Handbook of Validation
V3.03 Booklet: Linear static of the plates and shells
Document: V3.03.116

SSLS116 - Loading membrane of an offset plate

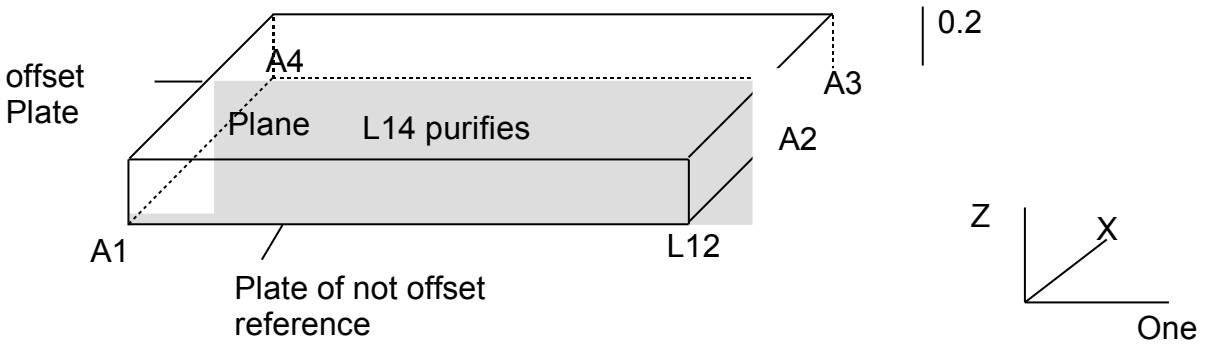
Summarized:

This test relates to the eccentring of a plate compared to the plane of the mesh or plane of diagram. The loading is purely membranous.

The reference is given by a first resolution where a not offset plate is modelled. It validates the second computation where one models a plate offset compared to the plane of the mesh.

1 Problem of reference

1.1 Geometry



represented there here the plate offset compared to the plane of diagram (which is confused here with the lower plan of the offset plate).
To avoid overloading the diagram, one does not trace the plate of not offset reference, for which the plane of diagram is also the average plane.

1.2 Properties of the materials

the material constituting plate is characterized by the following data:

$EL=20000.\text{Pa}\quad ET=20000.\text{Pa}\quad EN=20000.\text{Pa}$
$\nu LN=0.\quad \nu LT=0\quad \nu TN=0.\quad GLT=2000.\text{Pa}\quad GLN=0.\quad GTN=0.$
$\rho=1000.\text{kg}/m^3$

1.3 Boundary conditions and loadings

the mesh $L14$ is clamped $DX=DY=DZ=0.$
$DRX=DRY=DRZ=0.$

One applies the forces to the mesh $L12$

$FX=1000.\text{N}\quad MY=100.\text{N.m}$ to the plate offset
$FX=1000.\text{N}$ on the not offset plate

These loadings are applied by means of FORCE_ARETE of AFFE_CHAR_MECA in the plane of diagram.

Note:

The fact of applying a force FX to the plate offset to the level of the plane of diagram generates one moment MY that it is necessary to compensate to find itself under purely membrane conditions on the level of the offset plate.

2 Reference solution

2.1 Method of calculating used for reference solution

The computation of the membrane type with the not offset plate is used as reference. The non regression one compared to the results got by this first computation is checked.

2.2 Results of reference

They are made up by the values of the field of displacement DX , DY , DZ , DRX , DRY to the nodes $N66$ and $N52$ (for the DKT and the DST) and to the nodes $N1$ and $N16$ (for the DKQ and the DSQ) and of the computation of the frequencies of the first 4 modes.

2.3 Uncertainty on the solution

uncertainty is null since it is the same computation carried out by two different ways.

2.4 Bibliography

- [R3.07.03]: Shell elements DKT, DST, DKQ, DSQ and Q4G.
- [R3.07.06]: Processing of the eccentring for shell elements DKT, DST, DKQ, DSQ and Q4G.

3 Modelization A

3.1 Characteristic of the modelization

the elements used are shell elements DKT.

