SSLS114 - Non regression on cylindrical quarter of binding ring

Summarized:

It is about a test of mechanics in linear static.

The goal is to test the setting under pressure of a cylindrical quarter of binding ring with the shell elements and plate.

1 Problem of reference

1.1 Properties of the materials

$E = 200\,000\ MPa$
$\nu = 0.3$
$\rho = 1234.\ kg/m^3$ for the modelizations I, J and K.

1.2 Geometrical characteristics

One notes:

1) $R_1 = 0.975\ \mathrm{m}$ the interior radius of the cylinder;
2) $R_2 = 1.025\ \mathrm{m}$ the radius external of the cylinder;
3) $R = 1\ m$ the average radius of the cylinder equal to the half the sum of two the radius preceding ones;
4) $e = 0.05\ \mathrm{m}$ the radial thickness of the cylinder;
5) $h = 0.5\ \mathrm{m}$ the height of the cylinder.

1.3 Mechanical boundary conditions and loadings

Conditions of Dirichlet

DDL_IMPO, the nodes blocked depend on the modelization.

pressure on the shell elements and of plate: $P = 10\ MPa$ on cylinder

PRES_REP
FORCE_COQUE (real or given by a function)

2 analytical Reference solution

Solution.

2.1 Results of reference

Displacement of the average average

Forced of the average average, averages superior and inferior.

In the modelizations I, J and K, one calculates the mass, the coordinates of the center of gravity and the terms of the matrix of inertia. The analytical statements are given in documentation [R3.07.02].

2.1.1 Method of calculating used for the reference solution in displacements and stresses

Into incompressible:

$$\begin{cases} u_r = \dfrac{B}{r} \\ u_\theta = u_z = 0 \end{cases} \qquad \text{avec } B = \frac{(1+\nu)}{E} P \frac{a^2 b^2}{\left(b^2-a^2\right)}$$

$$\begin{cases} \varepsilon_{rr} = -\dfrac{B}{r^2} \\ \varepsilon_{\theta\theta} = +\dfrac{B}{r^2} \\ \varepsilon_{r\theta} = \varepsilon_{zz} = 0 \end{cases}$$

$$\begin{cases} J_{rr} = P \dfrac{a^2}{b^2-a^2}\left(1-\dfrac{b^2}{r^2}\right) \\ J_{\theta\theta} = P \dfrac{a^2}{b^2-a^2}\left(1+\dfrac{b^2}{r^2}\right) \\ \sigma_{r\theta} = 0 \\ \sigma_{zz} = 2\,\nu\,P \dfrac{a^2}{b^2-a^2} \end{cases}$$

Transition in the Cartesian system:

$$\begin{aligned} \sigma_{xx} &= \sigma_{rr} \cos^2\theta + \sigma_{\theta\theta} \sin^2\theta - 2\,\sigma_{r\theta} \sin\theta\cos\theta \\ \sigma_{yy} &= \sigma_{rr} \sin^2\theta + \sigma_{\theta\theta} \cos^2\theta + 2\,\sigma_{r\theta} \sin\theta\cos\theta \\ \sigma_{xy} &= \sigma_{rr} \sin\theta\cos\theta - \sigma_{\theta\theta} \sin\theta\cos\theta - 2\,\sigma_{r\theta}\left(\cos^2\theta \sin^2\theta\right) \end{aligned}$$

2.1.2 Determination of the masses, center of gravity and tensor of inertia

For modelization I of standard shell of revolution around an axis OZ

1) the mass is worth: $M = \rho h \pi (R_2^2 - R_1^2) = 2\pi \rho h e R$;

1) the coordinates of the center of gravity are: $\begin{pmatrix} x_G \\ y_G \\ z_G \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ h/2 \end{pmatrix}$;

1) the tensor of inertia compared to O is worth:

$$\begin{pmatrix} I_{xx} & I_{xy} & I_{xz} \\ I_{xy} & I_{yy} & I_{yz} \\ I_{xz} & I_{yz} & I_{zz} \end{pmatrix} = \begin{pmatrix} \frac{MR^2}{2}[1+\frac{1}{4}(\frac{e}{R})^2]+\frac{M}{3}h^2 & 0 & 0 \\ 0 & \frac{MR^2}{2}[1+\frac{1}{4}(\frac{e}{R})^2]+\frac{M}{3}h^2 & 0 \\ 0 & 0 & MR^2[1+\frac{1}{4}(\frac{e}{R})^2] \end{pmatrix}$$

