundary conditions and loadings

· Imposed Température:
-
dimensioned [BC] and [AD] T = 0°C,
-
dimensioned [AB] T = 100°C.

· Imposed Flux:
-
dimensioned [CD] = 0

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

4T

[- (2n+1) y/l]
p
E
(2n +)
1 X
T (X, y) =

.sin

2n + 1

L

N =0

where X
: X-coordinate
y
:
ordinate

Tp: temperature imposed on the with dimensions one [AB]

N = 0,1,2,3,…

The values of reference are obtained with N = 1000

2.2
Results of reference

Temperature at the points E, F, G, H, I, J, K

2.3
Uncertainty on the solution

Analytical solution.

2.4 References
bibliographical

[1]
J.R. Welty, E.C. Wicks, R.E. Wilson, "Fundamentals of momentum heat and mass transfer",
third edition, John Wiley & Sounds, 1983.
Handbook of Validation

3 Modeling
With

3.1
Characteristics of modeling

HULL (TRIA6)

y
Limiting conditions:
D
M
- dimensioned Al
= 100°C
- dimensioned AD
= 0°C
.1
- dimensioned LM
= 0
- dimensioned DM
= 0
2.
Points
X
Y
Nodes
E
0.05 0.05

N21
F
0.05 0.10
N39
G
0.05 0.15
N57
H
0.10 0.05
N23
I
0.10 0.10
N41
J
0.10 0.15
N59
X
K
0.10 0.20
N77
With
L
Cutting:
- 4 elements
according to X
- 40 elements
according to y

3.2
Characteristics of the grid

A number of nodes:
729
A number of meshs and types: 320 TRIA6

3.3 Functionalities
tested

Orders

AFFE_MODELE

THERMICS
HULL
ALL

AFFE_CHAR_THER_F
TEMP_IMPO
TEMP_SUP
TEMP_INF

TEMP

THER_LINEAIRE
CARA_ELEM

EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

3.4 Remarks

Limiting conditions, T = 100°C on AB, and T = 0°C on AD, are incompatible at point A. It Code_Aster applies a "law of overload" which, in this case, consists in taking into account last condition limits entered. The order of assignment of the imposed temperatures thus has large influence on the results obtained.

In the treated case, the temperature assigned to point A is of 0°C.

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster difference
tolerance
Temperature (°C)

N21 (surface_supérieure) 43.496
43.499
0.007
1%
N21 (surface_moyenne) 43.496
43.499
0.007
1%
N21 (surface_inférieure) 43.496
43.499
0.007
1%
N39 (surface_supérieure) 18.978
18.957
-0.112
1%
N39 (surface_moyenne) 18.978
18.957
-0.112
1%
N39 (surface_inférieure) 18.978
18.957

-0.112
1%
N57 (surface_supérieure) 8.559
8.554
-0.057
1%
N57 (surface_moyenne) 8.559
8.554
-0.057
1%
N57 (surface_inférieure) 8.559
8.554
-0.057
1%
N23 (surface_supérieure) 54.467
54.514
0.087
1%
N23 (surface_moyenne) 54.467
54.514
0.087
1%
N23 (surface_inférieure) 54.467
54.514
0.087
1%
N41 (surface_supérieure) 26.096
26.096
-0.001
1%
N41 (surface_moyenne) 26.096
26.096
-0.001
1%
N41 (surface_inférieure) 26.096
26.096
-0.001
1%
N59 (surface_supérieure) 12.032
12.025
-0.061
1%
N59 (surface_moyenne) 12.032

12.025
-0.061
1%
N59 (surface_inférieure) 12.032
12.025
-0.061
1%
N77 (surface_supérieure) 5.499
5.496
-0.063
1%
N77 (surface_moyenne) 5.499
5.496
-0.063
1%
N77 (surface_inférieure) 5.499
5.496
-0.063
1%

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 3.19 seconds
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TPLP302 Plates rectangular with imposed temperature

Date:
20/09/02

5
Summary of the results

Modeling HULL with meshs TRIA6 gives very satisfactory results, the variation maximum obtained is 0.11%. The interest of this test is of:

· to test meshs TRIA6 in HULL,
· to compare the results compared to an analytical solution.

