

SSLS111 - Simple offsetting of plate

Summary:

This test makes it possible to validate the offsetting of the simple plates (i.e. that it is neither about multi-layer, nor of a homogenized behavior).

Eight modelings are used: DST (modeling *A*), DKT (modeling *B*) and DST (modeling *C*), Q4G (modeling *D*), Q4G (modeling *E*), DKT (modeling *F*), DST (modeling *G*) and DKT (modeling *O*).

Modelings *A* and *B* : one models 2 plates offset compared to the average plan and one compares the results with an analytical solution.

Modeling *C* :

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.

Modeling *D*, *E*, *F*, *G* :

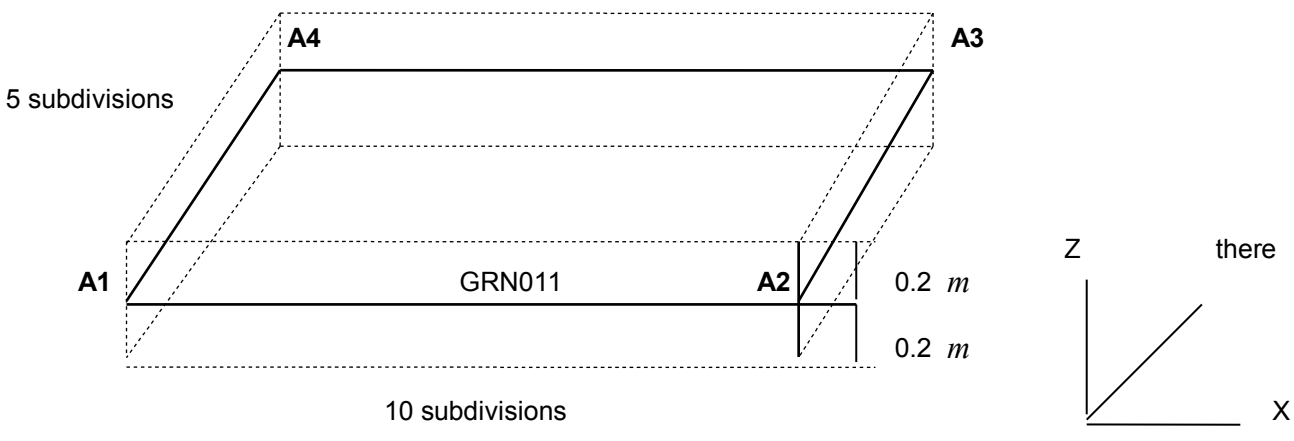
One models only one plates offset compared to the average plan and one compares the results with an analytical solution.

Modeling *O* :

One models only one plates offset compared to the average plan in order to validate the calculation of the components of the constraints *SIXZ* and *SIYZ*. Two calculations are carried out, the first into full-course being used as reference to the second into multi-layer.

1 Problem of reference

1.1 Geometry



The coordinates of the points are given in meters (m):

$$\begin{array}{ll} A1(0,0,0) & A3(10,5,0) \\ A2(10,0,0) & A4(0,5,0) \end{array}$$

1.2 Material properties

1.2.1 Modelings A, B and D

The material has an isotropic elastic behavior:

Young modulus: $E = 200000 \text{ MPa}$

Poisson's ratio: $\nu = 0$.

Density: $\rho = 1000 \text{ Kg/m}^3$

1.2.2 Modeling C

The material is double-layered.

The material constituting the first layer is elastic orthotropic and is characterized by the following data:

$$EL = 20000 \text{ MPa} \quad ET = 20000 \text{ MPa} \quad VLT = 0.3 \quad GLT = 2000 \text{ MPa}$$

The material constituting the second layer is also elastic orthotropic and is characterized by the following data:

$$EL = 15000 \text{ MPa} \quad ET = 15000 \text{ MPa} \quad VLT = 0.3 \quad GLT = 1500 \text{ MPa}$$

1.3 Boundary conditions and loadings

1.3.1 Modelings A and B

The edge $A1A4$ is embedded.

A nodal force is applied $F_z = -1000$ N on the edge $A1A2$.

