

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 a sinusoidal pressure.

Displacement in the center is calculated, the constraints σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} with the lower interfaces average and higher, efforts of membrane N_{xx} , N_{yy} , N_{xy} , the efforts cutting-edges T_x , T_y and moments M_{xx} , M_{yy} and M_{xy} .

The test gathers 14 modelings: with regard to modelings with with F, the got results are compared for modelings DKQ, DSQ, DKT, DST, COQUE_3D with triangular meshes and COQUE_3D with rectangular meshes. Modelings G and H allow 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 total reference mark and user. They make it possible to estimate the distribution of the plane constraints and transverse shearing inside the plate.

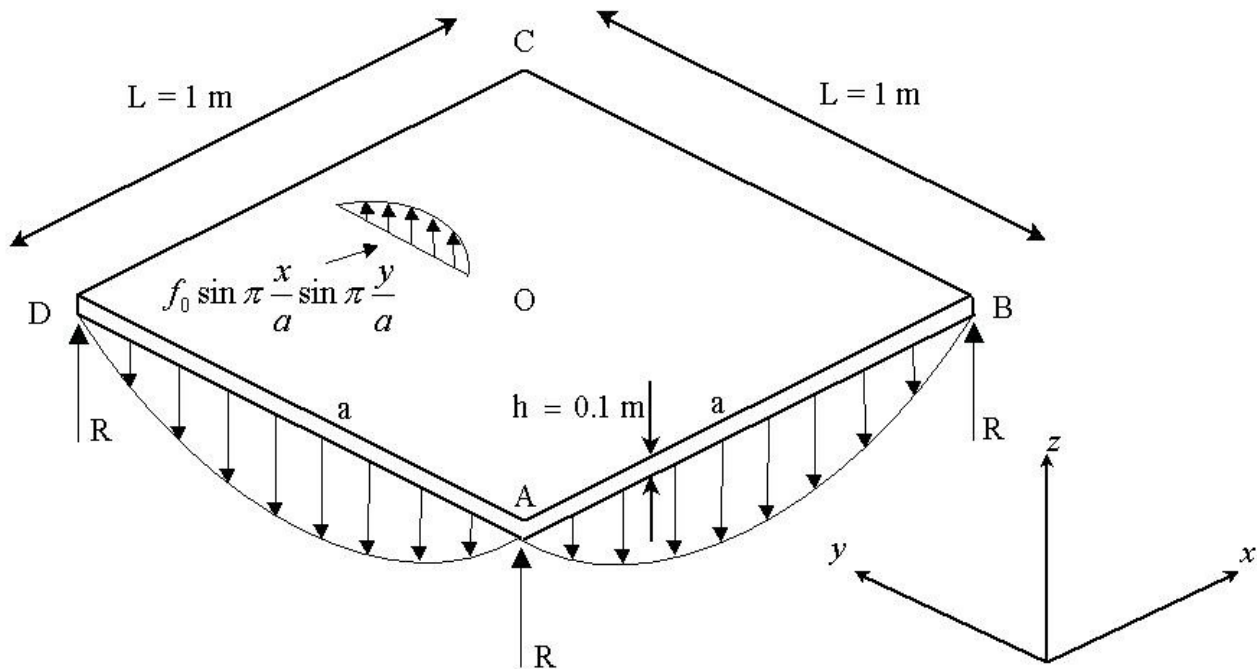
Modelings O with R validate the element Q4G.

Modelings S with T validate modeling Q4GG.

Modeling W validate the element T3G.

1 Problem of reference

1.1 Geometry



1.2 Material properties

$$E = 25 \text{ Pa}$$

$$\nu = 0.25$$

$$\rho = 1 \text{ kg/m}^3$$

1.3 Boundary conditions and loadings

Simple bearing plate

<i>AB</i>	$DX = 0.$	$DZ = 0.$	$DRY = 0.$	$MY = 0.$	
<i>BC</i>	$DY = 0.$	$DZ = 0.$	$DRX = 0.$	$MX = 0.$	
<i>CD</i>	$DX = 0.$	$DZ = 0.$	$DRY = 0.$	$MY = 0.$	
<i>DA</i>	$DY = 0.$	$DZ = 0.$	$DRX = 0.$	$MX = 0.$	
Not <i>O</i>	$DX = 0.$	$DY = 0.$	$DRX = 0.$	$DRY = 0.$	$DRZ = 0.$

Loading:

FORCE_COQUE Sinusoidal pressure *P*

With $P = f_0 \sin \pi \frac{x}{a} \sin \pi \frac{y}{a}$, where $f_0 = 1$ and $a = 1$

1.4 Initial conditions

Without object for the static analysis.

2 Reference solution

2.1 Method of calculating used for the reference solution

The analytical solution of reference is based on the theory of Coil-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:

$$w = \frac{f_0 a^4}{4\pi^4 D} \sin \pi \frac{x}{a} \sin \pi \frac{y}{a}$$

with:

$$D = \frac{E h^3}{12(1-\nu^2)}, \quad f_0 = 1, \quad a = 1 \quad \text{and} \quad \nu = 0.25$$

For the calculation of the moments, the theory leads to the following expressions:

$$\begin{aligned} M_{xx} &= \alpha(1+\nu) \sin \pi \frac{x}{a} \sin \pi \frac{y}{a} \\ M_{yy} &= M_{xx} \\ M_{xy} &= -\alpha(1-\nu) \cos \pi \frac{x}{a} \cos \pi \frac{y}{a} \end{aligned}$$

For the calculation of the curves, the theory leads to the following expressions:

$$\begin{aligned} \kappa_{xx} &= -\frac{f_0 a^2}{4\pi^2 D} \sin \left(\pi \frac{x}{a}\right) \sin \left(\pi \frac{y}{a}\right) \\ \kappa_{yy} &= -\frac{f_0 a^2}{4\pi^2 D} \sin \left(\pi \frac{x}{a}\right) \sin \left(\pi \frac{y}{a}\right) \\ \kappa_{xy} &= \frac{f_0 a^2}{4\pi^2 D} \cos \left(\pi \frac{x}{a}\right) \cos \left(\pi \frac{y}{a}\right) \end{aligned}$$

$$\text{with } \alpha = \frac{f_0 a^2}{4\pi^2}$$

For the efforts cutting-edges, one obtains:

$$\begin{aligned} T_x &= \frac{f_0 a}{2\pi} \cos \pi \frac{x}{a} \sin \pi \frac{y}{a} \\ T_y &= \frac{f_0 a}{2\pi} \sin \pi \frac{x}{a} \cos \pi \frac{y}{a} \end{aligned}$$

For a homogeneous plate, the plane constraints are given by:

$$\begin{pmatrix} \sigma_{xx} \\ \sigma_{yy} \\ \sigma_{xy} \end{pmatrix} = z[A] \begin{pmatrix} M_{xx} \\ M_{yy} \\ M_{xy} \end{pmatrix}$$

with $[A] = \frac{12}{h^3}[I]$ and z the position in the thickness of the plate

and stresses shear transverse by:

$$\begin{pmatrix} \sigma_x \\ \sigma_y \end{pmatrix} = [D_1(z)] \begin{pmatrix} T_x \\ T_y \end{pmatrix},$$

with $[D_1(z)] = \frac{6}{h^3} \left(\left(\frac{h}{2} \right)^2 - z^2 \right)$

For the deformation energy in inflection, one obtains:

$$E_{flexion} = \frac{1}{2} \int_S [(M_{xx} \cdot \kappa_{xx} + M_{yy} \cdot \kappa_{yy} + M_{xy} \cdot \kappa_{xy})] dS$$

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 the side AB , constraints σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on the plans:
 - inferior, means and superior of the plate in the full-course case,
 - inferior, means and superior of each slice in the multi-layer case (5 layers),
- in the center, with the corners and in the middle of the sides AB and AD , efforts of membrane N_{xx} , N_{yy} , N_{xy} , the efforts cutting-edges T_x , T_y and moments M_{xx} , M_{yy} and M_{xy} ,
- in the center (not O), point A, deformations of membrane e_{xx} , e_{yy} , e_{xy} and curves κ_{xx} , κ_{yy} , κ_{xy} ,

For modeling V, one calculates in the center (not O) the deformation energy $TOTALE$, of $MEMBRANE$ and of $FLEXION$.