Organization (S): EDF/AMA, EDF/UTO/SIS, Delta CAD

Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
V4.05.303 document

TPLP303 - Distribution of the temperature in section of a conduit of chimney

Summary:

This test results from the validation independent of version 3 in linear stationary thermics.

It is about a problem plane 2D represented by seven modelings mixing each one several types elements.

The functionalities tested are as follows:
· plane thermal element,
· voluminal thermal element,
· limiting condition: convection.

The interest of the test lies in the mixture of different elements.

The results are compared with an analytical solution.

1
Problem of reference

1.1 Geometry

= 1.2192 m have
B = 0.3048 m
12 C
Z
Y
10
11
B
X
has
7
8
9
H
B
D
I Ti
4
5
6
has
He Te
With
B
1
2
3

1.2

Properties of material

=
1.7307 Thermal W/m °C Conductivity

1.3
Boundary conditions and loadings

· Interior Surface: hi = 68.135 W/m ² °C; Ti = 37.78 °C,
· External Surface: He = 17.034 W/m ² °C; Te = -17.78 °C.

1.4 Conditions
initial

Without object.

2
Reference solution

2.1
Method of calculation used for the reference solution

The original reference solution given in the book [bib1] is based on a method of relieving numerical. This reference is quoted in the handbook of checking of ANSYS [bib2].

2.2
Results of reference

Temperature at the points n°1 to 11.

2.3
Uncertainty on the solution

Unknown factor, it was not possible to get the original reference (delivers old, more published).

2.4 References
bibliographical

[1]
Kreith, F., "Principles of heat transfer", International Textbook Co., Scranton, Pennsylvania, 2nd Printing, 1959.
[2]
ANSYS: "checking manual", 1st edition, June 1, 1976

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3 Modeling
With

3.1 Characteristics of modeling

PLAN (TRIA3, QUAD4)

C
N3
N6
y
N9
N2
N11
N5
N12
N8
N1
B
D
N4
45°
N10
N7
Boundary conditions:
With
- dimensioned AD: Text = 37.778 °C
H = 68.135 W/m ² °C
0.3
- dimensioned BC: Text = -17.778 °C
H = 17.034 W/m ² °C
X
- dimensioned AB, CD = 0

3.2 Characteristics of the grid

A number of nodes:
12
A number of meshs and types: 6 (5 QUAD4, 1 TRIA3)

3.3 Functionalities

tested

Orders

AFFE_MODELE
THERMICS
PLAN
ALL

AFFE_CHAR_THER
EXCHANGE

THER_LINEAIRE
EXCIT
CHARGE

RECU_CHAMP
NUME_ORDRE

4
Results of modeling A

4.1 Values

tested

Relative variation %
Absolute deviation
Identification Reference
Aster difference
tolerance
difference tolerance
Temperature (°C)

Points

N1 30.889
29.795
-3.541
2%
-1.09
0.5
N2
-1.333
-2.528
89.632
2%
-1.19
0.5
N3
-15.167
-16.036
5.729
2%
-0.869
0.5
N4 34.000
34.718
2.111
2% 0.718 0.5
N5 8.611

8.566
-0.518
2%
-0.045
0.5
N6
-11.278
-10.810
-4.152
2%
-4.152
0.5
N7 34.278
34.114
-0.480
2%
-0.164
0.5
N8 12.556
12.716
1.274
2%
0.160
0.5
N9
-7.611
-8.152
7.111
2%
-0.541
0.5
N10 13.500
13.973
3.506
2% 0.473 0.5
N11
-5.889
-5.909
0.336 2% -0.02
0.5
N12
-5.444
-5.377

-1.229
2% 0.067 0.5

4.2 Parameters
of execution

Version: 5.03

Machine: SGI - ORIGIN 2000 - R12000

Obstruction memory:
8 megawords
Time CPU To use: 2.36 seconds

5
Complementary modelings B, C, D, E, F and G

Modeling b:

· Maillage identical to that described in the card of modeling, on 1/8 of the structure, but with quadratic elements,
· Système of unit (°C, W, m, S).

It is noted that the quadratic interpolation improves the results, the maximum change is 49.16% for *the value of reference nearest to 0.*

Modeling C:

· Finer Maillage (22 QUAD8 + 4 TRIA6), on 1/8 of the structure,
· Système of unit (°C, W, m, S).