1.3.2 Modeling C

The node $A1$ is embedded:

$$\begin{aligned} dx &= 0. & dy &= 0. & dz &= 0. \\ dRx &= 0. & dRy &= 0. & dRz &= 0. \end{aligned}$$

The node $A2$ is blocked according to the following degrees of freedom:

$$dx = 0. \quad dy = 0.$$

A nodal force is applied $F_z = -1000$ N on the node $A3$.

In addition, one applies to 3 meshes (see drawing into 5.2) the loading divided into following local reference mark (keyword `FORCE_COQUE`):

$$F1 = 200 \text{ N/m}^2, \quad F2 = -500 \text{ N/m}^2, \quad F3 = -500 \text{ N/m}^2, \quad MF1 = 100 \text{ N/m}, \quad MF2 = 40 \text{ N/m}$$

in the plan of the grid.

1.3.3 Modeling D, E, F and G

The edge $A1A4$ is embedded. The plate has as a thickness $0,8$ m. The plate is offset of $e = 0,4$ m.

A nodal force distributed transverse is applied $F_z = -1000$ N/m on the edge $A2A3$ and a nodal force distributed of traction $F_x = 4000$ N/m on the same edge $A2A3$.

2 Reference solution

2.1 Method of calculating used for the reference solution

2.1.1 Modelings A and B

The arrow fl is given by the formula: $fl = FIL^3/3EI$
where l is the width, L the length of the plate, and $I = lh^3/12$, h being the thickness.

2.1.2 Modeling C

Calculation with double-layered material is used as reference. Nonthe regression of the results got for this first calculation is checked.

2.2 Results of reference

2.2.1 Modelings A and B

They are made up by the values of the field of displacement DZ with not $A3$ and of the efforts at the point $A1$. In addition, the 4 smaller frequencies of the structure are calculated.

2.2.2 Modeling C

They are made up by the values of the field of displacement DX, DY, DZ, DRX, DRY at the point $A3$ (node NI for Code_Aster) and at the point of coordinates $(9,2,0)$.

One compares also the efforts with the point $A1$.

In addition, the 4 smaller frequencies of the structure are calculated.

2.2.3 Modeling D

One represents in this case only one plates offset (offsetting $e = 0,4 m$, thickness $h/2 = 0,4 m$). The arrow w at the loose lead is given by the expression:
 $w = (2F_z L - 3F_x e) \ell L^2 / 6EI + F_z L / (6Gh5/6)$. Total requests on the embedded edge $A1A4$, length $\ell = 5 m$ are: $N_x = F_x$ and $V_z = -F_z$.

2.3 Uncertainty on the solution

For modelings A and B , the reference solution is analytical. There is thus no uncertainty.

For modeling C , uncertainties are Nulles since it is about the same calculation carried out by two different ways.

2.3.1 Modeling D, E, F, G

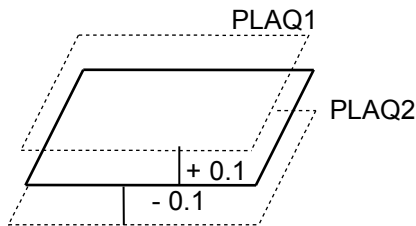
One uses as reference solution for the Eigen frequency another solution coming from a nonexcentré calculation.

3 Modeling A

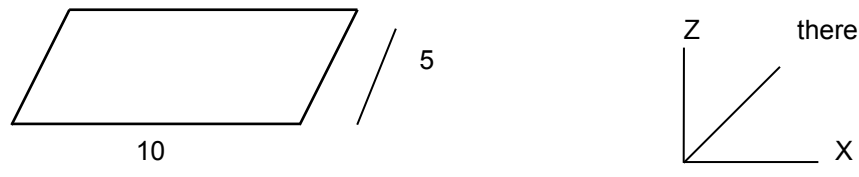
3.1 Characteristics of modeling

The model consists of 2 offset plates of the distances -0.1 m and 0.1 m .

The elements used are elements of plate DSQ.



3.2 Characteristics of the grid



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 meshes DSQ (QUAD4) and 66 nodes.

