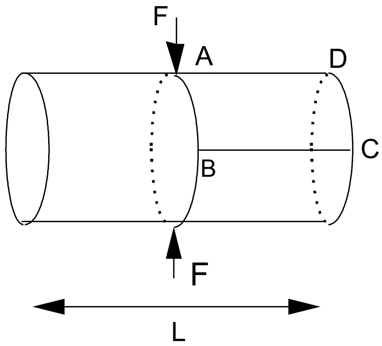
SSLS20 - Free cylindrical shell pinch on board

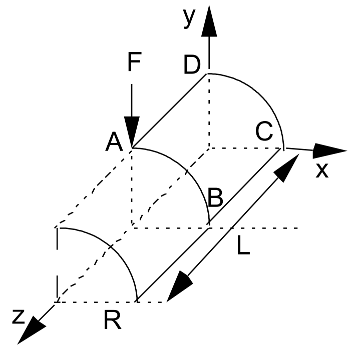
Abstract:

The test from guide VPCS, makes it possible to check the effect of a specific loading on a thin cylindrical shell in linear elasticity. One compares the deflections with the point of application of the loading compared to a modelization of the thin cylindrical shell in elements DKT and two modelizations COQUE_3D (1/8 cylinder is represented).

1 Problem of reference

1.1 Geometry





huitième de cylindre

Longueur	L = 10.35 m
Rayon	R = 4.953 m
Epaisseur	t = 0.094 m

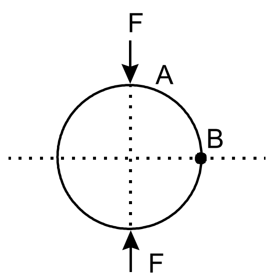
1.2 Material properties

$E = 10.5 10^6 Pa$

$\nu = 0.3125$

1.3 Boundary conditions and loadings

Forces specific: $F = 100. N$



2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is that given in file SSLS20/89 of guide VPCS.

It was established by average of results of several software packages of computation by the finite element method.

2.2 Results of reference

Displacement of the following A point y : $v=-0.1139$

2.3 Uncertainty on the solution

Less than 2%

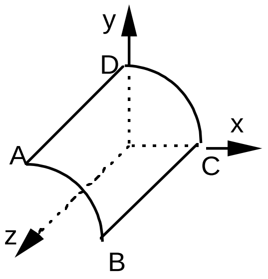
2.4 bibliographical References

1) G. HORRIGMOE, P.G. BERGAN "Not linear analysis of free from shells by flat finite elements" Mathematics Computer in Applied Mechanics and Amsterdam Engineering, North Holland, vol. 16 (1978)

3 Modelization A

3.1 Characteristic of the modelization

Shell element DKT



élancement longitudinal $\frac{L}{30t} = 3.7$

élancement circonférentiel $\frac{0.5\,\pi R}{10\,t} = 8.3$

Modélisation d'un huitième de cylindre

Cutting: 10 on AD and BC 15 on AB and DC : 300 meshes TRIA3

limiting Conditions:

in all the nodes of arc AB	DDL_IMPO:	(GROUP_NO: AB DZ: 0. , DRX: 0. , DRY: 0.)
segment) AD)		(GROUP_NO: ADsansA DX: 0. , DRY: 0. , DRZ: 0.)
segment) BC)		(GROUP_NO: BCsansB DY: 0. , DRX: 0. , DRZ: 0.)
in A		(GROUP_NO: A DX: 0. , DRZ: 0.)
in B		(GROUP_NO: B DY: 0. , DRZ: 0.)

Loading:

with node A FORCE_NODALE: (GROUP_NO: A Fy: - 25.)