It is noted that compared to modeling B, the maximum change does not decrease but increases (54.58%).

Modeling D:

· Maillage identical to that described in the card of modeling, on 1/8 of the structure,
· Système of English unit (°F, Btu, feet, hr).

It is noted that the maximum relative variation decreases in an important way (33.29%), this variation is not more
located at the same place. On the other hand it is always located on the value of reference nearest to 0.

Modeling E:

· Maillage identical to that described in the card of modeling, on 1/8 of the structure, but with quadratic elements,
· Système of English unit (°F, Btu, feet, hr).

It is noted that the quadratic elements improve the results by with a linear modeling (maximum change of 6.5%).

Modeling F:

· cutting identical to that described in the card of modeling (12 QUAD4) but on 1/4 of the structure,
· Système of English unit (°F, Btu, feet, hr).

It is noted that this grid with linear elements (without TRIA3) is much more precise, the maximum change is 5.27%.

Modeling G:

· Découpage identical to that described in the card of modeling, but on 1/4 of the structure and with quadratic elements,
· Système of English unit (°F, Btu, feet, hr).

It is noted that this grid (without TRIA3) is much less precise than at the time of modeling F, the maximum change is 6.26%.

6
Results of modelings B, C, D, E, F and G

On the figure below we present the points of observation (for more details to see the card of test corresponding).

12 C
10
11
7
8
9
D
4
5
6
With
B
1
2
3

In the tables presented below we give for each modeling the results
obtained with Code_Aster, like for modeling has the results obtained with code NISA

(calculations carried out by Mr. CLERK EDF/DER/ADE). We grayed the upper deviations than tolerance (2%).

Calculations carried out out of W, m, °C
Mod has*
Mod B Mod* C Mod* has*
Points Réf ASTER
Variation
%
ASTER
Variation % ASTER
Variation %
NISA
Variation %
1 34.278 34.114
-0.480
34.141
-0.401 34.181 -0.283 34.114 -0.480
2 13.500 13.973 3.506
13.277
-1.653 13.277 -1.649 13.973
3.506
3 -5.444 -5.377
-1.229
-5.685
4.421 -5.681 4.357 -5.377 -1.229
4 34.000 34.718 2.111
33.715
-0.840 33.847 -0.450 34.718
2.111
5 12.556 12.716 1.274
12.140
-3.314 12.056 -3.982 12.716
1.274
6 -5.889 -5.909 0.336
-6.258
6.258 -6.283 6.694 -5.909 0.336
7 30.889 29.795
-3.541
29.440
-4.690 29.290 -5.177 29.795 -3.541
8 8.611 8.566

-0.518
7.057
18.049
7.012 -18.566 8.566 -0.518
9 -7.611 -8.152 7.111
-8.283
8.693 -8.300 9.049 -8.152 7.111
10 -1.333 -2.528 89.632
-1.988
49.164 -2.061 54.578 -2.528 89.632
11 -11.278 -10.810 -4.152
-11.571 2.597 -11.579 2.671 -10.810 -4.152
12 -15.167 -16.036 5.729 -15.273 0.701 -15.287 0.791 -16.036 5.729

**** Modeling***
Handbook of Validation
V4.05 booklet: Stationary thermics of the plane structures
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Calculations carried out in Btu, feet, °F

MOD D
MOD E
MOD F
MOD G
Points Réf ASTER Variation %
ASTER
Variation %
ASTER
Variation % ASTER Variation
%
1 93.7
93.404 -0.316 93.453 -0.264 93.454 -0.262
93.450
-0.267
2 56.3
57.152 1.513 55.898 -0.713 56.872 1.017
55.884
-0.739
3 22.2
22.321 0.545 21.767 -1.948 22.220 0.090
21.761
-1.975
4 93.2
94.492 1.386 92.686 -0.552 94.149 1.018
92.688
-0.549