3.3 Sizes tested and results

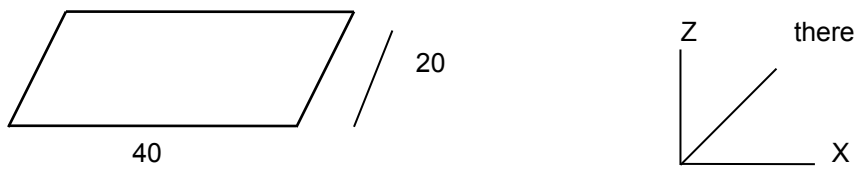
Identification	Type of reference	Values of reference	Tolerance
DZ (A 3)	'ANALYTICAL'	$-3.90625 \cdot 10^{-5}$	0,005
MXX(A 1)	'ANALYTICAL'	5000.	0,001
QX(A 1)	'ANALYTICAL'	-500.	0,001
SIXX(M1, PT1, SSPT 1)	'ANALYTICAL'	0.	1.0E-8
SIXX(M1, PT1, SSPT 2)	'ANALYTICAL'	990,585	0.0001
Frequency 1 ^{er} mode	'NON_REGRESSION'	18.2	0.0001
Frequency 2 ^{ème} mode	'NON_REGRESSION'	84.6	0.0001
Frequency 3 ^{ème} mode	'NON_REGRESSION'	101.21	0.0001
Frequency 4 ^{ème} mode	'NON_REGRESSION'	111.28	0.0001

4 Modeling B

4.1 Characteristic of modeling

The model is the same one as that of modeling A, with this close that instead of having elements of plate DSQ , there are elements DKT .

4.2 Characteristic of the grid



The grid is regular. There are 40 subdivisions according to x and 20 subdivisions according to y ; that is to say on the whole 1600 meshes DKT and 861 nodes.

4.3 Sizes tested and results

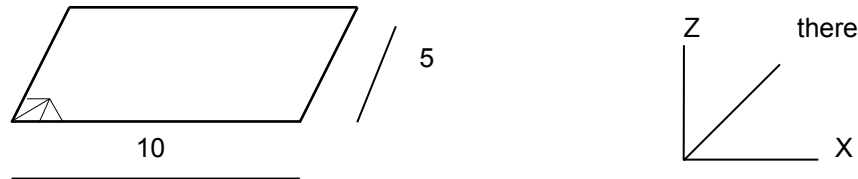
Identification	Type of reference	Values of reference	Tolerance
DZ (A3)	'ANALYTICAL'	$-3.90625 \cdot 10^{-5}$	0,005
MXX(A1)	'ANALYTICAL'	5000.	0.3
QX(A1)	'ANALYTICAL'	-500.	0.15
Frequency 1 ^{er} mode	'NON_REGRESSION'	18.25	0.0001
Frequency 2 ^{eme} mode	'NON_REGRESSION'	88.35	0.0001
Frequency 3 ^{eme} mode	'NON_REGRESSION'	100.1	0.0001
Frequency 4 ^{eme} mode	'NON_REGRESSION'	113.5	0.0001

5 Modeling C

5.1 Characteristics of modeling

The model is the same one as that of modeling *A*, with this close that instead of having elements of plate *DSQ*, there are elements *DST*. (Modeling *DST* with meshes *TRIA3*).

5.2 Characteristics of the grid



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 meshes *DST* and 66 nodes.