The expression of these quantities at the points O, A, B, C, D give:

	w	M_{xx}	M_{yy}	M_{xy}	T_x	T_y	κ_{xx}	κ_{yy}	κ_{xy}
O	$\frac{3(1-\nu^2)}{\pi^4 E h^3}$	$\alpha(1+\nu)$	$\alpha(1+\nu)$	0	0	0	$\frac{-\alpha}{D}$	$\frac{-\alpha}{D}$	0
A	-	0	0	$-\alpha(1-\nu)$	0	0	0	0	$\frac{\alpha}{D}$
B	-	0	0	$\alpha(1-\nu)$	0	0	-	-	-
BI	-	0	0	0	0	$1/2 \pi$	-	-	-
C	-	0	0	$-\alpha(1-\nu)$	0	0	-	-	-
D	-	0	0	$\alpha(1-\nu)$	0	0	-	-	-

Digital application:

$$\frac{3(1-\nu^2)}{\pi^4 E h^3} = 1.154923$$

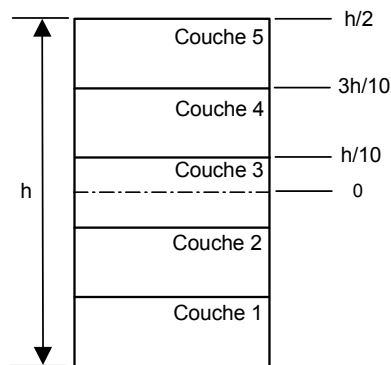
$$\alpha(1+\nu) = 0.0316629$$

$$\alpha(1-\nu) = 0.0189972$$

$$1/2 \pi = 0.159155$$

The distribution of the plane constraints and shearing at the points O and BI inside the plate is the following one:

O	σ_{xx}	σ_{yy}	σ_{xy}	σ_{xz}	σ_{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
$-3h/10$	-	-	0	0	0
$-h/2$	-	-	0	0	0
	18.9972	18.9972			



BI	σ_{xx}	σ_{yy}	σ_{xy}	σ_{xz}	σ_{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 Bibliographical references

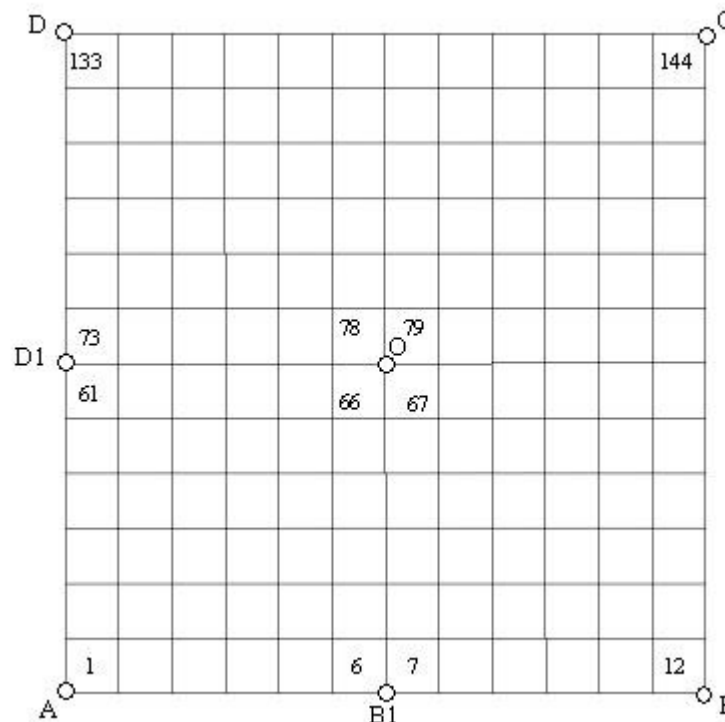
- 1) BATOZ and DHATT. Modeling of the structures by finite elements. Beams and Plates. Volume 2 HERMES, 1990.

3 Modeling A

3.1 Characteristics of modeling

Quadrangular element of hull DKQ.

The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

3.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 144 QUAD4

3.3 Sizes tested and results

Identification

Not O ($M78$) σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layers inferior, medium and superior

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Vertical arrow $w = DZ$

Not B1 (M6) $\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

Not O	(M78)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M79)	T_x, T_y
	(M66)	T_x, T_y
	(M67)	T_x, T_y

Identification

Not A	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M12)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not C	(M144)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M133)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M6)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M7)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

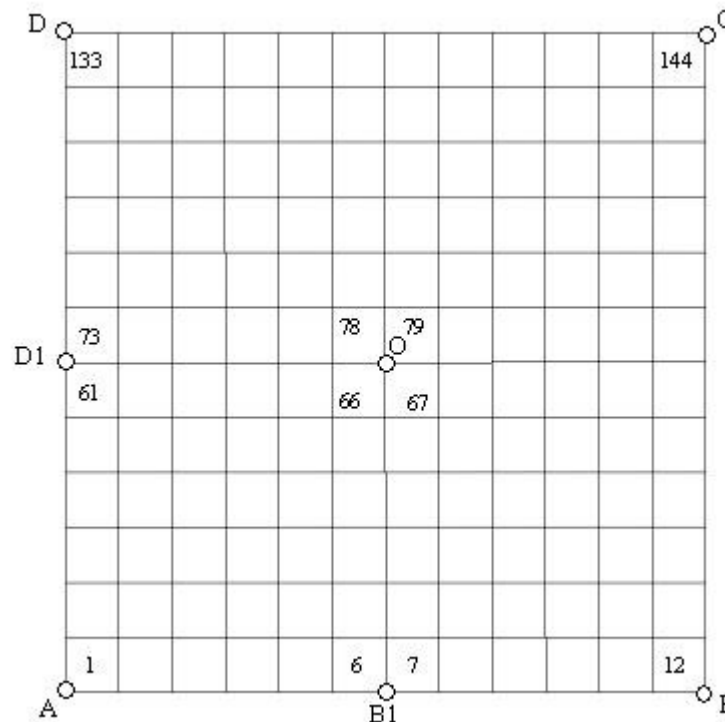
Not D1	(M61)	T_x, T_y
	(M73)	$, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

4 Modeling B

4.1 Characteristics of modeling

Quadrangular element of hull DSQ.

The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY
MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX:
0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY
MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX:
0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX:
0. , DRY MARTINI: 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.)
```

4.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 144 QUAD4

4.3 Sizes tested and results

Identification	
Not O M78	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior Vertical arrow $w = DZ$
Not BI (M6)	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification	
	(M78) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not O	(M79) T_x, T_y
	(M66) T_x, T_y
	(M67) T_x, T_y

Identification	
Not A	(M1) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M12) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification	
Not C	(M144) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M133) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification	
Not BI	(M6) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M7) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

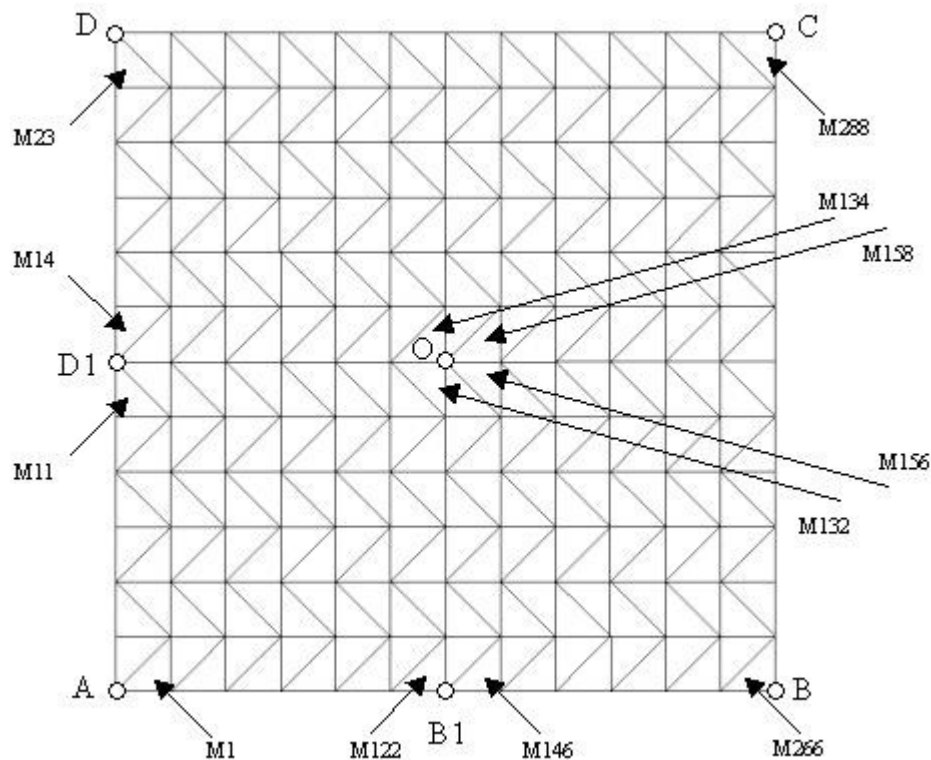
Identification	
Not DI	(M61) T_x, T_y
	(M73) $, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

5 Modeling C

5.1 Characteristics of modeling

Triangular element of hull DKT.

The reference mark user is confused with the reference mark of orthotropism.



Conditions with limits:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

5.2 Characteristics of the grid

Many nodes: 170

Number of meshes and type: 288 TRIA3

5.3 Sizes tested and results

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Identification

Not O	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
<i>M134</i>	
Displacement	$w = DZ$
Not B1	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

Not	<i>(M1)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
With		
Not B	<i>(M266)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	<i>(M288)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	<i>(M23)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	<i>(M122)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	<i>(M146)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

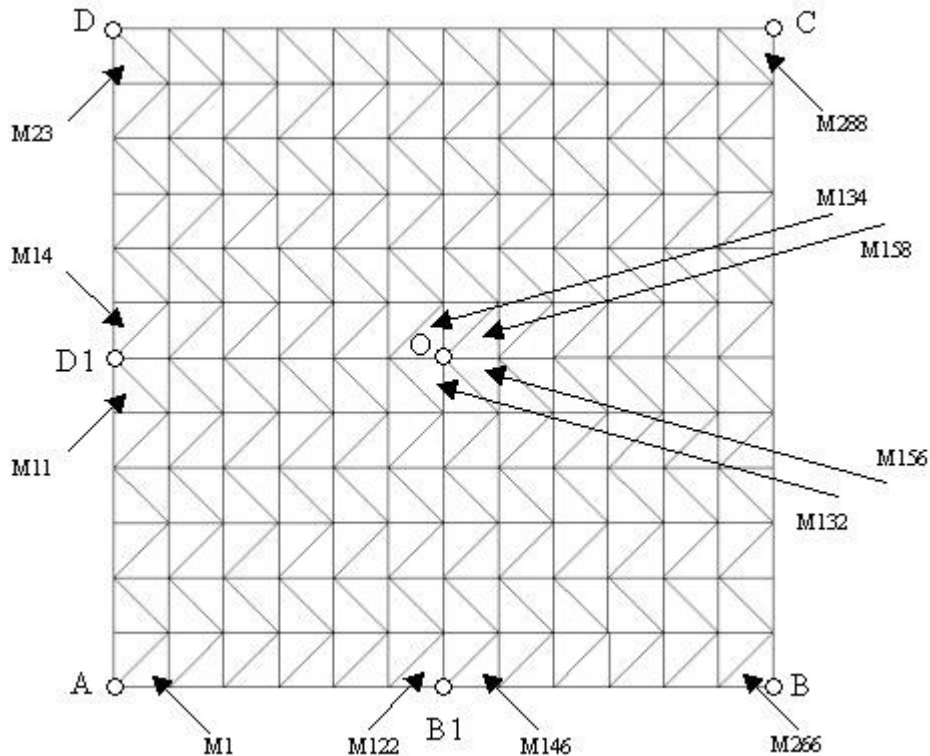
Not D1	<i>(M11)</i>	T_x, T_y
	<i>(M14)</i>	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

6 Modeling D

6.1 Characteristics of modeling

Triangular element of hull DST.

The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY MARTINI:
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.)
```