5 54.6
54.889 0.529 53.852 -1.370 54.568 -0.590
53.821
-1.427
6 21.4
21.364 -0.168 20.736 -3.101 20.936 -2.167
20.725
-3.155
7 87.6
85.631 -2.247 84.992 -2.977 96.572 -1.173
85.064
-2.894
8 47.5
47.419 -0.169 44.702 -5.890 45.003 -5.257
44.523
-6.268
9 18.3
17.326 -5.323 17.091 -6.507 17.335 -5.273
17.237
-5.807
10 29.6 27.450 -7.264 28.421 -3.983 29.899 1.010
27.978
-5.480
11 11.7 12.542 7.201 11.172 -4.509 11.560 -1.194
11.272
-3.659
12 4.7 3.135 -33.285 4.509 -4.089 4.824 2.633
4.452
-4.932

From these 7 analyses, we can make the following observations:

· the grid suggested in the test probe (5 QUAD4 + 2 TRIA3) is not adapted. For to bring closer the reference solution there are two possibilities:
-
to use the quadratic grid on 1/8 of the structure,
-
to use a linear grid without triangle on ¼ of the structure,
· the choice of the system of unit to important considerable in the calculation of the relative variation,
· for same modeling (A) the results between Code_Aster and NISA are identical.

7

Summary of the results

The modeling carried out on 1/8 of the structure gives results of which many values exceed the tolerance fixed initially (2%). The maximum change obtained is 89%, it is on smaller value of reference. The analysis of the isotherms shows that those are not perpendiculars with right-hand side cd., the condition of symmetry is not observed.

To find an explanation to these important differences, several complementary modelings (cf were carried out annexes B). The conclusions are as follows:

· the change of the system of units (°C - >°F) makes it possible to decrease the maximum change with one
value of 33%,
· modeling with quadratic elements (and in °F) improves the results, the variation
maximum is 6.8%,
· the modeling of one 1/4 of the structure with only of the QUAD4 (and in °F) improves them
results, the maximum change is 5.27%,
· the modeling A, carried out with software NISA, gives results identical to those of
Code_Aster.

Moreover, it was not possible to get the original reference (delivers of Kreith) quoted in handbook of checking of ANSYS. Method of acquisition of the reference solution and its uncertainty are thus not known.

The results are regarded as acceptable taking into account the points evoked above.
However it will be necessary to seek complementary elements on the reference solution.

Organization (S): EDF/AMA

Handbook of Validation
V4.21 booklet: Transitory thermics of the linear structures
Document: V4.21.001

TTLL01 - Thermal shock on an infinite wall

Summary:

· Thermique linear transient,
· elements 2D and 3D (7 modelings),
· interests of the test:
-
test the algorithm of linear thermics transitory with change of step of time,
-
imposed temperature (with discontinuity),
-
filing of some not of time.
· The shock is modelled in 2 different ways:
-
by a linear slope: T = 100. in 103 second,
-
by true a discontinuity of imposed temperature.

Handbook of Validation

V4.21 booklet: Transitory thermics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TTLL01 - Thermal shock on an infinite wall

Date:
30/08/02
Author (S):
J. Key PELLET
:
V4.21.001-F Page:
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1
Problem of reference

1.1 Geometry

B
With
A'
M1
M2
X
0
2L

AA = 2L = 2 m
X (M1) = 0.2 m
X (m2) = 0.8 m

1.2
Material properties

= 1 W/m °C
CP = 1 J/m3 °C

1.3
Boundary conditions and loadings

· A: T (0, T) = Tp = 100°C
for T > 0
· A': T (2L, T) = Tp = 100°C

1.4 Conditions
initial

T (X, 0) = 0°C for any X

1.5
Specified concerning modelings

Discretization in time (T):

The thermal shock requires a "fine" discretization in time nearly T = 0.

The goal of the test being to validate the various elements (various modelings), we have chosen a single discretization in time:

10 steps
for [0.
,
1.D3] is T = 104 S
9
not for
[1 D3
,
1.D2]
that is to say
T = 103 S
9 steps
for
[1.D2
,
1.D1]
that is to say
T = 102 S
9
not for
[1.D1
,
1.]
that is to say

T = 101 S
10
not for
[1.
,
2.]
that is to say
T = 101 S

The shock is defined in two different ways:

· for modeling B, it acts of a true shock (Tp is discontinuous):
T -

p ()
To = 0.

T +

p ()
To = 100.
· for modelings A, C, D, E, F, G, it acts of a linear slope:

T

p (A) t= =
0
0.