5.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DX <i>N66</i>	'AUTRE_ASTER'	- 6.49678E-06	0.0015
DEPL DY <i>N66</i>	'AUTRE_ASTER'	- 6.08932E-07	0,004
DEPL DZ <i>N66</i>	'AUTRE_ASTER'	- 5.33844E-03	0,004
DEPL DRX <i>N66</i>	'AUTRE_ASTER'	- 4.29182E-04	0,003
DEPL DRY MARTINI <i>N66</i>	'AUTRE_ASTER'	4.75601E-04	0,003
DEPL DX <i>N53</i>	'AUTRE_ASTER'	-3.58293E-06	0,003
DEPL DY <i>N53</i>	'AUTRE_ASTER'	- 1.18788E-06	0,002
DEPL DZ <i>N53</i>	'AUTRE_ASTER'	- 3.63885E-03	0,004
DEPL DRX <i>N53</i>	'AUTRE_ASTER'	- 4.05175E-04	0,004
DEPL DRY MARTINI <i>N53</i>	'AUTRE_ASTER'	4.23116E-04	0.0035
EFGE NXX <i>N6</i>	'AUTRE_ASTER'	1.70005E+04	0.0035
EFGE NYY <i>N6</i>	'AUTRE_ASTER'	1.14438E+04	0.0035
EFGE NXY <i>N6</i>	'AUTRE_ASTER'	3.53598E+03	0,005
EFGE MXX <i>N6</i>	'AUTRE_ASTER'	2.14585E+04	0,009
EFGE MYY <i>N6</i>	'AUTRE_ASTER'	1.53094E+04	0,004
EFGE MXY <i>N6</i>	'AUTRE_ASTER'	5.71331E+03	0,005
EFGE QX <i>N6</i>	'AUTRE_ASTER'	- 3.03380E+03	0.0065
EFGE QY <i>N6</i>	'AUTRE_ASTER'	1.76436E+03	0,015
MODE 1	'AUTRE_ASTER'	1.01181E+00	0,003
MODE 2	'AUTRE_ASTER'	4.27003E+00	0,003
MODE 3	'AUTRE_ASTER'	8.39151E+00	0,004

MODE 4	'AUTRE_ASTER'	1.72305E+01	0,006
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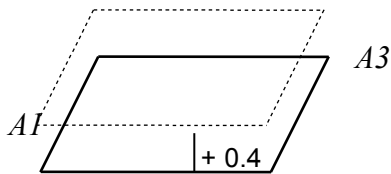
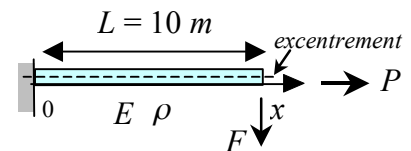
5.4 Remarks

One notes a difference between the solution obtained for a double-layered hull and that resulting from two offset full-course hulls, without it being possible at the time of the drafting of the test to determine from which the variation comes.

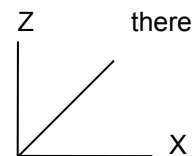
6 Modeling D

6.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate Q4G.



6.2 Characteristics of the grid



The grid is regular. There are 20 subdivisions according to x and 10 subdivisions according to y ; that is to say on the whole 200 meshes QUAD4 and 231 nodes.

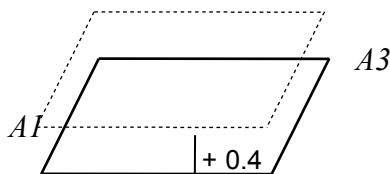
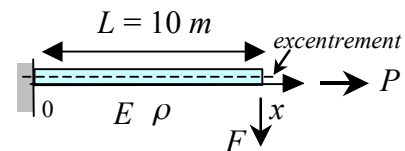
6.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DZ A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	0.03
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE NI MESH MI	'ANALYTICAL'	8400.0	0.03
MODE 0	'NON_REGRESSION'	18.2307742712	1, e-9
MODE 1	'AUTRE_ASTER'	18.2307742712	0.04

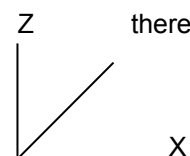
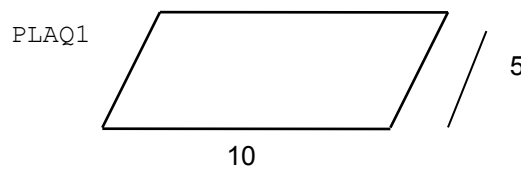
7 Modeling E

7.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate Q4G.



7.2 Characteristics of the grid



The grid is regular. There are 5300 nets and 5151 nodes. This modeling shows the influence of the grid on modeling Q4G.