6.2 Characteristics of the grid

Many nodes: 170

Number of meshes and type: 288 TRIA3

6.3 Sizes tested and results

Identification

Not O MI34	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	
Not O	DZ
Not B1 MI22	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

	(MI34)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(MI58)	T_x, T_y
Not O	(MI32)	T_x, T_y
	(MI56)	T_x, T_y

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M266)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	(M288)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M23)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(MI22)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(MI46)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

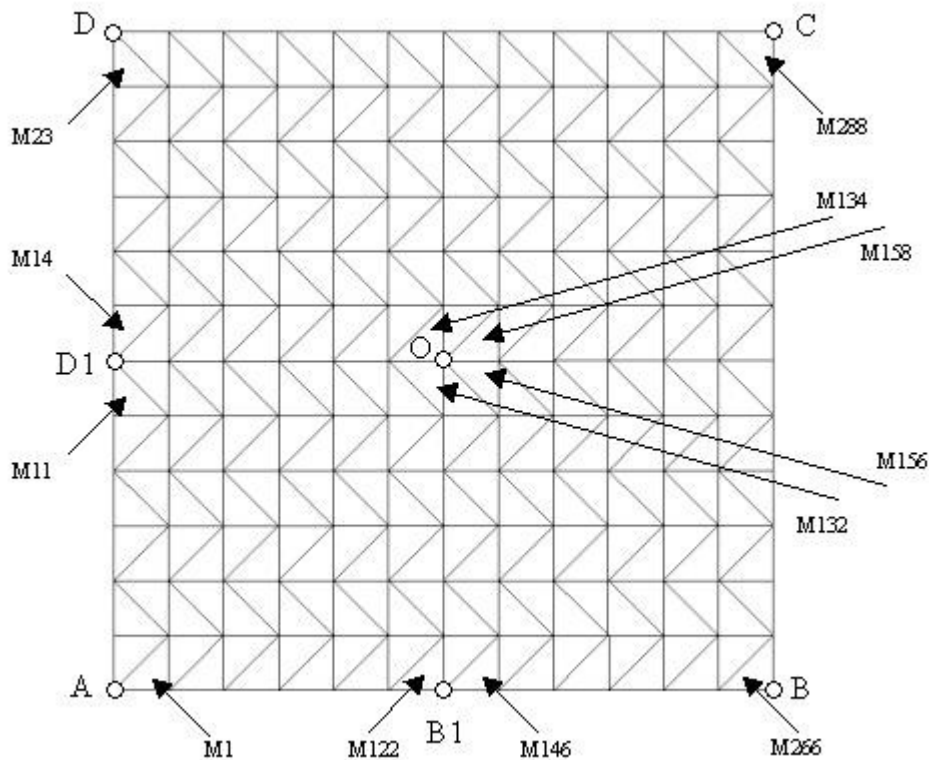
Not D1	(M11)	T_x, T_y
	(M14)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

7 Modeling E

7.1 Characteristics of modeling

Element of hull COQUE_3D triangle.

The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

7.2 Characteristics of the grid

Many nodes: 626

Number of meshes and type: 288 TRIA6

7.3 Sizes tested and results

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Identification

Not o (MI34)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	DZ
Not B (MI22)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Mesh (MI32)	
Equivalent deformations	INVA2
Mesh (MI32)	
Equivalent constraints Von Mises	VMIS
Equivalent constraints Tresca	TRESCA

Identification

Not O	(MI34)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(MI58)	T_x, T_y
	(MI32)	$T_x, T_y, K_{xx}, K_{yy}, K_{xy}$
	(MI56)	T_x, T_y

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M266)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	(M288)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M23)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(MI22)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(MI46)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not D1	(M11)	T_x, T_y
	(MI4)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

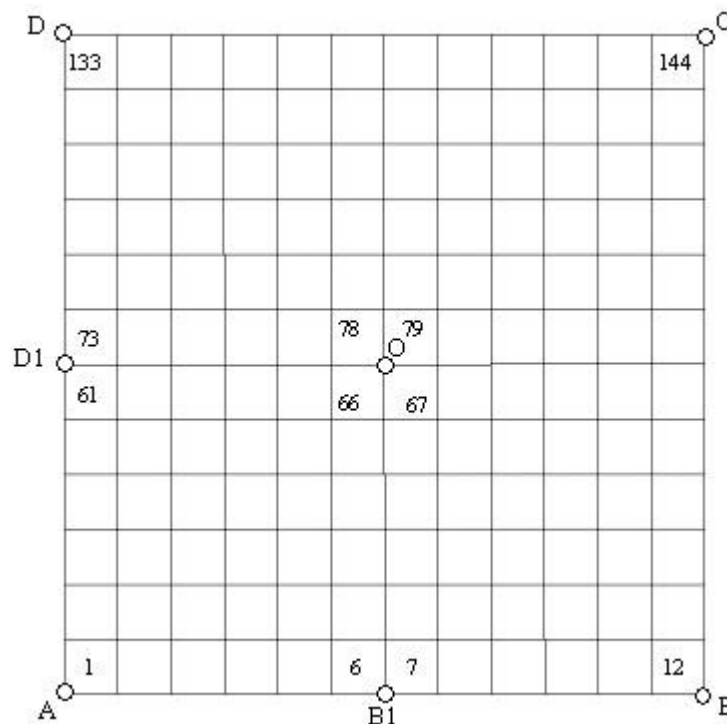
Not 7	(MI32)	INVA2
	(MI32)	VMIS, TRESCA

8 Modeling F

8.1 Characteristics of modeling

Element of hull COQUE_3D quadrangle.