T

p (A) t= -3 =
10
100.
Handbook of Validation
V4.21 booklet: Transitory thermics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:

TTLL01 - Thermal shock on an infinite wall

Date:
30/08/02
Author (S):
J. Key PELLET
:
V4.21.001-F Page:
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2
Reference solution

2.1
Method of calculation used for the reference solution

T (X, T) -

Tp
4
1
N X

N2
= sin
exp-
.
.t
0
T - T

N
L
L
C
p
N 1
2
=
2
p

X =
X-coordinate

T =
time
0
T = températur initial

E
Tp = températur imposed

E
N =
,
1 ,
3 ...
,
5

2.2
Results of reference

Temperatures at the points M1 (X = 0.2) and m2 (X = 0.8), and at various moments (T = 0.1, 0.2, 0.7 and 2.0).

The values of reference are those given in guide VPCS.

2.3
Uncertainty on the solution

Numerical series.

2.4 References bibliographical

[1]
J.F. SACCADURA: Initiation with the thermal transfers, Paris, Technique and documentation (1982).

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3 Modeling
With

3.1
Characteristics of modeling

QUAD8

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height H = 1.0 with only one layer of elements.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: J = 0

H
on [AD]: Tp is imposed
With
M1

M2
B
Tp
100 °C
20 elements
0
T
10 - 3 S
points
nodes

Initial conditions
M1
N9
T = 0 °C
M2
N33
One fixes here the duration of the shock at 10 - 3 S.

3.2
Characteristics of the grid

A number of nodes: 103
A number of meshs and types: 20 QUAD8

3.3 Functionalities
tested

Orders

THER_LINEAIRE
LIST_INST

RECU_CHAMP
INST

4
Results of modeling A

4.1 Values
tested

Identification Reference
Aster %
difference
M1 (X = 0.2) N9

T = 0.1
65.48
65.294
-0.28
T = 0.2
75.58
75.814
+0.31
T = 0.7
93.01
92.867
-0.15
T = 2.0

99.72
99.700
-0.02

M2 (X = 0.8) N33

T = 0.1
8.09
8.0357
-0.67
T = 0.2
26.37
25.790
-2.20
T = 0.7
78.47
78.047
-0.54
T = 2.0
99.13
99.077
-0.05

:
V4.21.001-F Page:
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5 Modeling
B

5.1
Characteristics of modeling

QUAD8

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height H = 1.0 with only one layer of elements.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed Tp = 100°C
With
M1
M2
B
Tp
100 °C
20 elements
0
T
points
nodes

Initial conditions
M1
N9
One affects the temperature directly of
M2

N33
100°C at moment 0.

5.2
Characteristics of the grid

A number of nodes: 103
A number of meshs and types: 20 QUAD8

5.3 Functionalities
tested

Orders

THER_LINEAIRE
TEMP_INIT
CHAM_NO

RECU_CHAMP
INST

AFFE_CHAM_NO

Handbook of Validation
V4.21 booklet: Transitory thermics of the linear structures
HT-66/02/001/A

Code_Aster ®
Version
5.0

Titrate:
TTLL01 - Thermal shock on an infinite wall

Date:
30/08/02
Author (S):

6
Results of modeling B

6.1 Values tested

Identification	*Reference*	*Aster*	*% difference*
M1 (X = 0.2) N9			
T = 0.1	*65.48*	*65.369*	*-0.17*
T = 0.2	*75.58*	*75.841*	*0.35*
T = 0.7	*93.01*	*92.875*	*-0.14*
T = 2.0	*99.72*	*99.700*	*-0.02*
M2 (X = 0.8) N33			
T = 0.1	*8.09*		

8.113
0.28
T = 0.2
26.37
25.872
-1.89
T = 0.7
78.47
78.071
-0.51
T = 2.0
99.13
99.078
-0.05

7 Modeling
C

7.1
Characteristics of modeling

HEXA8

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height and a thickness H = 1.0 with only one layer of elements.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed
With
M1
M2
B H
Tp
100 °C
20 elements HEXA8
0
T
103 S
points
nodes

Initial conditions
M1

N21 with N24
T = 0°C
M2

N69 with N72
One fixes here the duration of the shock at 103 S.