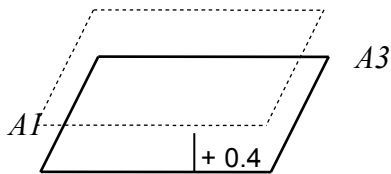
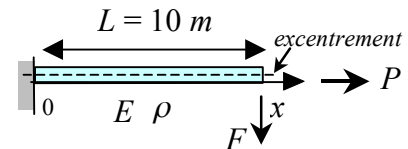
7.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DZ A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX AI	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX AI	'ANALYTICAL'	10000	0.05
EFGE_NOEU QX AI	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE NI MESH MI	'ANALYTICAL'	8400.0	0.01
MODE 0	'NON_REGRESSION'	18.2307742712	1.e-9
MODE 1	'AUTRE_ASTER'	18.2307742712	0.01

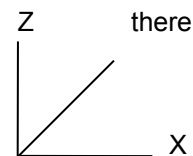
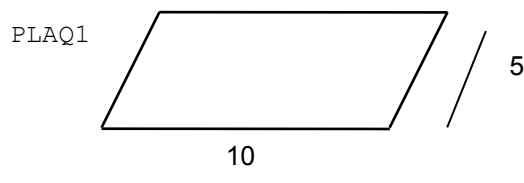
8 Modeling F

8.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate Q4G.



8.2 Characteristics of the grid



The grid is regular. There are 20 subdivisions according to x and 10 subdivisions according to y ; that is to say on the whole 200 meshes QUAD4 and 231 nodes. This modeling shows the influence of the grid on modeling DKT.

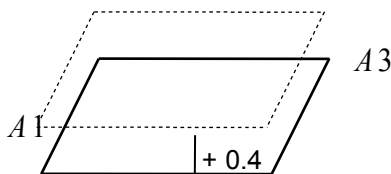
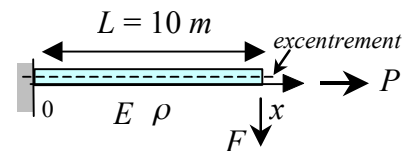
8.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DX A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX AI	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX AI	'ANALYTICAL'	10000	1.e-9
EFGE_NOEU QX AI	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE NI MESH MI	'ANALYTICAL'	8400.0	1.e-9
MODE 0	'NON_REGRESSION'	18.2307742712	1.e-9
MODE 1	'AUTRE_ASTER'	18.2307742712	0,005

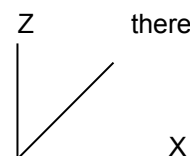
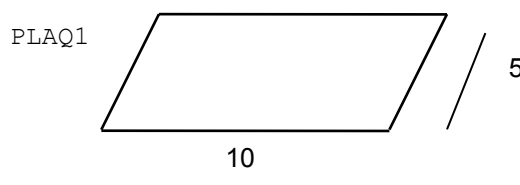
9 Modeling G

9.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate Q4G.



9.2 Characteristics of the grid



The grid is regular. There are 20 subdivisions according to x and 10 subdivisions according to y ; that is to say on the whole 200 meshes QUAD4 and 231 nodes. This modeling shows the influence of the grid on modeling DST.

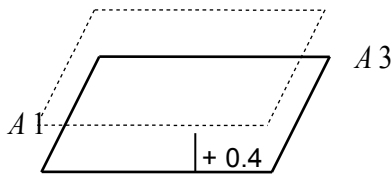
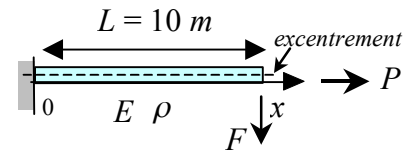
9.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DX A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	1.e-9
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE N1 MESH M1	'ANALYTICAL'	8400.0	1.e-9
MODE 0	'NON_REGRESSION'	18.2307742712	1.e-9
MODE 1	'AUTRE_ASTER'	18.2307742712	1.e-9

10 Modeling H

10.1 Characteristics of modeling

The model consists of a plate offset of $0.4m$ (PLAQ1) (compared to the initial grid). The total thickness is of $0,8m$. The elements used are elements of plate DKTG with MECA_STATIQUE.



