ZZZZ112 - Roll under variable pressure. Validation of Summarized

LIRE_PLEXUS:

The purpose of this test is validating operation LIRE_PLEXUS of the command. This one makes it possible to read fields of pressures calculated by PLEXUS on a telegraphic mesh, and to apply these pressures to a mesh made up of shells or telegraphic elements.

This test has an analytical solution: it is about a cylinder subjected to a pressure which varies linearly along its axis.

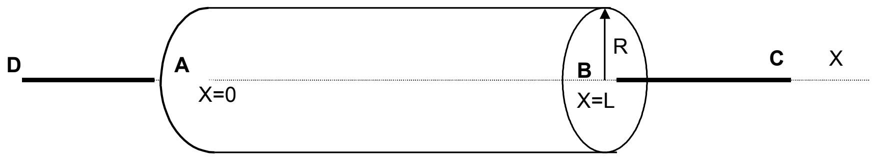
Two modelizations are proposed: the cylinder is with a grid in elements DKT (modelization A) or elements COQUE_3D (modelization B).

The results differ from the reference solution only by the lack of refinement of the mesh of shells (in particular for the modelization A).
This test thus validates command LIRE_PLEXUS.

1 Problem of reference

1.1 Geometry

Rolls of axis X, length L, average radius R, thickness e.



Here $L=1\text{m}$ $R=0.1\text{m}$ $e=0.01\text{m}$.

1.2 Material properties

linear Elasticity:

Young modulus: $E = 2.\ 10^{11}\ Pa$
Poisson's ratio $\nu = 0.3$

1.3 Boundary conditions and loadings

The mesh in shells are connected to beam elements in A and B. This makes it possible to give boundary conditions compatible with the kinematics of beam. However, One is interested here only in the solution of shells subjected to an internal pressure.
The point D is clamped.

The pressure is read on a mesh "plexus" of the segment AB, comprising 20 beam elements.

It varies in the following way:

$$P = 10.\left(1-\frac{X}{L}\right)Pa$$

2 Reference solution

2.1 Method of calculating used for the analytical reference solution

:

If the pressure varies like:

$$P=-P_0.\left(1+\lambda_p-\frac{X}{L}\right)$$

then the circumferential component of the stress tensor is worth:

$$\sigma_{\theta\theta}=\frac{P_0 R}{e}.\left(1+\lambda_p-\frac{X}{L}\right)$$

and the field of displacement is worth:

$$u_x=-\frac{\nu}{E}\frac{P_0 R}{e}.X\left(1+\lambda_p-\frac{X}{2L}\right)$$

$$u_r=-\frac{}{E}\frac{P_0 R^2}{e}.\left(1+\lambda_p-\frac{X}{L}\right)$$

2.2 Results of Reference

Here $\lambda_p=0$.

X	u_r (m)	u_x (m)	$\sigma_{\theta\theta}$ (Pa)
0	5d-11	0.100	
1		0.7.5d-1 1	0

2.3 Uncertainty on the analytical

solution Solution.

2.4 Bibliographical references

• PILKEY W.D.: “Formulated for stress, strain and structural matrixes”. Wiley & Sounds, New - York, 1994.

3 Modelization A

3.1 Characteristic of the modelization

Modelization DKT and POU_D_E

3.2 Characteristics of the mesh

Many nodes: 339
Number of meshes and types: 395 QUAD4
7 SEG2

3.3 Quantities tested and results

Identification	X	Reference	*Aster*	% difference
$\sigma_{\theta\theta}$	0.100		97.13	2.9
u_r	0	5.D-11	4.84D-11	3.1

4 Modelization B

4.1 Characteristic of the modelization

Modelization `COQUE_3D` and `POU_D_E`

4.2 Characteristics of the mesh

Many nodes: 429
Number of meshes and types: 145 `QUAD9`
7 `SEG2`

4.3 Quantities tested and results

Identification	X	Reference	*Aster*	% difference
$\sigma_{\theta\theta}$	0.100		98.7	1.3
u_r	0	5.D-11	4.81D-11	3.8

5 Modelization C

5.1 Characteristic of modelization

Modelization COQUE_3D, PIPE and POU_D_T
a half of cylinder ($0<X<L/2$) are with a grid in shell elements, other half is with a grid in elements PIPE.

5.2 Characteristics of the mesh

Many nodes: 436
Number of meshes and types: 100 QUAD9 (modelization COQUE_3D), 5 SEG3 (modelization PIPE), 4 SEG2 (modelization POU_D_T)

5.3 Quantities tested and results

Identification	X	**Reference**	***Aster***	**% difference**
$\sigma_{\theta\theta}$	0.100		95	5
u_r	0	5.D-11	4.85D-11	3.0

6 Summary of the results

the results differ from the reference solution only by the lack of refinement of the mesh of shells (in particular for the modelization A).

This test thus validates command LIRE_PLEXUS.