7.2
Characteristics of the grid

A number of nodes: 84
A number of meshs and types: 20 HEXA8

7.3 Functionalities
tested

Orders

THER_LINEAIRE
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8
Results of modeling C

8.1 Values
tested

Identification Reference
Aster %
difference
M1 (X = 0.2) N21

T = 0.1
65.48
65.31
-0.26
T = 0.2
75.58
75.81
+0.31
T = 0.7
93.01
92.87
-0.15
T = 2.0
99.72
99.70
-0.02

M2 (X = 0.8) N69

T = 0.1
8.09
7.98
-1.31
T = 0.2
26.37
25.76
-2.30
T = 0.7
78.47
78.05
-0.53
T = 2.0

99.13
99.08
-0.05

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9 Modeling D

9.1 Characteristics of modeling

HEXA20

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height and a thickness H = 1.0 with only one layer of elements.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed
With
M1
M2
B H
Tp

100 °C
20 elements HEXA20
0
T
103 S
points
nodes

Initial conditions
M1

N57 with N64
T = 0°C
M2

N201 with N208
One fixes here the duration of the shock at 103 S.

9.2
Characteristics of the grid

A number of nodes: 248
A number of meshs and types: 20 HEXA20

9.3 Functionalities
tested

Orders

THER_LINEAIRE
LIST_INST

RECU_CHAMP
INST

10 Results of modeling D

10.1 Values tested

Identification Reference
Aster %
difference
M1 (X = 0.2) N57

T = 0.1
65.48
65.29
-0.28
T = 0.2
75.58
75.81
+0.31
T = 0.7
93.01
92.87
-0.15
T = 2.0
99.72

99.70
-0.02

M2 (X = 0.8) N201

T = 0.1
8.09
8.04
-0.67
T = 0.2
26.37
25.79
-2.20
T = 0.7
78.47
78.05
-0.54
T = 2.0
99.13
99.08
-0.05

11 Modeling
E

11.1 Characteristics of modeling

PENTA6

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height and a thickness H = 1.0 with only one layer of elements. Each cube is cut out in 2 pentahedrons.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed
With
M1
M2
B H
Tp
100 °C
20 elements PENTA6
0
T
103 S
points
nodes

Initial conditions
M1

N21 with N24
T = 0°C

M2

N69 with N72
One fixes here the duration of the shock at 103 S.

11.2 Characteristics of the grid

A number of nodes: 84
A number of meshs and types: 40 PENTA6

11.3 Functionalities tested

Orders

THER_LINEAIRE
LIST_INST

RECU_CHAMP
INST

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12 Results of modeling E

12.1 Values tested

Identification	Reference	Aster	% difference
M1 (X = 0.2) N21			
T = 0.1	65.48	65.31	-0.26
T = 0.2	75.58	75.81	+0.31
T = 0.7	93.01	92.87	-0.15
T = 2.0	99.72	99.70	-0.02
M2 (X = 0.8) N69			
T = 0.1	8.09	7.98	-1.31
T = 0.2			

26.37
25.76
-2.30
T = 0.7
78.47
78.05
-0.53
T = 2.0
99.13
99.08
-0.05

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13 Modeling F

13.1 Characteristics of modeling

PENTA15

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height and a thickness H = 1.0 with only one layer of elements. Each cube is cut out in 2 pentahedrons.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed
With
M1
M2
B H
Tp
100 °C
20 elements PENTA15
0
T
103 S
points
nodes

Initial conditions
M1

N62 with N70
T = 0°C
M2

N218 with N226
One fixes here the duration of the shock at 103 S.

13.2 Characteristics of the grid

A number of nodes: 269
A number of meshs and types: 40 PENTA15

13.3 Functionalities tested

Orders

THER_LINEAIRE
LIST_INST

RECU_CHAMP
INST

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14 Results of modeling F

14.1 Values tested

Identification Reference
Aster %
difference
M1 (X = 0.2) N62

T = 0.1

65.48
65.29
-0.28
T = 0.2
75.58
75.81
+0.31
T = 0.7
93.01
92.87
-0.15
T = 2.0
99.72
99.70
-0.02

M2 (X = 0.8) N218

T = 0.1
8.09
8.04
-0.67
T = 0.2
26.37
25.79
-2.20
T = 0.7
78.47
78.05
-0.54
T = 2.0
99.13
99.08
-0.05

15 Modeling G

15.1 Characteristics of modeling

TETRA4

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height and a thickness H = 1.0 with only one layer of elements. Each cube is cut out in 5 tetrahedrons.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed
With
M1
M2
B H
Tp

100 °C
20 elements TETRA4
0
T
103 S
points
nodes

Initial conditions
M1
N12,
N17
T = 0°C
M2
N48,
N53
One fixes here the duration of the shock at 103 S.