1) the tensor of inertia compared to G is worth:

$$\begin{pmatrix} I_{xx} & I_{xy} & I_{xz} \\ I_{xy} & I_{yy} & I_{yz} \\ I_{xz} & I_{yz} & I_{zz} \end{pmatrix} = \begin{pmatrix} \frac{MR^2}{2}[1+\frac{1}{4}(\frac{e}{R})^2]+\frac{M}{12}h^2 & 0 & 0 \\ 0 & \frac{MR^2}{2}[1+\frac{1}{4}(\frac{e}{R})^2]+\frac{M}{12}h^2 & 0 \\ 0 & 0 & MR^2[1+\frac{1}{4}(\frac{e}{R})^2] \end{pmatrix}$$

For the modelizations J and K where the trace of a quarter of cylinder of cross-section around an axis OZ on a level perpendicular to this axis is represented

1) the mass per unit height is worth: $M = \rho \frac{\pi}{2} \frac{(R_1 + R_2)}{2} e = \rho \frac{\pi}{2} \mathrm{Re}$;

1) the coordinates of the center of gravity are: $\begin{pmatrix} x_G \\ y_G \end{pmatrix} = \begin{pmatrix} \frac{2}{\pi} R[1+\frac{1}{12}(\frac{e}{R})^2] \\ \frac{2}{\pi} R[1+\frac{1}{12}(\frac{e}{R})^2] \end{pmatrix}$

1) the tensor of inertia compared to O is worth:

$$\begin{pmatrix} I_{xx} & I_{xy} & I_{xz} \\ I_{xy} & I_{yy} & I_{yz} \\ I_{xz} & I_{yz} & I_{zz} \end{pmatrix} = \begin{pmatrix} \frac{M}{2}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2] & \frac{M}{\pi}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2] & 0 \\ \frac{M}{\pi}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2] & \frac{M}{2}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2] & 0 \\ 0 & 0 & MR^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2] \end{pmatrix}$$

1) the tensor of inertia compared to G is worth:

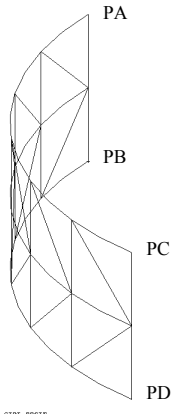
$$\begin{pmatrix} I_{xx} & I_{xy} & I_{xz} \\ I_{xy} & I_{yy} & I_{yz} \\ I_{xz} & I_{yz} & I_{zz} \end{pmatrix} = \begin{pmatrix} \frac{M}{2}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2]-My_G^2 & \frac{M}{\pi}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2]-Mx_Gy_G & 0 \\ \frac{M}{\pi}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2]-Mx_Gy_G & \frac{M}{2}R^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2]-Mx_G^2 & 0 \\ 0 & 0 & MR^2[1+\frac{1}{4}\left(\frac{e}{R}\right)^2]-M(x_G^2+y_G^2) \end{pmatrix}$$

Note:

In practice, one neglects the terms in $(\frac{e}{R})^2$ these statements.

3 Modelization A

3.1 Characteristic of the mesh



Coordinated 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 meshes: 24 COQUE_3D
24 TRIA7

Boundary conditions:

Mesh group AB :
1) displacement following the axis Y : DY = 0
2) rotation around the axis X : DRX = 0
3) rotation around the axis Z : DRZ = 0

Mesh group CD :
1) displacement following the axis X : DX = 0
2) rotation around the axis Y : DRY = 0
3) rotation around the axis Z : DRZ = 0

Nodes group PB :
1) displacement following the axis Z : DZ = 0

with AB the mesh group connecting PA and PB
CD that connecting PC and PD

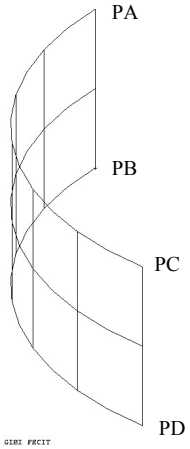
3.2 Quantities tested and results

In a systematic way, one takes the values of displacements and the stresses on the node PA