The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY MARTINI:
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.)
```

8.2 Characteristics of the grid

Many nodes: 482

Number of meshes and type: 144 QUAD8

8.3 Sizes tested and results

Identification

Not O

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M78	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacements	DZ
Not B1	
M6	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

Not O	(M78)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M79)	T_x, T_y
	(M66)	$T_x, T_y, K_{xx}, K_{yy}, K_{xy}$
	(M67)	T_x, T_y

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M12)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	(M144)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M133)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M6)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M7)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

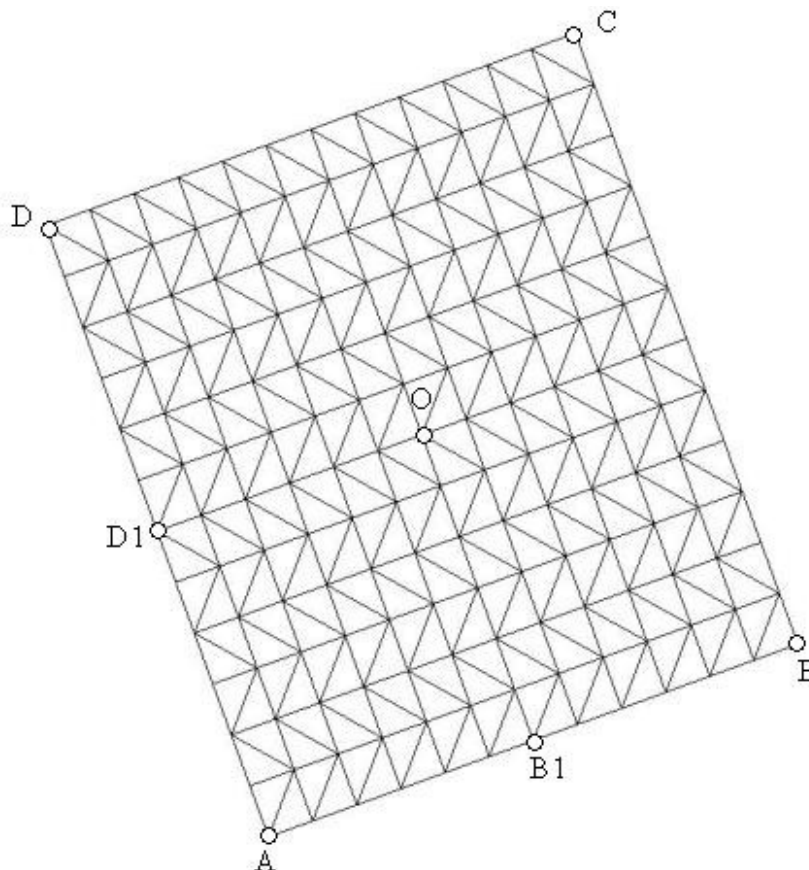
Not D1	(M61)	T_x, T_y
	(M73)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

9 Modeling G

9.1 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 meshes is identical to that of modeling D .



Boundary conditions:

LIAISON_OBLIQUE

(GROUP_NO: AB, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DZ:
0. , DRY MARTINI: 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 MARTINI: 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 MARTINI: 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.)

9.2 Characteristics of the grid

Many nodes: 170
Number of meshes and type: 288 TRIA3

9.3 Sizes tested and results

Identification	
Not o (M134)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	DZ
Not B1 (M122)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification	
Not o	(M134) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M158) T_x, T_y
	(M132) T_x, T_y
	(M156) T_x, T_y
Not With	(M1) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M266) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification	
Not C	(M288) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M23) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B1	(M122) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M146) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification	
Not D1	(M11) T_x, T_y
	(M14) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

9.4 Remarks

The value of reference of displacement to the point O is obtained by projecting the displacement calculated for modeling D in the reference mark turned (displacement for modeling D being vertical, new displacement is function of the projection of the axis Z).

In the local reference mark, the projection of the axis Z is the following one:

$$\begin{bmatrix} \sin \beta \cos \alpha \\ \sin \beta \sin \alpha \\ \cos \beta \end{bmatrix}, \text{ with } \alpha = 20. \text{ and } \beta = 30.$$

In addition, the expression of the sinusoidal pressure in the turned reference mark becomes:

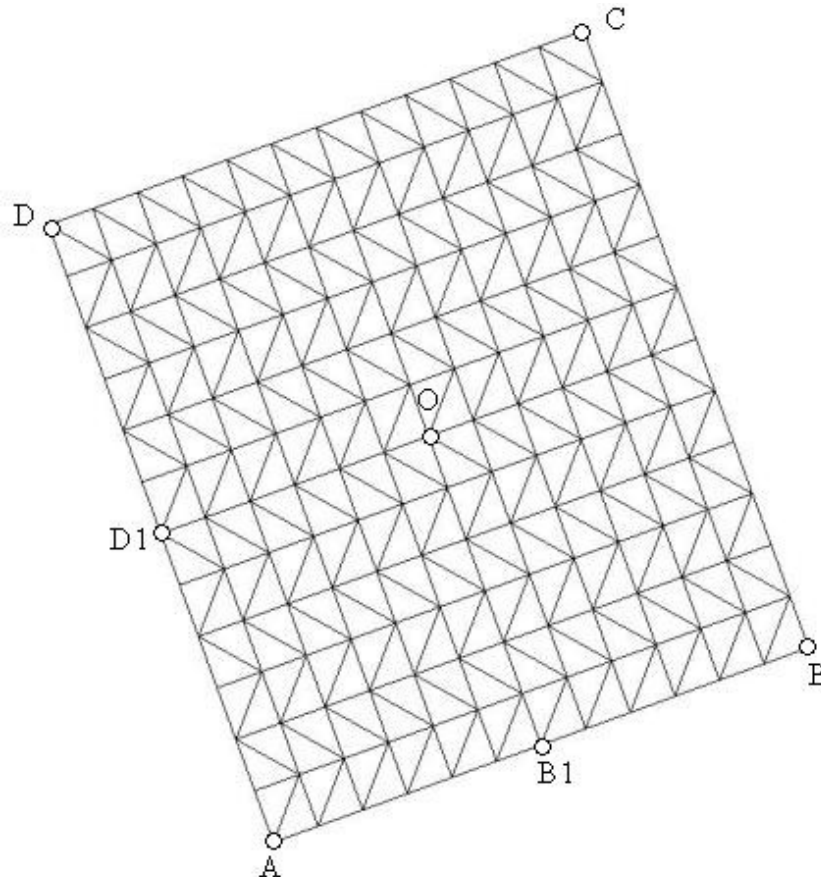
$$P = f_0 \sin \pi \frac{\cos \alpha \cos \beta x + \sin \alpha \cos \beta y - \sin \beta z}{a} \sin \pi \frac{\cos \alpha y - \sin \alpha x}{a}$$

10 Modeling H

10.1 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 meshes is identical to that of modeling *E*.



Boundary conditions:

LIAISON_OBLIQUE

(GROUP_NO: AB, ANGL_NAUT= (20. , 30. , 0.), DX: 0. , DZ: 0. , DRY
MARTINI: 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
MARTINI: 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 MARTINI: 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.)

10.2 Characteristics of the grid

Many nodes: 626
Number of meshes and type: 288 TRIA6

10.3 Sizes tested and results

Identification

Not o (M134)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	DZ
Not B1 (M122)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

	(M134)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M158)	T_x, T_y
Not o	(M132)	T_x, T_y
	(M156)	T_x, T_y
Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M266)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not C	(M288)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M23)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M122)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M146)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not D1	(M11)	T_x, T_y
	(M14)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

10.4 Remarks

The value of reference of displacement to the point O is obtained by projecting the displacement calculated for modeling E in the reference mark turned (displacement for modeling E being vertical, new displacement is function of the projection of the axis Z).

In the local reference mark, the projection of the axis Z is the following one:

$$\begin{bmatrix} \sin \beta \cos \alpha \\ \sin \beta \sin \alpha \\ \cos \beta \end{bmatrix}, \text{ with } \alpha = 20. \text{ and } \beta = 30.$$

In addition, the expression of the sinusoidal pressure in the turned reference mark becomes:

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

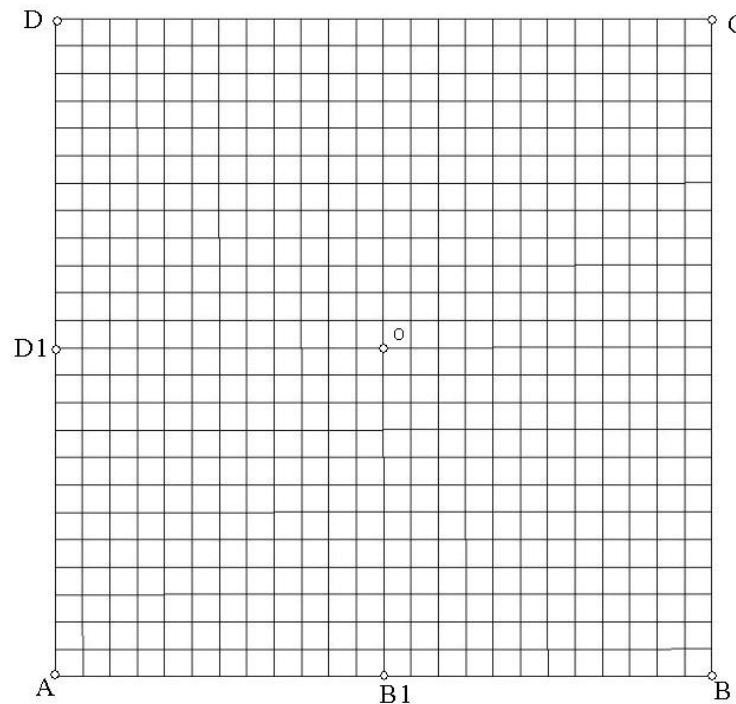
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$$P = f_0 \sin \pi \frac{\cos \alpha \cos \beta x + \sin \alpha \cos \beta y - \sin \beta z}{a} \sin \pi \frac{\cos \alpha y - \sin \alpha x}{a}$$

11 Modeling I

11.1 Characteristics of modeling

Quadrangular element of hull DSQ . The plate is modelled with a grid 24×24 .
The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

11.2 Characteristics of the grid

Many nodes: 626
Number of meshes and type: 576 QUAD4

11.3 Sizes tested and results

Identification

Not o (M300)

Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	DZ
Not B1 (M12)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

Not O	(M300)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M301)	T_x, T_y
	(M276)	T_x, T_y
	(M277)	T_x, T_y

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M24)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	(M576)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M576)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M12)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M13)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

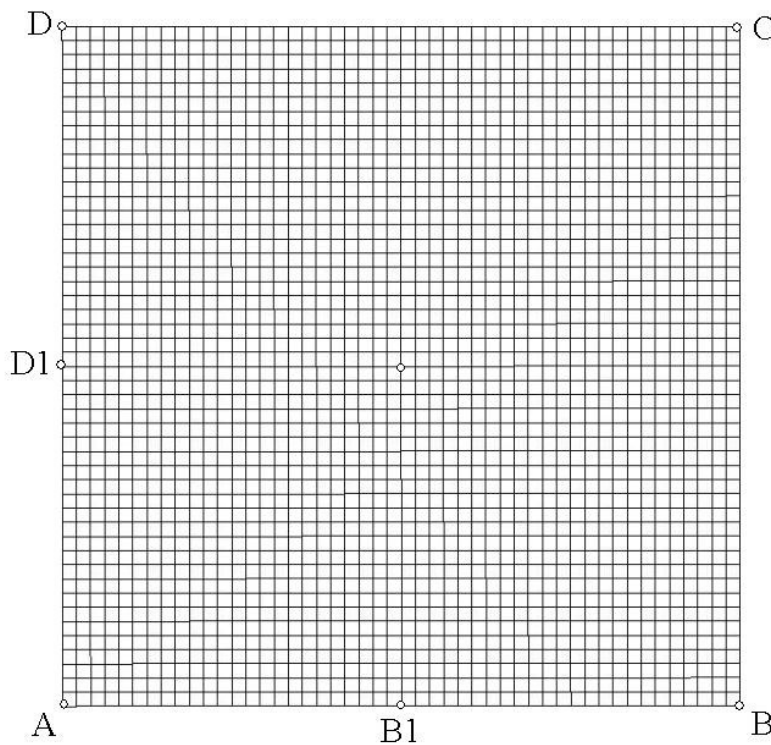
Identification

Not D1	(M265)	T_x, T_y
	(M289)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

12 Modeling J

12.1 Characteristics of modeling

Quadrangular element of hull DSQ . The plate is modelled with a grid 48×48 .
The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY  
MARTINI: 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.)
```