10.2 Characteristics of the grid

The grid is composed of triangles TRIA3.

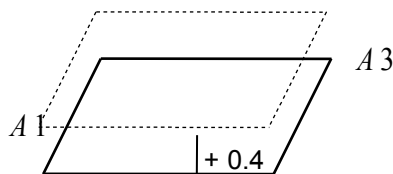
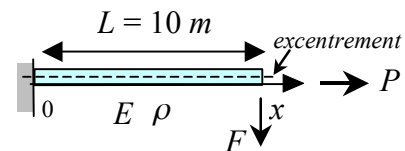
10.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DZ A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	0.1%
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	0; 1%
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	0; 1%
EFGE_ELNO MXX NODE NI MESH MI	'ANALYTICAL'	8400.0	0; 1%
MODE 0	'NON_REGRESSION'	18.2307742712	0; 1%
MODE 1	'AUTRE_ASTER'	18.2307742712	5%

11 Modeling I

11.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate DKTG with MECA_STATIQUE.



11.2 Characteristics of the grid

The grid is composed of quadrangles QUAD4.

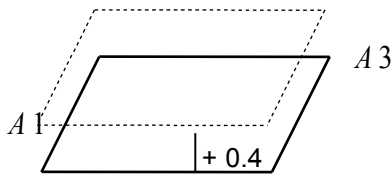
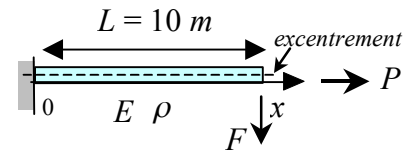
11.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DZ A3	'ANALYTICAL'	-2.97625E-05	0.5%
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	3%
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	0.1%
EFGE_ELNO MXX NODE NI MESH M1	'ANALYTICAL'	8400.0	3%
Modal calculation MODE 0	'NON_REGRESSION'	18.2307742712	0.0001%
Modal calculation MODE 1	'AUTRE_ASTER'	18.2307742712	4%

12 Modeling J

12.1 Characteristics of modeling

The model consists of a plate offset of $0.4m$ (PLAQ1) (compared to the initial grid). The total thickness is of $0,8m$. The elements used are elements of plate Q4GG with MECA_STATIQUE.



12.2 Characteristics of the grid

The grid is composed of triangles TRIA3.

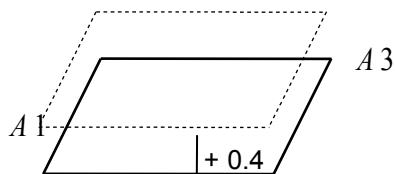
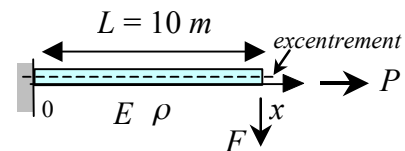
12.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DZ A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	1.e-9
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE NI MESH MI	'ANALYTICAL'	8400.0	1.e-9
MODE 0	'NON_REGRESSION'	18.2307742712	1.e-9
MODE 1	'AUTRE_ASTER'	18.2307742712	1.e-9

13 Modeling K

13.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate Q4GG with MECA_STATIQUE.



13.2 Characteristics of the grid

The grid is composed of quadrangles QUAD4.

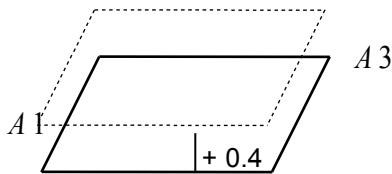
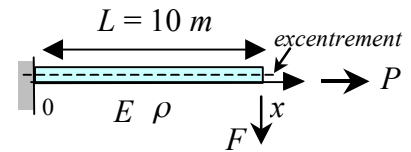
13.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DZ A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	15%
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	0.1%
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE NI MESH M1	'ANALYTICAL'	8400.0	5%

14 Modeling M

14.1 Characteristics of modeling

The model consists of a plate offset of $0.4m$ (PLAQ1) (compared to the initial grid). The total thickness is of $0,8m$. The elements used are elements of plate Q4GG with STAT_NON_LINE.