15.2 Characteristics of the grid

A number of nodes: 84
A number of meshs and types: 100 TETRA4

15.3 Functionalities tested

Orders

THER_LINEAIRE
TEMP_INIT
STATIONARY

IMPR_RESU
NUMERO_ORDRE

AFFE_CHAR_THER_F
TEMP_IMPO

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16 Results of modeling G

16.1 Values tested

Identification Reference
Aster %
difference
M1 (X = 0.2)

T = 0.1 N12
65.48
65.37
-0.17
N17
65.49
65.27
-0.33
T = 0.2 N12
75.58
75.84

+0.34
N17
75.58
75.80
+0.29
T = 0.7 N12
93.01
92.88
-0.14
N17
93.01
92.86
-0.16
T = 2.0 N12
99.72
99.70
-0.02
N17
99.72
99.70
-0.02

M2 (X = 0.8)

T = 0.1 N48
8.09
8.08
-0.11
N53
8.09
7.97
-1.43
T = 0.2 N48
26.37
25.85
-1.96
N53
26.37
25.74

-2.39
T = 0.7 N48
78.47
78.07
-0.51
N53
78.47
78.04
-0.55
T = 2.0 N48
99.13
99.08
-0.05
N53
99.13
99.08
-0.05

16.2 Remarks

At the beginning of transient, one observes slightly different values between the nodes located in a plan X = constant (< 3 per 1000). This anomaly seems to be due to modeling in tetrahedrons with 4 nodes. The results remain nevertheless correct compared to the other elements 3D.

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17 Modeling
J

17.1 Characteristics of modeling

TETRA4_D

One nets only half the thickness of the wall by reason of symmetry; modeling is made under a height and a thickness H = 1.0 with only one layer of elements. Each cube is cut out in 5 tetrahedrons.

One uses modeling "3D_DIAG" applied to TETRA4, which corresponds to the lumpage of stamp of thermal mass.

L = 0.05
Limiting conditions

D
C
on [BC], [AB] and [cd.]: = 0

H
on [AD]: Tp is imposed
With
M1
M2
B H
Tp
100 °C
20 elements TETRA4_D
0
T
103 S
points
nodes

Initial conditions
M1
N12,
N17

T = 0°C
M2
N48,
N53
One fixes here the duration of the shock at 103 S.

17.2 Characteristics of the grid

A number of nodes: 84
A number of meshs and types: 100 TETRA4

17.3 Functionalities tested

Orders

THER_LINEAIRE
TEMP_INIT
STATIONARY

IMPR_RESU
NUMERO_ORDRE

AFFE_CHAR_THER_F
TEMP_IMPO

Date:
30/08/02
Author (S):
J. Key PELLET
:
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18 Results of modeling J

18.1 Values tested

Identification Reference
Aster %
difference
M1 (X = 0.2)

T = 0.1 N12
65.48
65.34
-0.21
N17
65.49
65.24
-0.36
T = 0.2 N12
75.58
75.84
+0.34
N17
75.58
75.80
+0.29
T = 0.7 N12
93.01
92.87
-0.15
N17
93.01

92.86
-0.16
T = 2.0 N12
99.72
99.70
-0.02
N17
99.72
99.70
-0.02

M2 (X = 0.8)

T = 0.1 N48
8.09
8.18
+1.16
N53
8.09
8.08
-0.15
T = 0.2 N48
26.37
25.90
-1.77
N53
26.37
25.79
-2.20
T = 0.7 N48
78.47
78.06
-0.52
N53
78.47
78.02
-0.57
T = 2.0 N48
99.13

99.07
-0.05
N53
99.13
99.07
-0.05