12.2 Characteristics of the grid

Many nodes: 2402
Number of meshes and type: 2304 QUAD4

12.3 Sizes tested and results

Identification

Not O M1176	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	DZ
Not B1 (M24)	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

Not O	(M1176)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M1177)	T_x, T_y
	(M1128)	T_x, T_y
	(M1129)	T_x, T_y

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M48)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	(M2304)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M2257)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M24)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M25)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

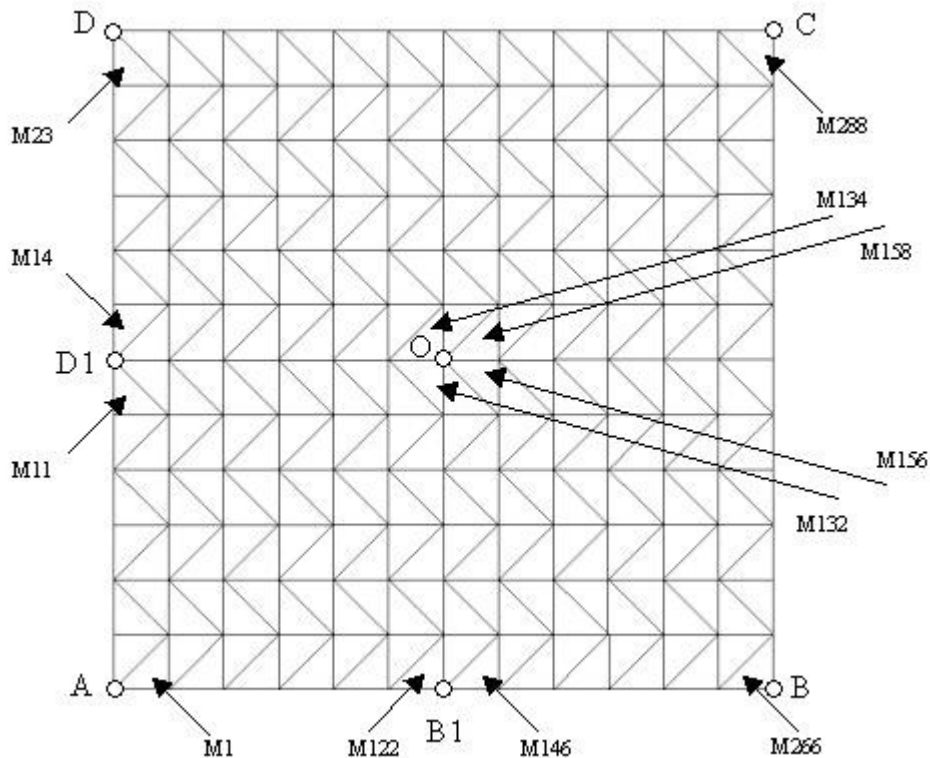
Identification

Not D1	(M1105)	T_x, T_y
	(M1153)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

13 Modeling K

13.1 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.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

13.2 Characteristics of the grid

Many nodes: 170

Number of meshes and type: 288 TRIA3

13.3 Sizes tested and results

Identification

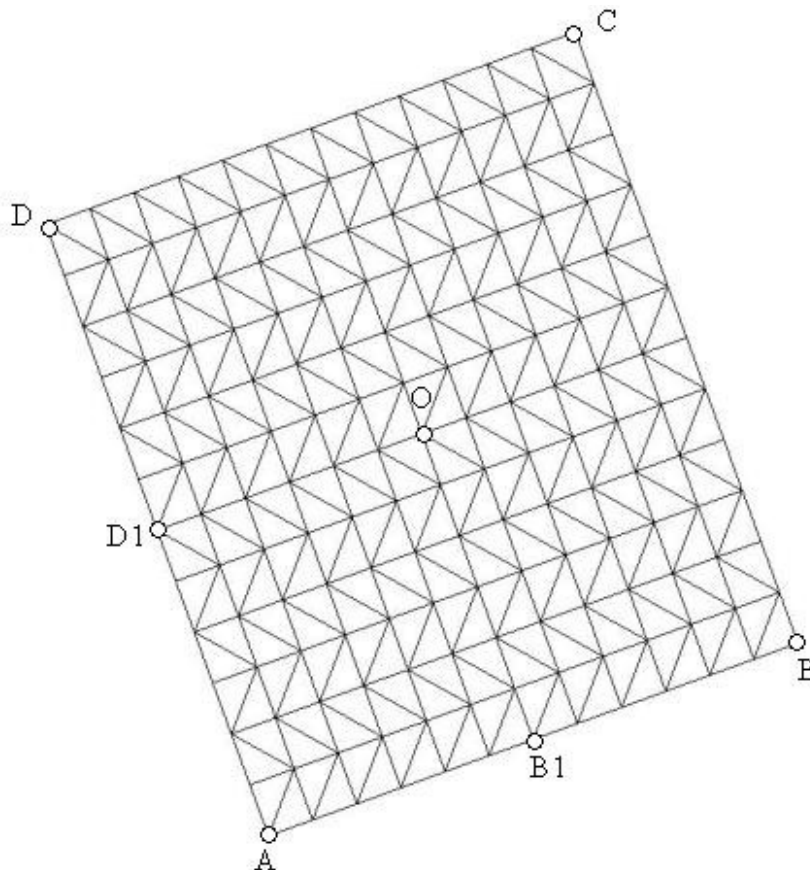
Not O MI34	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer
Displacement	<i>DZ</i>
Not BI MI22	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer