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	– 9.81907 10^{-10}	3.3%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	0.7%
	Average higher	"ANALYTIQUE"	200.125	27.%
	Average lower	"ANALYTIQUE"	190.125	27.%
FORCE_COQUE (REEL)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10^{-10}	3.3%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	0.7%
	Average higher	"ANALYTIQUE"	200.125	27.%
	Average lower	"ANALYTIQUE"	190.125	27.%
FORCE_COQUE (FONCTION)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10^{-10}	3.3%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	0.7
	Average higher	"ANALYTIQUE"	200.125	27.%
	lower Average	"ANALYTIQUE"	190.125	27.%

4 Modelization B

4.1 Characteristic of the mesh



Coordinated 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 meshes: 12 COQUE_3D
12 QUAD9

Boundary conditions:

Mesh group AB :
1) displacement following the axis Y : DY = 0
2) rotation around the axis X : DRX = 0
3) rotation around the axis Z : DRZ = 0

Mesh group CD :
1) displacement following the axis X : DX = 0
2) rotation around the axis Y : DRY = 0
3) rotation around the axis Z : DRZ = 0

Nodes group PB :
1) displacement following the axis Z : DZ = 0

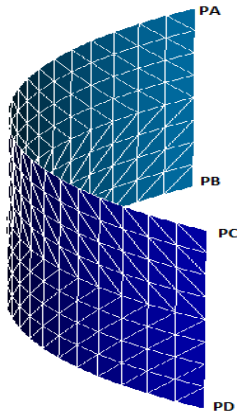
with AB the mesh group connecting PA and PB
CD that connecting PC and PD

4.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	– 9.81907 10^{-10}	1.5%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	2.3%
	Average higher	"ANALYTIQUE"	200.125	2.2%
	lower Average	"ANALYTIQUE"	190.125	2.3%
FORCE_COQUE (REEL)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10^{-10}	1.5%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	2.3%
	Average higher	"ANALYTIQUE"	200.125	2.2%
	lower Average	"ANALYTIQUE"	190.125	2.3%
FORCE_COQUE (FONCTION)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10^{-10}	1.5%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	2.3%
	Average higher	"ANALYTIQUE"	200.125	2.2%
	lower Average	"ANALYTIQUE"	190.125	2.3%

5 Modelization C

5.1 Characteristic of the mesh



Coordinated 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 meshes: 192 DKT
192 DST

Boundary conditions:

Mesh group AB :
1) displacement following the axis Y : DY = 0
2) rotation around the axis X : DRX = 0
3) rotation around the axis Z : DRZ = 0

Mesh group CD :
1) displacement following the axis X : DX = 0
2) rotation around the axis Y : DRY = 0
3) rotation around the axis Z : DRZ = 0

Nodes group PB :
1) displacement following the axis Z : DZ = 0

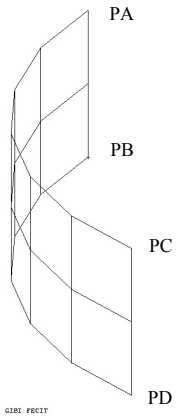
with AB the mesh group connecting PA and PB
CD that connecting PC and PD

5.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	2.0%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	3.0%
	Average higher	"ANALYTIQUE"	200.125	5.5%
	lower Average	"ANALYTIQUE"	190.125	3.0%
FORCE_COQUE (REEL)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	2.0%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	3.0%
	Average higher	"ANALYTIQUE"	200.125	5.5%
	lower Average	"ANALYTIQUE"	190.125	3.0%
FORCE_COQUE (FONCTION)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	2.0%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	3.0%
	Average higher	"ANALYTIQUE"	200.125	5.5%
	lower Average	"ANALYTIQUE"	190.125	3.0%

6 Modelization D

6.1 Characteristic of the mesh



Coordinated 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 meshes: 6 DKQ
6 DSQ

Boundary conditions:

Mesh group AB :
1) displacement following the axis Y : DY = 0
2) rotation around the axis X : DRX = 0
3) rotation around the axis Z : DRZ = 0

Mesh group CD :
1) displacement following the axis X : DX = 0
2) rotation around the axis Y : DRY = 0
3) rotation around the axis Z : DRZ = 0