Name of the nodes:

Not $A=NO176$ Not $C=NO1$
Not $B=NO11$ Not $D=NO166$

3.2 Characteristic of the mesh

Many nodes: 176
Number of meshes and types: 300 TRIA3

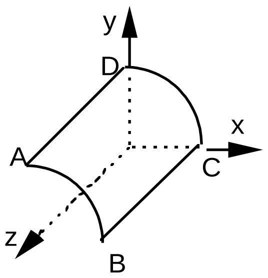
3.3 Values tested

Not	Quantity and unit	Reference
A	displacement v (m)	– 0.1139

4 Modelization B

4.1 Characteristic of the modelization

Shell element `COQUE_3D MEC3QU9H`



élancement longitudinal $\frac{L}{30t}=3.7$

élancement circonférentiel $\frac{0.5\,\pi R}{10\,t}=8.3$

Modélisation d'un huitième de cylindre

Cutting: 4 on AD and BC 4 on AB and DC : 16 meshes limiting

QUAD9 Conditions:		
in all the nodes of arc AB	DDL_IMPO:	(GROUP_NO: AB DZ: 0. , DRX: 0. , DRY: 0.)
segment) AD)		(GROUP_NO: ADsansA DX: 0. , DRY: 0. , DRZ: 0.)
segment) BC)		(GROUP_NO: BCsansB DY: 0. , DRX: 0. , DRZ: 0.)
in A		(GROUP_NO: A DX: 0. , DRZ: 0.)
in B		(GROUP_NO: B DY: 0. , DRZ: 0.)
Loading:		
with node A	FORCE_NODALE:	(GROUP_NO: A Fy: - 25.)

Name of the nodes:

Not $A=NO3$ Not $C=NO1$
Not $B=NO4$ Not $D=NO2$

4.2 Characteristic of the mesh

Many nodes: 65
Number of meshes and types: 16 QUAD9

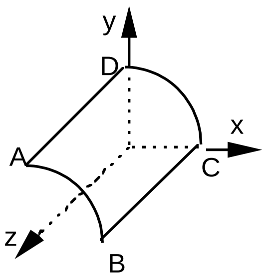
4.3 Values tested

Not	Quantity and unit	Reference
A	displacement v (m)	– 0.1139

5 Modelization C

5.1 Characteristic of the modelization

Shell element COQUE_3D MEC3TR7H



élancement longitudinal $\frac{L}{30t} = 3.7$

élancement circonférentiel $\frac{0.5\,\pi\,R}{10\,t} = 8.3$

Modélisation d'un huitième de cylindre

Cutting: 5 on AD and BC 12 on AB and DC : 120 meshes limiting

TRIA7 Conditions:

in all the nodes of arc AB	DDL_IMPO:	(GROUP_NO: AB DZ: 0. , DRX: 0. , DRY: 0.)
segment) AD)		(GROUP_NO: ADsansA DX: 0. , DRY: 0. , DRZ: 0.)
segment) BC)		(GROUP_NO: BCsansB DY: 0. , DRX: 0. , DRZ: 0.)
in A		(GROUP_NO: A DX: 0. , DRZ: 0.)
in B		(GROUP_NO: B DY: 0. , DRZ: 0.)

Loading:

with node A	FORCE_NODALE:	(GROUP_NO: A Fy: - 25.)

Name of the nodes:

Not $A=NO3$ Not $C=NO1$
Not $B=NO4$ Not $D=N02$

5.2 Characteristic of the mesh

Many nodes: 275
Number of meshes and types: 120 TRIA7

5.3 Values tested

Not	Quantity and unit	Reference	*Aster*	% difference
A	displacement v (m)	– 0.1139	– 0.1112	– 1.76

6 Summary of the results

With regard to the elements:

- DKT :
  - Suitable solution for a fine network.
  - A to supplement later on:
  - by a less fine mesh,
  - an analysis of the stresses,
  - 4 modelizations (DKQ, DST, DSQ, Q4G).
- MEC3QU9H : very good solution obtained with a relatively coarse network.
- MEC3TR7H : to arrive at a suitable solution, that requires a fine mesh, compared to that for element MEC3QU9H. In the same way compared to the element DKT, the total number of nodes is much more important.