14 Modeling L

14.1 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 α and of 30 degrees according to β . The classification of the meshes is identical to that of modeling `K`.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY  
MARTINI: 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.)
```

14.2 Characteristics of the grid

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Many nodes: 170
Number of meshes and type: 288 TRIA3

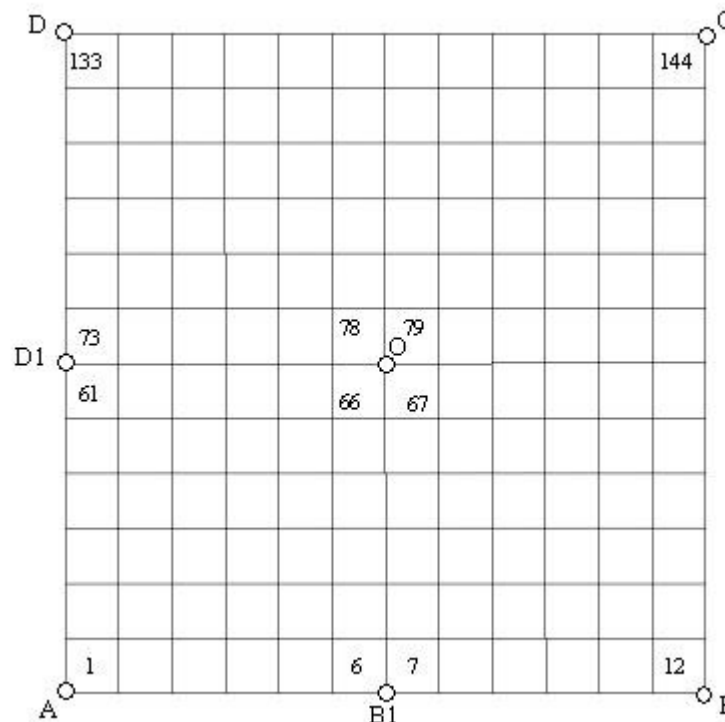
14.3 Sizes tested and results

Identification	
Not O MI34	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , $\bar{\sigma}_{xz}$, $\bar{\sigma}_{yz}$ on higher layer
Displacement	DZ
Not B1 MI22	
Lay down 1	$\bar{\sigma}_{xx}$, $\bar{\sigma}_{yy}$, $\bar{\sigma}_{xy}$, $\bar{\sigma}_{xz}$, $\bar{\sigma}_{yz}$ on lower layer
3 sleep	$\bar{\sigma}_{xx}$, $\bar{\sigma}_{yy}$, $\bar{\sigma}_{xy}$, $\bar{\sigma}_{xz}$, $\bar{\sigma}_{yz}$ on layer medium
5 sleep	$\bar{\sigma}_{xx}$, $\bar{\sigma}_{yy}$, $\bar{\sigma}_{xy}$, $\bar{\sigma}_{xz}$, $\bar{\sigma}_{yz}$ on higher layer

15 Modeling M

15.1 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 MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

15.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 144 QUAD4

15.3 Sizes tested and results

Identification

Not O MI34

Code Aster

Version
default

Titre : SSLS118 - Plaque carrée posée soumise à une pressi[...]
Responsable : DE SOZA Thomas

Date : 08/10/2013 Page : 33/54
Clé : V3.03.118 Révision :
690c953077fb

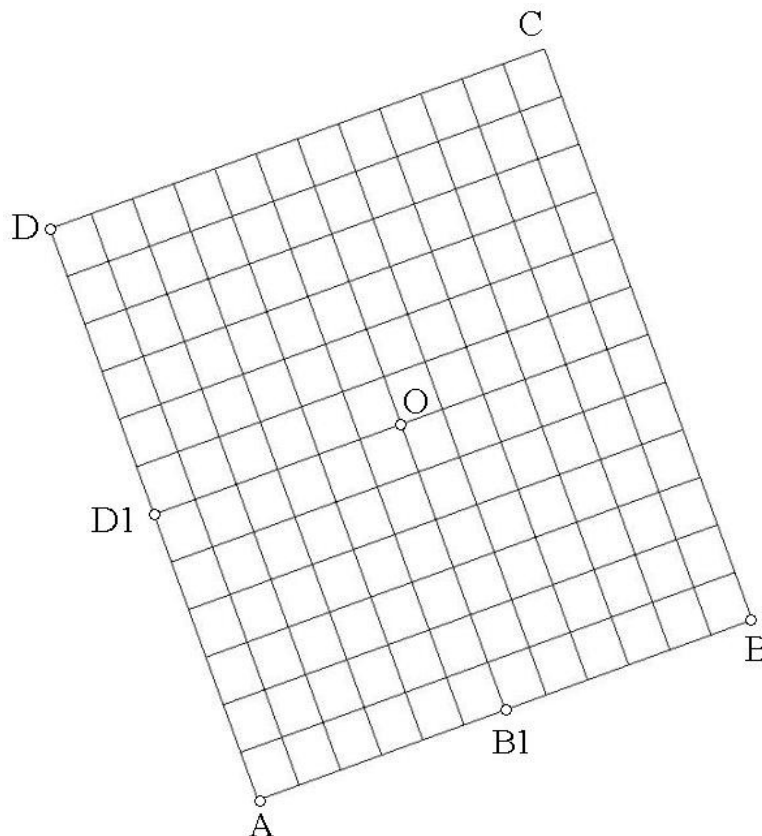
Lay down 1	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on lower layer
3 sleep	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layer medium
5 sleep	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on higher layer
Displacement	<i>DZ</i>
Not B1 M122	
Lay down 1	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on lower layer
3 sleep	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layer medium
5 sleep	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on higher layer

16 Modeling NR

16.1 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 meshes is identical to that of modeling Mr.



Boundary conditions:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY MARTINI:
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.)
```

16.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 144 QUAD4

16.3 Sizes tested and results

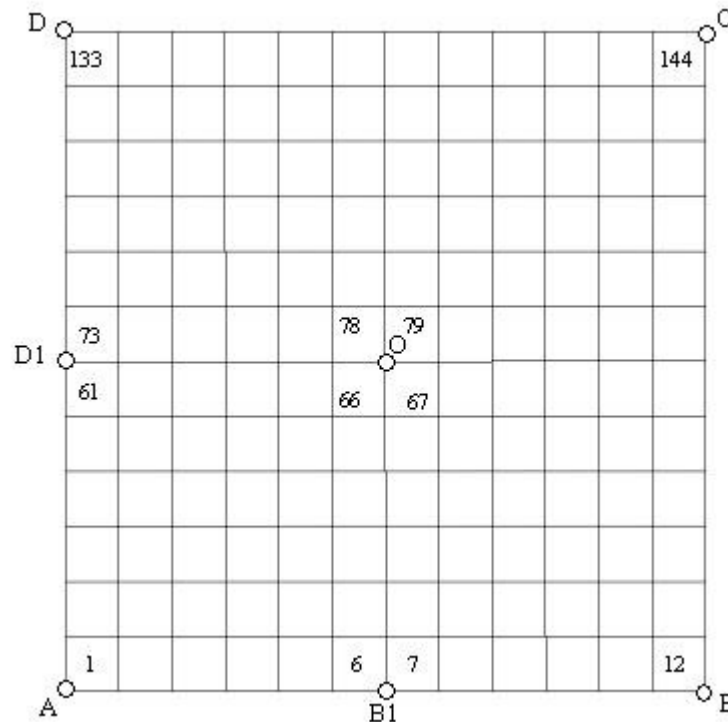
	Identification
Not O MI34	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer
Displacement	DZ
Not B1 MI22	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer

17 Modeling O

17.1 Characteristics of modeling

Quadrangular element of hull Q4G.

The reference mark user is confused with the reference mark of orthotropism.



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY MARTINI:
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.)
```

17.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 144 QUAD4

17.3 Sizes tested and results

Identification

Not O M78	
Constraints	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior
Displacement	DZ
Not B1 M6	
	$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}, \sigma_{xz}, \sigma_{yz}$ on layers inferior, medium and superior

Identification

Not O	(M78)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M79)	T_x, T_y
	(M66)	T_x, T_y
	(M67)	T_x, T_y

Identification

Not C	(M144)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M133)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not D1	(M61)	T_x, T_y
	(M73)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
----------	------	--

Identification

Not B	(M12)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
-------	-------	--

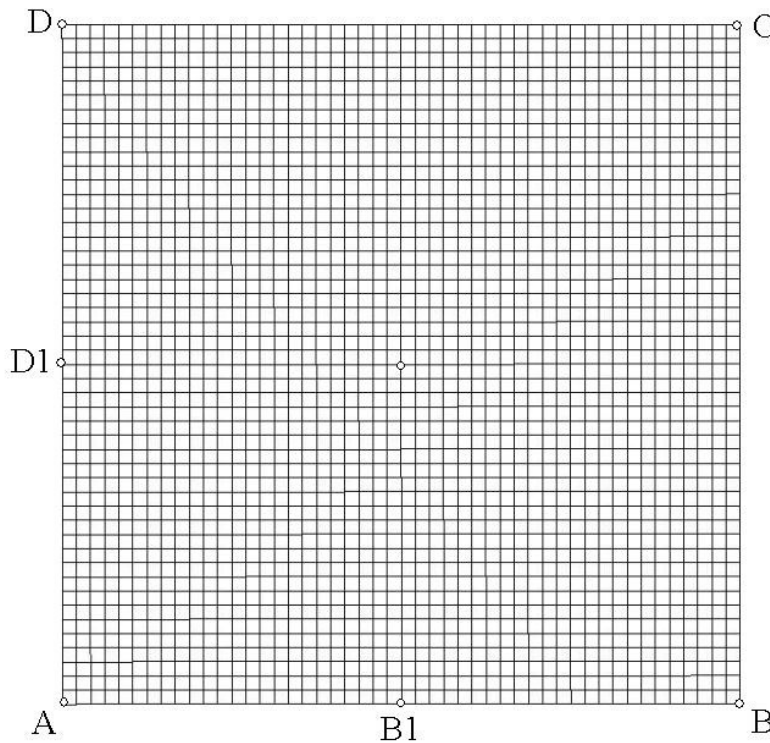
Identification

Not B1	(M6)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M7)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

18 Modeling P

18.1 Characteristics of modeling

Quadrangular element of hull Q4G. The plate is modelled with a grid 48×48 .
The reference mark user is confused with the reference mark of orthotropism.



Limiting conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY MARTINI:  
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.)
```

18.2 Characteristics of the grid

Many nodes: 2402
Number of meshes and type: 2304 QUAD4

18.3 Sizes tested and results

Identification

Not O M1176

Constraints

σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layers inferior, medium and superior

Displacement

DZ

Not B1 M24

Constraints

σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layers inferior, medium and superior

Identification

Not O	(M1176)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y
	(M1177)	T_x , T_y
	(M1128)	T_x , T_y
	(M1129)	T_x , T_y

Identification

Not With	(M1)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y
Not B	(M48)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y
Not C	(M2304)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y
Not D	(M2257)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y

Identification

Not B1	(M24)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y
	(M25)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y

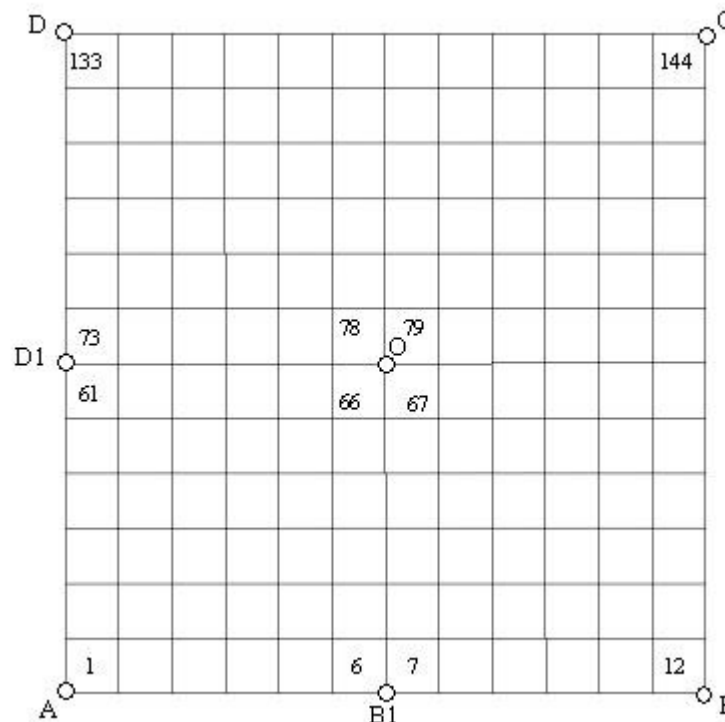
Identification

Not D1	(M1105)	T_x , T_y
	(M1153)	N_{xx} , N_{yy} , N_{xy} , M_{xx} , M_{yy} , M_{xy} , T_x , T_y

19 Modeling Q

19.1 Characteristics of modeling

Isotropic multi-layer plate (5 layers in the thickness). Quadrangular element of hull Q4G.
The reference mark user is confused with the reference mark of orthotropism.