Nodes group PB :
1) displacement following the axis Z : DZ = 0

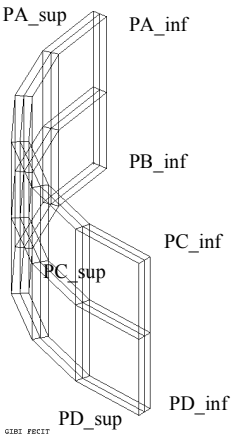
with AB the mesh group connecting PA and PB
CD that connecting PC and PD

6.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	1.0%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	1.8%
	Average higher	"ANALYTIQUE"	200.125	1.0%
	lower Average	"ANALYTIQUE"	190.125	4.3%
FORCE_COQUE (REEL)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	1.0%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	1.8%
	Average higher	"ANALYTIQUE"	200.125	1.0%
	lower Average	"ANALYTIQUE"	190.125	4.3%
FORCE_COQUE (FONCTION)	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	1.0%
	Stresses ($SIXX$)			
	Average average	"ANALYTIQUE"	194.93754	1.8%
	Average higher	"ANALYTIQUE"	200.125	1.0%
	lower Average	"ANALYTIQUE"	190.125	4.3%

7 Modelization E

7.1 Characteristic of the mesh



Coordinated 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 meshes: 24 meshes HEXA8 3D linear

Boundary conditions:

Mesh group S_AB :
1) displacement following the axis Y : DY = 0
2) displacement following the axis Z : DZ = 0

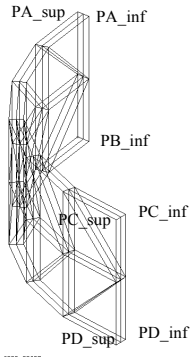
Mesh group S_CD :
1) displacement following the axis X : DX = 0
2) displacement following the axis Z : DZ = 0

7.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP (REEL)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.6%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.3%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.6%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	8.3%
	Average lower	"ANALYTIQUE"	200.125	9%
	higher Average	"ANALYTIQUE"	190.125	8%
PRES_REP (FONCTION)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.6%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.3%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.6%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	8.3%
	Average lower	"ANALYTIQUE"	200.125	9%
	higher Average	"ANALYTIQUE"	190.125	8%

8 Modelization F

8.1 Characteristic of the mesh



Coordinated 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 meshes: 48 meshes PENTA6 3D linear

Boundary conditions:

Mesh group S_AB :
1) displacement following the axis Y : DY = 0
2) displacement following the axis Z : DZ = 0

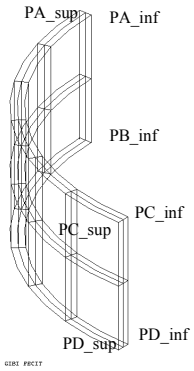
Mesh group S_CD :
1) displacement following the axis X : DX = 0
2) displacement following the axis Z : DZ = 0

8.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP (REEL)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.7%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.2%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.8%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	10%.21%
	Average lower	"ANALYTIQUE"	200.125	
	higher Average	"ANALYTIQUE"	190.125	2.1%
PRES_REP (FONCTION)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.7%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.2%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.8%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	10%.21%
	Average lower	"ANALYTIQUE"	200.125	
	higher Average	"ANALYTIQUE"	190.125	2.1%

9 Modelization G

9.1 Characteristic of the mesh



Coordinated 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 meshes: 24 meshes HEXA20 3D quadratic

Boundary conditions:

Mesh group S_AB :
1) displacement following the axis Y : DY = 0
2) displacement following the axis Z : DZ = 0

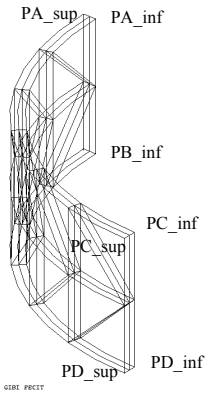
Mesh group S_CD :
1) displacement following the axis X : DX = 0
2) displacement following the axis Z : DZ = 0

9.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP (REEL)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.6%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.2%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.7%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	13%.13%.11 %
	Average lower	"ANALYTIQUE"	200.125	
	higher Average	"ANALYTIQUE"	190.125	
PRES_REP (FONCTION)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.6%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.2%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.7%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	13%.13%.11 %
	Average lower	"ANALYTIQUE"	200.125	
	higher Average	"ANALYTIQUE"	190.125	