3.2 Characteristics of the mesh

Coordinated of the nodes:

Node	$X(m)$	$Y(m)$	$Z(m)$
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 meshes DKT (TRIA3)

3.3 Functionalities tested

Commands	Factor key word
AFFE_CARA_ELEM	EXCENTREMENT
AFFE_CHAR_MECA	FORCE_ARETE

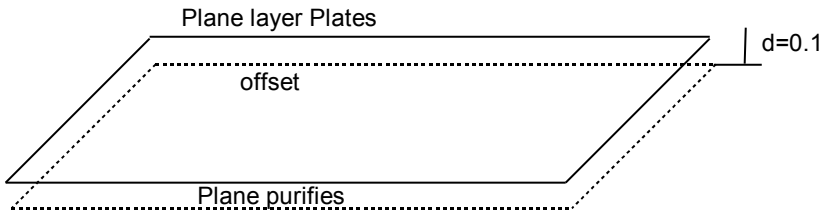
4 Results of the modelization A

4.1 Values tested

Identification	Reference (m)	*Aster* (m)	% difference
DX (N66)	2.5m	2.5	1.78 E-15
DY (N66)	0.m	4.615 E-14	4.615 E-14
DZ (N66)	0.m	1.158 E-12	1.158 E-12
DRX (N66)	0.rad	2.76 E-13	2.76 E-13
DRY (N66)	0.rad	– 7.86 E-14	– 7.86 E-14
DX (N52)	2.	2.	1.49 E-08
DY (N52)	0.	3.90 E-14	3.90 E-14
DZ (N52)	0.	2.72 E-13	2.72 E-13
DRX (N52)	0.	2.34 E-13	2.34 E-13
DRY (N52)	0.	– 1.84 E-14	– 1.84 E-14
Frequency 1st mode	1.4439E-03Hz	1.4465 E-03	0.182
Frequency 2nd mode	3.71554 E-03	3.7984 E-03	2.231
Frequency 3rd mode	9.01537 E-03	9.1305 E-03	1.277
Frequency 4th mode	1.34708 E-02	1.4077 E-02	4.501

5 Modelization B

5.1 Characteristic of the modelization



the elements used are shell elements DKQ.

5.2 Characteristics of the mesh

Coordinated of the nodes:

Node	$X(m)$	$Y(m)$	$Z(m)$
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 meshes DKQ (QUAD4)

5.3 Functionalities tested

Commands	Factor key word
AFFE_CARA_ELEM	EXCENTREMENT
AFFE_CHAR_MECA	FORCE_ARETE

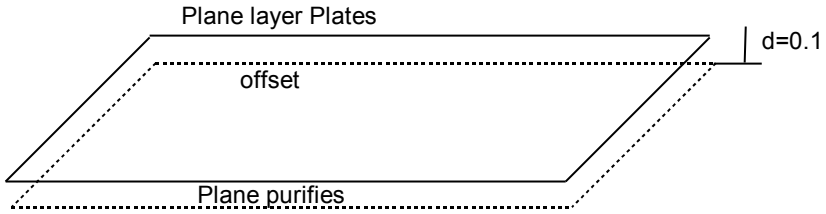
6 Results of the modelization B

6.1 Values tested

Identification	Reference (m)	*Aster* (m)	% difference
DX (N1)	2.5m	2.5	– 3.42 E-14
DY (N1)	0.m	2.52 E-14	2.52 E-14
DZ (N1)	0.m	– 1.521 E-12	– 1.521 E-12
DRX (N1)	0.rad	1.54 E-14	1.54 E-14
DRY (N1)	0.rad	2.63 E-13	2.63 E-13
DX (N16)	2.	2.	1.49 E-08
DY (N16)	0.	2.03 E-14	2.03 E-14
DZ (N16)	0.	– 1.12 E-12	– 1.12 E-12
DRX (N16)	0.	4.29 E-14	4.29 E-14
DRY (N16)	0.	2.19 E-13	2.19 E-13
Frequency 1st mode	1.44474E-03 Hz	1.446841 E-03	0.145
Frequency 2nd mode	3.69339 E-03	3.703038 E-03	0.261
Frequency 3rd mode	9.04773 E-03	9.14141 E-03	1.023
Frequency 4th mode	1.33393 E-02	1.34463 E-02	0.802

7 Modelization C

7.1 Characteristic of the modelization



the elements used are shell elements DST.

