SSLS107 - Subjected cylindrical panel with its own weight

Summary:

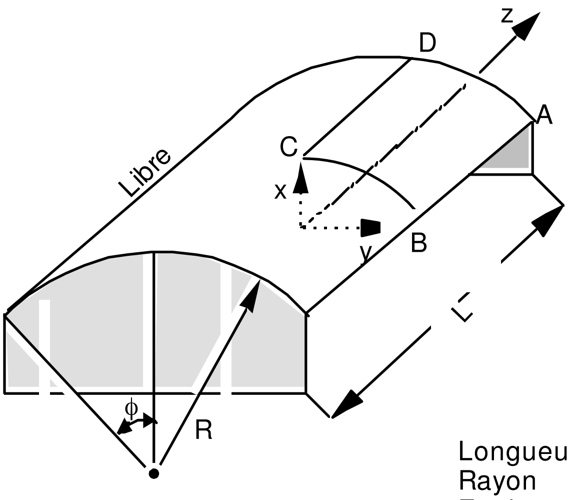
This test makes it possible to validate two finite elements of thick hull in linear elasticity. Modeling A tests the quadrangle, modeling B tests the triangle associated with the formulation. This problem of cylindrical panel under actual weight is a classical test of hull.

The results of reference are analytical solutions.

One will note the good performances obtained with the quadrangle and the results much less good got with the triangle.

1 Problem of reference

1.1 Geometry



Longueur L = 6. m
Rayon R = 3. m
Epaisseur t = 0.03 m
Section angulaire ϕ = 40°

Coordinates of the points:

	A	B	C	D
x	$3.\cos 40°$	$3.\cos 40°$	3.	3.
y	$3.\sin 40°$	$3.\sin 40°$	0.	0.
z	3.	0.	0.	3.

1.2 Material properties

$E=3.10^{10}\,Pa$
$\nu=0.$
$\rho=2.0833\,10^4\,kg/m^3$

1.3 Boundary conditions and loadings

Rigid diaphragm at each end: $u=v=0$, $\theta_z=0$.

Loading 1: Force due to gravity $g=-10\,m/s^2$

Loading 2: Force hull vertical distributed load $F_x=-6250.\mathrm{N}$

Two loadings leading to the same solution are tested.

2 Reference solution

2.1 Method of calculating used for the reference solution

The parameters of the problem and the results of reference (analytical solutions) are given by BATOZ and DHATT [bib1].

2.2 Results of reference

Displacement of the point B according to X
Displacement of the point C according to X.

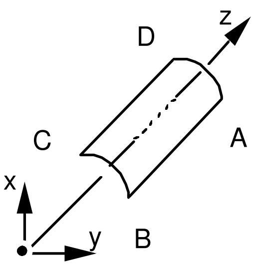
2.3 Bibliographical references

• BATOZ J.L., DHATT G.: Modeling of the structures by finite elements. Volume 3 hulls, p445-448 (1992).

3 Modeling A

3.1 Characteristics of modeling

Element of COQUE_3D MEC3QU9H



Modeling of a quarter of cylinder

Cutting:

6 on AB and DC
6 on AD and BC : 36 meshs QUAD9

Limiting conditions:

in all the nodes of:	DDL_IMPO:
arc (AD)	(GROUP_NO: AD DX: 0. , DY: 0. , DRZ: 0.)
segment] CD [	(GROUP_NO: CDsansCD DY: 0. , DRY MARTINI: 0. , DRZ: 0.)
arc (BC)	(GROUP_NO: BC DX: 0. , DRX: 0. , DRY MARTINI: 0.)
in C	(GROUP_NO: C DY: 0. , DRZ: 0.)

Loading:

FORCE_COQUE:	(FX: -6250.)
GRAVITY:	(10. -1. 0. 0.)

Names of the nodes:

Not A	$N03$
Not B	$N02$
Not C	$N01$
Not D	$N04$

3.2 Characteristics of the grid

Many nodes: 169
Many meshs and types: 36 QUAD9

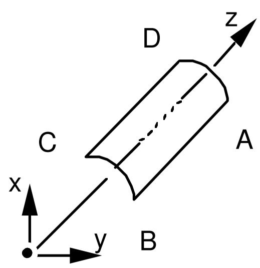
3.3 Values tested

Identification	Reference
Not B displacement DX	$-3.61\ 10^{-2}$
Not C displacement DX	$5.44\ 10^{-3}$

4 Modeling B

4.1 Characteristics of modeling

Element of hull `3D MEC3TR7H`



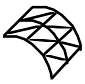
Modeling of a quarter of cylinder

Cutting:

12 on AB and DC
12 on AD and BC : 288 meshs TRIA7

Limiting conditions:

in all the nodes of:	DDL_IMPO:
arc (AD)	(GROUP_NO: AD DX: 0. , DY: 0. , DRZ: 0.)
segment) CD (	(GROUP_NO: CDsansCD DY: 0. , DRY MARTINI: 0. , DRZ: 0.)
arc (BC)	(GROUP_NO: BC DX: 0. , DRX: 0. , DRY MARTINI: 0.)
in C	(GROUP_NO: C DY: 0. , DRZ: 0.)

The grid is of directed type: 

Loading:

```
FORCE_COQUE:        (       FX: -6250.)
GRAVITY:            (10.  -1.  0.  0.)
```

Names of the nodes:

Not A	$N03$
Not B	$N02$
Not C	$N01$
Not D	$N04$

4.2 Characteristics of the grid

Many nodes: 913
Many meshs and types: 288 TRIA7

4.3 Values tested

Identification	Reference
Not B displacement DX	$-3.61\ 10^{-2}$

Not C displacement DX	$5.41\ 10^{-3}$

5 Summary of the results

The element MEC3QU9H allows to obtain a good solution with a coarse network, while the element MEC3TR7H require a very fine grid to reach a satisfactory precision.

It is noted that the reference solution is the analytical solution obtained starting from the theory of the “deep” hulls. The 2 elements of hull converge towards this solution and not towards the theory of the “not very deep” hulls.