10 Modelization H

10.1 Characteristic of the mesh



Coordinated 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 meshes: 48 meshes PENTA15 3D quadratic

Boundary conditions:

Mesh group S_AB :
1) displacement following the axis Y : $DY=0$
2) displacement following the axis Z : $DZ=0$

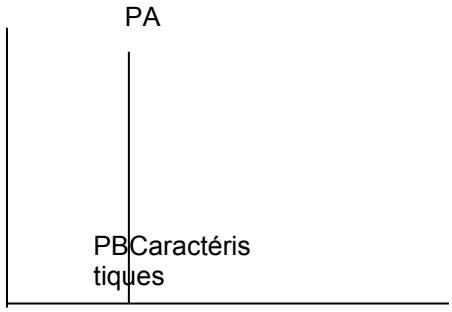
Mesh group S_CD :
1) displacement following the axis X : $DX=0$
2) displacement following the axis Z : $DZ=0$

10.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP (REEL)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.7%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.2%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.8%
	Stresses ($SIYY$)			
	Average average	"NON_DEFINI"	194.93754	10.%
	Average lower	"NON_DEFINI"	200.125	21.%
	Average higher	"NON_DEFINI"	190.125	2.1%
PRES_REP (FONCTION)	Average Displacements average	"ANALYTIQUE"	– 9.81907 10-10	1.7%
	Average lower	"ANALYTIQUE"	– 9.90234 10-10	1.2%
	higher Average	"ANALYTIQUE"	– 9.81907 10-10	2.8%
	Stresses ($SIYY$)			
	Average average	"NON_DEFINI"	194.93754	10.%
	Average lower	"NON_DEFINI"	200.125	21.%
	Average higher	"NON_DEFINI"	190.125	2.1%

11 Modelization I

11.1 of the mesh



Coordinated of the points:

GROUP_NO	$Coor_x$	$Coor_y$
PA	1.0.0.5.1.0	
PB		0.

Characteristics of the elements:

Types of meshes: 2 COQUE_AXI

Thus $R1=1.025\,m$ and $R2=0.975\,m$.
$h=0.5\mathrm{m}$

For this modelization and the following, one specifies the density $\rho=1234.kg/m^3$

Boundary conditions:

Nodes group PB : displacement following the axis Y : $DY=0$

11.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	$-9.81907\ 10^{-10}$	2%
	Stresses ($SIYY$) Average average	"NON_DEFINI"	194.93754	10%
FORCE_COQUE (REEL) with MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	$-9.81907\ 10^{-10}$	2%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	2.8%
	lower Average	"ANALYTIQUE"	190.125	2.8%
FORCE_COQUE (FONCTION) with MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	$-9.81907\ 10^{-10}$	2%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	2.8%
	lower Average	"ANALYTIQUE"	190.125	2.8%
FORCE_COQUE (FONCTION) without MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	$-9.81907\ 10^{-10}$	2%
	Stresses ($SIYY$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	0.1%
	lower Average	"ANALYTIQUE"	190.125	5.2%

Standard	Identification of Reference	Value of reference	Tolerance
MASSE	"ANALYTIQUE"	1.93836 E+02	0.1%
CDG_X	"ANALYTIQUE"	0.0	0.001
CDG_Y	"ANALYTIQUE"	0.0	0.001
CDG_Z	"ANALYTIQUE"	2.5 E-01	0.1%
IX_G	"NON_REGRESSION"	1.00956 E+02	0.1%
IY_G	"NON_REGRESSION"	1.00956 E+02	0.1%
IZ_G	"NON_REGRESSION"	1.93836 E+02	0.1%
IXY_G		-8.42942	
IXZ_G		0.0	
IYZ_G		0.0	

12 Modelization J

12.1 Characteristic of the mesh

Coordinated of the points:

GROUP_NO	$Coor_x$	$Coor_y$
PA	1.0	0.
PC	0.	1.