7.2 Characteristics of the mesh

Coordinated of the nodes:

Node	X	Y	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 meshes DKT (TRIA3)

7.3 Functionalities tested

Commands	Factor key word
AFFE_CARA_ELEM	EXCENTREMENT
AFFE_CHAR_MECA	FORCE_ARETE

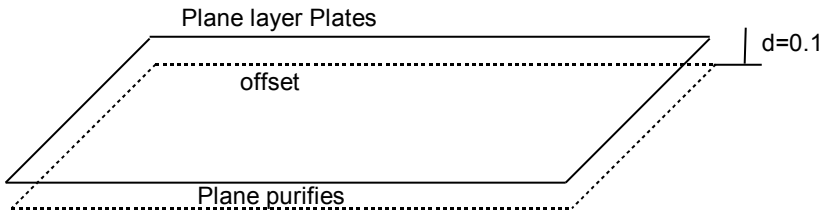
8 Results of the modelization C

8.1 Values tested

Identification	Reference	*Aster*	% difference
DX (N66)	2.5.2.5		5.73 E-14
DY (N66)	0.	– 6.62 E-15	– 6.62 E-15
DZ (N66)	0.	4.48 E-12	4.48 E-12
DRX (N66)	0.	– 2.19 E-13	– 2.19 E-13
DRY (N66)	0.	– 6.69 E-13	– 6.69 E-13
DX (N52)	2.	2.	1.49 E-08
DY (N52)	0.	– 4.08 E-15	– 4.08 E-15
DZ (N52)	0.	3.62 E-12	3.62 E-12
DRX (N52)	0.	– 1.60 E-13	– 1.60 E-13
DRY (N52)	0.	– 7.34 E-13	– 7.34 E-13
Frequency 1st mode	1.4439E-03	1.4465 E-03	0.182
Frequency 2nd mode	3.71554 E-03	3.7984 E-03	2.231
Frequency 3rd mode	9.01537 E-03	9.1305 E-03	1.277
Frequency 4th mode	1.34708 E-02	1.4077 E-02	4.501

9 Modelization D

9.1 Characteristic of the modelization



the elements used are shell elements DSQ.

9.2 Characteristics of the mesh

Coordinated of the nodes:

Node	X	Y	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 meshes DSQ (QUAD4)

9.3 Functionalities tested

Commands	Factor key word
AFFE_CARA_ELEM	EXCENTREMENT
AFFE_CHAR_MECA	FORCE_ARETE

10 Results of the modelization D

10.1 Values tested

Identification	Reference	*Aster*	% difference
DX (N1)	2.5.2.5		– 1.33 E-14
DY (N1)	0.	2.61 E-14	2.61 E-14
DZ (N1)	0.	– 6.26 E-13	– 6.26 E-13
DRX (N1)	0.	– 8.18 E-15	– 8.18 E-15
DRY (N1)	0.	9.57 E-14	9.57 E-14
DX (N16)	2.	2.	1.49 E-08
DY (N16)	0.	1.79 E-14	1.79 E-14
DZ (N16)	0.	– 3.97 E-13	– 3.97 E-13
DRX (N16)	0.	– 1.71 E-14	– 1.71 E-14
DRY (N16)	0.	9.03 E-14	9.03 E-14
Frequency 1st mode	1.44474E-03	1.446841 E-03	0.145
Frequency 2nd mode	3.69339 E-03	3.703038 E-03	0.261
Frequency 3rd mode	9.04773 E-03	9.14141 E-03	1.023
Frequency 4th mode	1.33393 E-02	1.34463 E-02	0.802

11 Summary of the results

For each modelization, DKT, DKQ, DST and DSQ , the results found for the offset plate coincide with the reference solution.