SSLS104 - Cylindrical hull pinch with diaphragm

Summary:

One treats in linear elasticity the case of a cylinder formed by two circular funds at the two ends and gripped with mid--length.

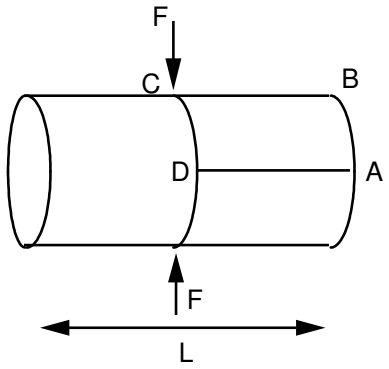
This makes it possible to treat the modes of deformation inextensionnels and a membrane behavior complexes due to the diaphragms.

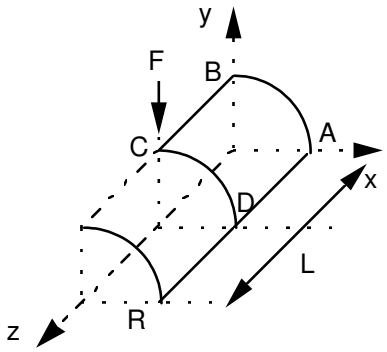
The value tested is the arrow at the point of application of the force.

Three modelings: DKT, COQUE_3D QUAD9 and COQUE_3D TRIA7.

1 Problem of reference

1.1 Geometry





huitième de cylindre

Longueur	L = 600
Rayon	R = 300
Epaisseur	t = 3

Coordinates of the points:

	A	B	C	D
x	300.	0.	0.	300.
y	0.	300.	300.	0.
z	0.	0.	300.	300.

1.2 Material properties

$E = 3.10^6 \, Pa$
$\nu = 0.3$
$A_{CIS} = 0.8333$

1.3 Boundary conditions and loadings

Rigid diaphragm at each end:

$u = v = 0 \, , \quad \theta_z = 0$

Specific force in C :

$F = 1. \, N$

2 Reference solution

2.1 Method of calculating used for the reference solution

The parameters of with the dealt problem and the results of reference are explicitly given in the publication quoted below.

2.2 Results of reference

Displacement of the point C according to y.

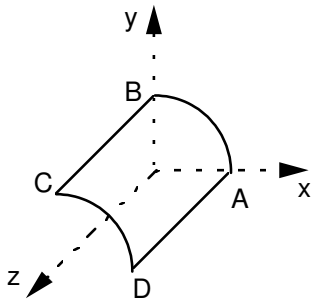
2.3 Bibliographical references

- Thomas J.R HUGHES, Ted BELYTSCHKO. Race notes for Recent advances in nonlinear finite element analysis. Volume III - p 238 and 239 (1990).

3 Modeling A

3.1 Characteristics of modeling

Element of hull DKT



Modeling of a eighth of plate

Cutting:

10 on AD and BC
16 on AB and DC : 364 meshs TRIA3

Limiting conditions:

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

Loading:

with the node C : (GROUP_NO: C FY: -0.25)

Names of the nodes:

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

3.2 Characteristics of the grid

Many nodes: 209
Many meshs and types: 364 TRIA3

3.3 Values tested

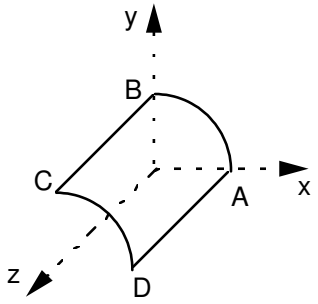
Identification	Reference
Not C displacement v	$-1.8248\ 10^{-5}$

With 1,366 nodes: $-1.8511F$ in C.

4 Modeling B

4.1 Characteristics of modeling

Element of hull 3D MEC3QU9H



Modeling of a eighth of plate

Cutting:

4 on AD and BC
8 on AB and DC : 32 meshs QUAD9

Limiting conditions:

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

Loading:

with the node C : (GROUP_NO: C FY: -0.25)

Names of the nodes:

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

4.2 Characteristics of the grid

Many nodes: 121
Many meshs and types: 32 QUAD9

4.3 Values tested

Identification	Reference
Not C displacement v	$-1.8248\ 10^{-5}$

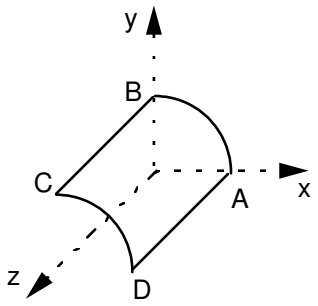
4.4 Remarks

For a grid of 60 meshs QUAD9 and 213 nodes (corresponding to cutting 6 on AD and BC and 10 on AB and DC), displacement v at the point C is worth – 1.8011 10^{-5}.

5 Modeling C

5.1 Characteristics of modeling

Element of hull MEC3TR7H



Modeling of a eighth of plate

Cutting:

10 on AD and BC
18 on AB and DC : 360 meshs TRIA7

Limiting conditions:

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

Loading:

with the node C : (GROUP_NO: C FY: -0.25)

Names of the nodes:

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

5.2 Characteristics of the grid

Many nodes: 777
Many meshs and types: 360 TRIA7

5.3 Values tested

Identification	Reference
Not C displacement v	$-1.8248\ 10^{-5}$

5.4 Remarks

For a grid with 500 meshs TRIA7 and 1071 nodes (cutting 10 on AD and BC, 25 on AB and DC), a displacement is obtained v at the point C of – 1.7723 10^{-5}. The relative error on displacement v in C is then of 2.88%. The results with this element for light grids is thus not very good and improves relatively little with an increase amongst meshs.

6 Summary of the results

With regard to the elements:

DKT:

The result is better with a finer grid (1366 nodes) which leads to an error < 1.5 %.

MEC3QU9H:

The result is acceptable with relatively few elements (compared with DKT). By increasing appreciably the number of elements (60 instead of 32), the error is < 1.3%.

MEC3TR7H:

Result little satisfying even with a fine grid leading to a great total number of nodes for MEC3TR7H (777 for MEC3TR7H to compare with 209 for DKT and 121 for MEC3QU9H). To arrive at an error lower than 2.9%, that requires one very a large number of nodes (1071). It seems recognized that this element is less good than MEC3QU9H.