Characteristics of the elements:

Types of meshes: 10 COQUE_C_PLAN

$R = 1\,m.$
$\rho = 1234.\,kg/m^3$

Boundary conditions:

Nodes group PA :
1) displacement following the axis $Y = 0$
2) rotation around the axis Z : $DRZ = 0$

Nodes group PC :
1) displacement following the axis X : $DX = 0$
2) rotation around the axis Z : $DZ = 0$

12.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	8%
	Stresses ($SIXX$) Average average	"NON_DEFINI"	194.93754	3%
FORCE_COQUE (REEL) with MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	8%
	Stresses ($SIXX$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	2.8%
	lower Average	"ANALYTIQUE"	190.125	2.8%
FORCE_COQUE (FONCTION) with MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	8%
	Stresses ($SIXX$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	2.8%
	lower Average	"ANALYTIQUE"	190.125	2.8%
FORCE_COQUE (FONCTION) without MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 $^{-10}$	8%
	Stresses ($SIXX$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	0.1%
	lower Average	"ANALYTIQUE"	190.125	5.2%

Standard	Identification of Reference	Value of reference	Tolerance
MASSE	"ANALYTIQUE"	9.69181 E+01	0.1%
CDG_X	"ANALYTIQUE"	6.36619 E-01	0.1%
CDG_Y	"ANALYTIQUE"	6.36619 E-01	0.1%
CDG_Z	"ANALYTIQUE"	0.0	0.001
IX_G	"NON_REGRESSION"	9.17961	0.1%
IY_G	"NON_REGRESSION"	9.17961	0.1%
IZ_G	"NON_REGRESSION"	1.83592 E+01	0.1%
IXY_G		-8.42942	
IXZ_G		0.0	
IYZ_G		0.0	

13 Modelization K

13.1 Characteristic of the mesh

Coordinated of the points:

GROUP_NO	$Coor_x$	$Coor_y$
PA	1.0	0.
PC	0.	1.

Characteristics of the elements:

Types of meshes: 10 COQUE_D_PLAN

$R = 1\,m.$
$\rho = 1234.\,kg/m^3$

Boundary conditions:

Nodes group PA :
1) displacement following the axis $Y = 0$
2) rotation around the axis Z : $DRZ = 0$

Nodes group PC :
1) displacement following the axis X : $DX = 0$
2) rotation around the axis Z : $DZ = 0$

13.2 Quantities tested and results

Standard	Key word	Identification of Reference	Value of reference	Tolerance
PRES_REP	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 – 10	8%
	Stresses ($SIXX$) Average average	"NON_DEFINI"	194.93754	3%
FORCE_COQUE (REEL) with MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 – 10	8%
	Stresses ($SIXX$) Average average	"ANALYTIQUE"	194.93754	8%
	Average higher	"ANALYTIQUE"	200.125	2.8%
	lower Average	"ANALYTIQUE"	190.125	2.8%
FORCE_COQUE (FONCTION) with MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 – 10	8%
	Stresses ($SIXX$) Average average	"ANALYTIQUE"	194.93754	8%
	Average higher	"ANALYTIQUE"	200.125	2.8%
	lower Average	"ANALYTIQUE"	190.125	2.8%
FORCE_COQUE (FONCTION) without MODI_METRIQUE	Displacements average Average	"ANALYTIQUE"	– 9.81907 10 – 10	8%
	Stresses ($SIXX$) Average average	"ANALYTIQUE"	194.93754	2.8%
	Average higher	"ANALYTIQUE"	200.125	0.1%
	lower Average	"ANALYTIQUE"	190.125	5.2%

Standard	Identification of Reference	Value of reference	Tolerance
MASSE	"ANALYTIQUE"	9.69181 E+01	0.1%
CDG_X	"ANALYTIQUE"	6.36619 E-01	0.1%
CDG_Y	"ANALYTIQUE"	6.36619 E-01	0.1%
CDG_Z	"ANALYTIQUE"	0.0	0.001
IX_G	"NON_REGRESSION"	9.17961	0.1%
IY_G	"NON_REGRESSION"	9.17961	0.1%
IZ_G	"NON_REGRESSION"	1.83592 E+01	0.1%
IXY_G		-8.42942	
IXZ_G		0.0	
IYZ_G		0.0	

14 Summary of the

results the key word PRES_REP (reality or function) and FORCE_COQUE (reality or function) can be indifferently used for the shell elements and of plate, the got results coincide.