14.2 Characteristics of the grid

The grid is composed of triangles TRIA3.

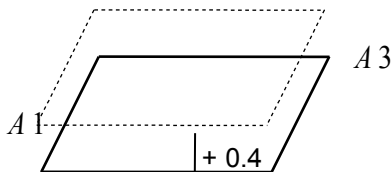
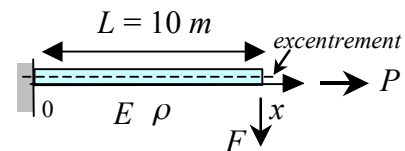
14.3 Sizes tested and results

Identification	Type of reference	Values of reference	Tolerance
DEPL DX A3	'ANALYTICAL'	-2.97625E-05	0,005
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	1.e-9
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	10%
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	1.e-9
EFGE_ELNO MXX NODE NI MESH MI	'ANALYTICAL'	8400.0	5%

15 Modeling NR

15.1 Characteristics of modeling

The model consists of a plate offset of 0.4 m (PLAQ1) (compared to the initial grid). The total thickness is of $0,8\text{ m}$. The elements used are elements of plate Q4GG with STAT_NON_LINE.



15.2 Characteristics of the grid

The grid is composed of quadrangles QUAD4.

15.3 Sizes tested and results

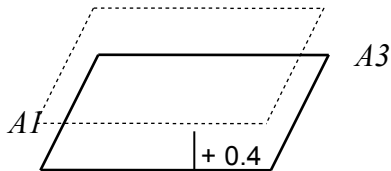
Identification	Type of reference	Values of reference	Tolerance
DEPL DX A3	'ANALYTICAL'	-2.96875E-05	7%
EFGE_NOEU NXX A1	'ANALYTICAL'	4000	0.1%
EFGE_NOEU MXX A1	'ANALYTICAL'	10000	0.1%
EFGE_NOEU QX A1	'ANALYTICAL'	-1000	0.1%
EFGE_ELNO MXX NODE NI MESH M1	'ANALYTICAL'	8400.0	0.1%

16 Modeling O

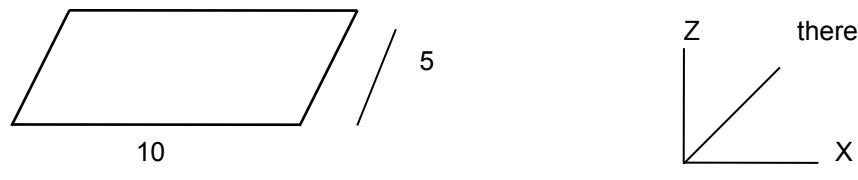
16.1 Characteristics of modeling

The model is made up of one plate of a thickness of 0.8 m offset of 0.4 m .

The elements used are elements of plate DKQ.



16.2 Characteristics of the grid



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 meshes DKQ (QUAD4) and 66 nodes.

16.3 Sizes tested and results

Full-course calculation:

Identification	Type of reference	Values of reference	Tolerance
SIXZ(M11, PT1, SSPT1)	'ANALYTICAL'	0.	0,001
SIXZ(M11, PT1, SSPT2)	'NON_REGRESSION'	-1.875000000E+03	-
SIXZ(M11, PT1, SSPT3)	'ANALYTICAL'	0.	0,001

Calculation Bi- layer:

Identification	Type of reference	Values of reference	Tolerance
SIXZ(M11, PT1, SSPT1)	'ANALYTICAL'	0.	0,001
SIXZ(M11, PT1, SSPT3)	'AUTRE_ASTER'	-1.875000000E+03	0,001
SIXZ(M11, PT1, SSPT6)	'ANALYTICAL'	0.	0,001

17 Summary of the results

The results of 3 modelings are very good, except for the efforts cutting-edges of modelings B and C (respectively 10% and 7% of error). Modelings D, E, F, G also good performances give. However, it should be noted that modeling $Q4G$ depends on the grid (because of the isoparametric interpolation of the rotation-translations). In other words, with a refinement of grid one reduces the mistakes made with modeling D . For modeling O , the results are in conformity with what is expected for an offset plate.