Limiting conditions:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY
MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX:
0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY
MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX:
0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX:
0. , DRY MARTINI: 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.)
```

19.2 Characteristics of the grid

Many nodes: 171
Number of meshes and type: 144 QUAD4

19.3 Sizes tested and results

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Identification

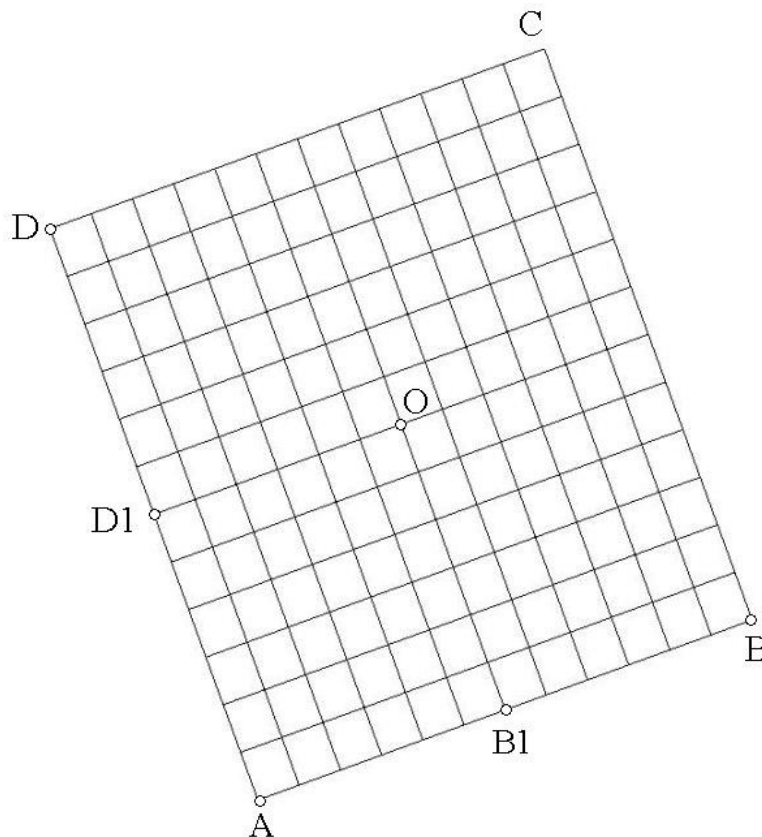
Not O MI34	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer
Displacement	Vertical arrow $w = DZ$
Not B1 MI22	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer

20 Modeling R

20.1 Characteristics of modeling

Isotropic multi-layer plate (5 layers in the thickness). Quadrangular element of hull Q4G.

The model of plate associated with modeling Q is turned of 20 degrees according to the nautical angle alpha and of 30 degrees according to beta. The classification of the meshes is identical to that of modeling Q .



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY  
MARTINI: 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.)
```

20.2 Characteristics of the grid

Many nodes: 171

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

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Number of meshes and type: 144 QUAD4

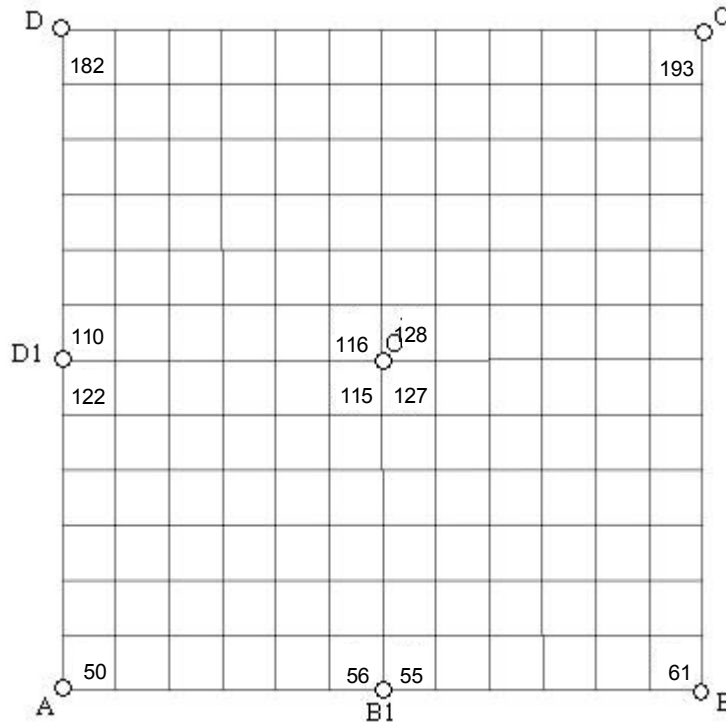
20.3 Sizes tested and results

		Identification
Not O M78		
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz}	on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz}	on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz}	on higher layer
Displacement	Vertical arrow $w = DZ$	
Not B1 M6		
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz}	on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz}	on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz}	on higher layer

21 Modeling S

21.1 Characteristics of modeling

Quadrangular element of hull Q4GG.



Boundary conditions:

DDL_IMPO

(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)

21.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 144 QUAD4

21.3 Sizes tested and results

Identification

Not ○	(M115)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M128)	T_x, T_y

	(M116)	T_x, T_y
	(M127)	T_x, T_y
		DZ

Identification

Not With	(M50)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M61)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not C	(M193)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M182)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M55)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M56)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

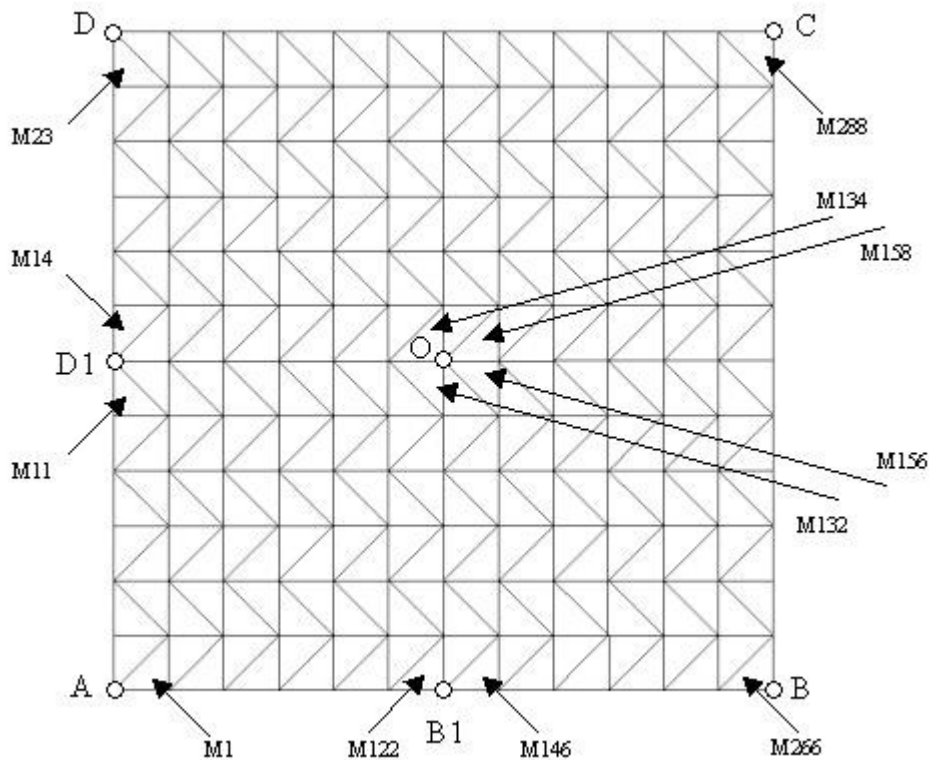
Identification

Not D1	(M122)	T_x, T_y
	(M110)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

22 Modeling T

22.1 Characteristics of modeling

Triangular element of hull Q4GG.



