ZZZZ112 - Cylinder under variable pressure. Validation of LIRE_PLEXUS

Summary:

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

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

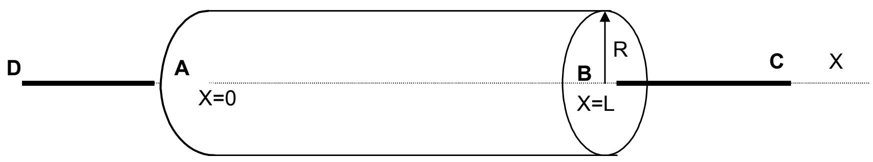
Two modelings are proposed: the cylinder is with a grid in elements DKT (modeling A) or in elements COQUE_3D (modeling B).

The results differ from the reference solution only by the lack of refinement of the grid of hulls (in particular for modeling A).
This test thus validates the order LIRE_PLEXUS.

1 Problem of reference

1.1 Geometry

Cylinder of axis X, length L, of 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 grid in hulls is connected to elements of beams 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 hulls subjected to an internal pressure.
The point D is embedded.

The pressure is read on a grid “plexus” of the segment AB, comprising 20 elements of beams.

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 reference solution

analytical:

If the pressure varies like:

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

then the circumferential component of the tensor of constraints 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-11	0

2.3 Uncertainty on the solution

Analytical solution.

2.4 Bibliographical references

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

3 Modeling A

3.1 Characteristics of modeling

Modeling DKT and POU_D_E

3.2 Characteristics of the grid

Many nodes: 339
Many meshs and types: 395 QUAD4
7 SEG2

3.3 Sizes 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 Modeling B

4.1 Characteristics of modeling

Modeling COQUE_3D and POU_D_E

4.2 Characteristics of the grid

Many nodes: 429
Many meshs and types: 145 QUAD9
7 SEG2

4.3 Sizes 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 Modeling C

5.1 Characteristics of modeling

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

5.2 Characteristics of the grid

Many nodes: 436
Many meshs and types: 100 QUAD9 (modeling COQUE_3D), 5 SEG3 (modeling PIPE), 4 SEG2 (modeling POU_D_T)

5.3 Sizes 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 grid of hulls (in particular for modeling A).

This test thus validates the order LIRE_PLEXUS.