Boundary conditions:

```
DDL_IMPO
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY MARTINI:
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.)
```

22.2 Characteristics of the grid

Many nodes: 170
Number of meshes and type: 288 TRIA3

22.3 Sizes tested and results

Identification

Not O	(M134)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M158)	T_x, T_y
	(M132)	T_x, T_y
	(M156)	T_x, T_y
		DZ

Identification

Not With	(M1)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not B	(M266)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not C	(M288)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not D	(M23)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification

Not B1	(M122)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	(M146)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

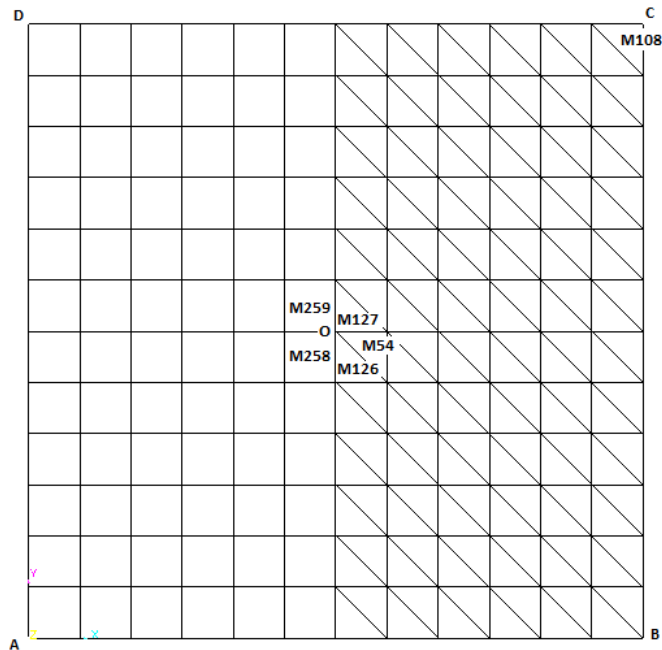
Identification

Not D1	(M11)	T_x, T_y
	(M14)	$N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

23 Modeling U

23.1 Characteristics of modeling

Element of quadrangular and triangular hull Q4GG.



Limiting conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

23.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 72 QUAD4 , 144 TRIA3

23.3 Sizes tested and results

Identification	
	(M258) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
Not	(M54) T_x, T_y
O	(M126) T_x, T_y
	DZ

Identification	
Not C	(M108) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

Identification		
(M126)	Point 1	M_{xx}
(M259)	Point 3	M_{yy}

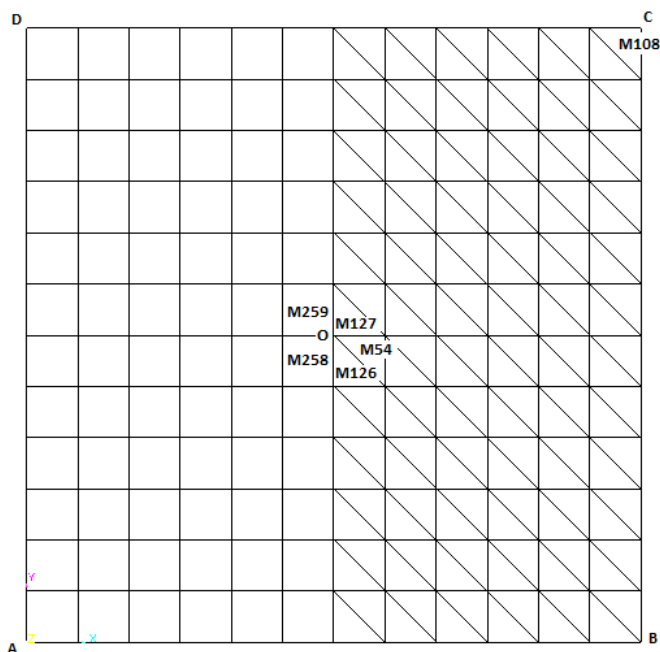
23.4 Remarks

In this modeling one checks that it is possible to calculate the generalized constraints (N , M , T) starting from fields of displacements coming from Europlexus.

24 Modeling V

24.1 Characteristics of modeling

Element of quadrangular and triangular hull DKTG.



Limiting conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY
MARTINI: 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.)
```

24.2 Characteristics of the grid

Many nodes: 171

Number of meshes and type: 72 QUAD4 , 144 TRIA3

24.3 Sizes tested and results

Identification	
Not O	(M258) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$
	Elastic energy: <i>TOTALE MEMBRANE FLEXION</i>
	(M54) T_x, T_y
	(M126) T_x, T_y
DZ	

Identification	
Not C	(M108) $N_{xx}, N_{yy}, N_{xy}, M_{xx}, M_{yy}, M_{xy}, T_x, T_y$

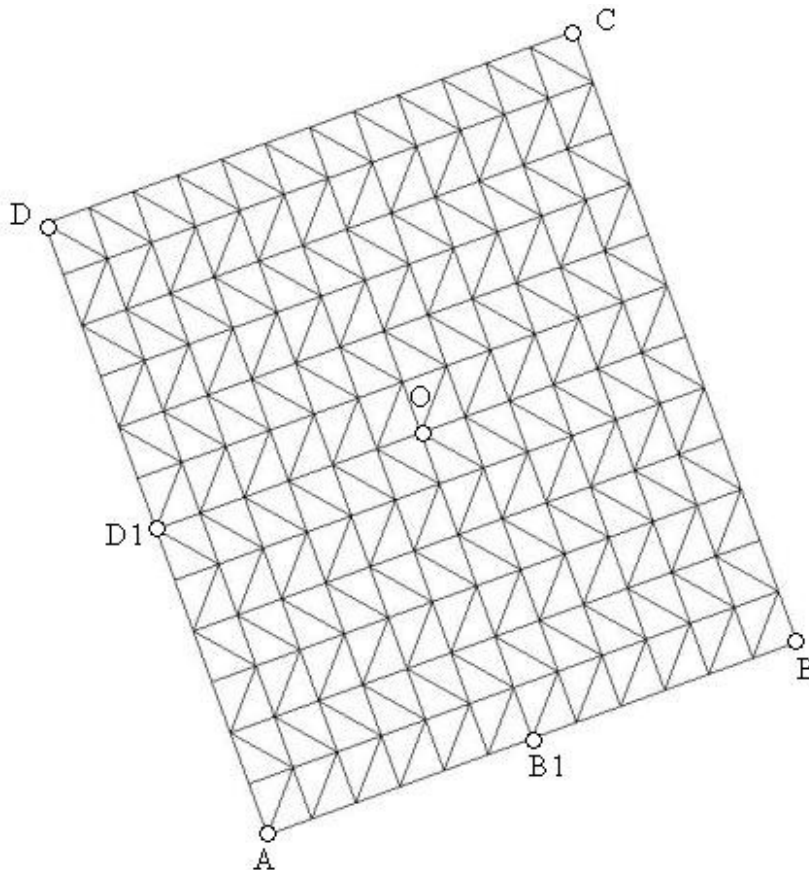
Identification		
(M126)	Point 1	M_{xx}
(M259)	Point 3	M_{yy}

25 Modeling W

25.1 Characteristics of modeling

Isotropic plate multi-layer (5 layers in the thickness). Triangular element of hull T3G.

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 meshes is identical to that of modeling K .



Boundary conditions:

DDL_IMPO

```
(GROUP_NO: AB, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: BC, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: CD, DX: 0. , DZ: 0. , DRY MARTINI: 0.)  
(GROUP_NO: DA, DY: 0. , DZ: 0. , DRX: 0.)  
(GROUP_NO: O, DX: 0. , DY: 0. , DRX: 0. , DRY  
MARTINI: 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.)
```

25.2 Characteristics of the grid

Many nodes: 170

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Number of meshes and type: 288 TRIA3

25.3 Sizes tested and results

Identification	
Not O MI34	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer
Displacement	<i>DZ</i>
Not B1 MI22	
Lay down 1	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on lower layer
3 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on layer medium
5 sleep	σ_{xx} , σ_{yy} , σ_{xy} , σ_{xz} , σ_{yz} on higher layer

26 Summary of the results

The got results show that:

- modeling `DSQ` provides a more precise estimate of the constraints and efforts cutting-edges (<5%) that modeling `DKQ` (=20%). The estimate of the moments is equivalent for two modelings,
- with grid of equivalent, modeling `DSQ` gets results more precise than modeling `Q4G` (comparison of modelings `B` and `O`). The 2 models converge towards the same results (comparison of modelings `J` and `P`). That is explained by the order of approximation of rotations which is quadratic for `DSQ` and bilinear for `Q4G`,
- the estimate of the constraints is more precise with modeling `DKT` (<2%) compared to modeling `DST` (<3,5%). The shearing action is estimated on the other hand better by `DST` (<10% for `DST` and <20% for `DKT`),
- for the configurations `COQUE_3D` triangle or quadrangle, the estimate of the transverse shear stress is constant in the thickness of the plate, in accordance with the assumptions of modeling,
- results expressed in the reference mark user for the configurations `DST` and `COQUE_3D` are identical to those expressed in the total reference mark,
- the refinement of the grid for the configuration `DSQ` improve the estimate of the constraints, efforts cutting-edges and moments; the tendency is reversed with regard to displacement,
- the multi-layer configuration makes it possible to visualize the distribution of the plane constraints and transverse shearing in the thickness of the plate, and to confirm the theory, namely 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 of the constraints,
- in a general way, with the nodes where one expects constraints or efforts analytically worthless, the got digital results are not correct owing to the fact that the estimates are made mesh by mesh then extrapolated with the nodes. Even the values realised with the nodes in question are not inevitably worthless.