SSLS09 - Thin cylinder under Summarized

inertia loading:

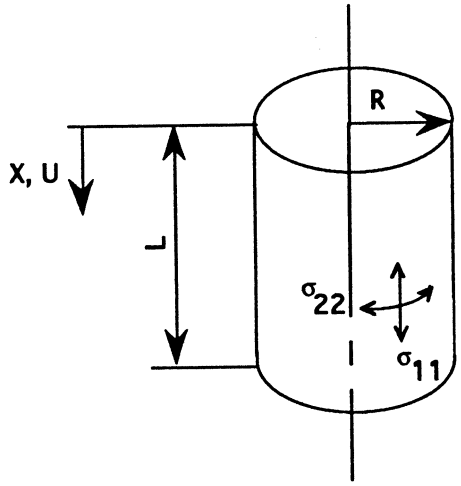
This test from guide VPCS (SSLS 09/89) aims to test a voluminal loading (here the inertia loading), in axisymmetric analysis, by means of key word FORCE_INTERNE.

One will use for that the two commands: AFFE_CHAR_MECA (modelization A) and AFFE_CHAR_MECA_F (modelization B).

The modelization C the incompressible elements by means of key word PESANTEUR tests on an equivalent loading.

1 Problem of reference

1.1 Geometry



Average radius	:	$R=1\mathrm{m}$
Thickness	:	$h=0.02\,m$
Height	:	$L=4\,m$

1.2 Material properties

Modulus Young	:	$E=2.1\times10^{11}\,Pa$
Poisson's ratio	:	$\nu=0.3$
Voluminal weight	:	$\gamma=7.85\times10^{4}\,N/m^{3}$

1.3 Boundary conditions and loadings

- axial Displacement no one at the low end ($u=0$) + conditions of symmetry
- Inertia loading, according to the axis, direction $+x$

2 Reference solution

2.1 Method of calculating used for the reference solution

In a point of coordinate X:

1) radial displacement: $U_r = -\frac{\gamma R \nu x}{E}$
2) axial displacement: $U_x = \frac{\gamma x^2}{2E}$
3) rotation of a generator: $\psi = -\frac{\gamma R \nu}{E}$
4) axial stress: $\sigma_{11} = \gamma x$
5) circumferential stress: $\sigma_{22} = 0$

2.2 Results of reference

1) axial Displacement high end: $U_x = 2.99 \times 10^{-6} m$
2) Low end radial displacement: $U_r = -4.49 \times 10^{-7} m$
3) $\psi = -1.12 \times 10^{-7} rad$
4) $\sigma_{11} = 3.14 \times 10^5 Pa$, at the end low
5) $\sigma_{22} = 0$ everywhere

2.3 Uncertainty on the analytical

solution Solution.

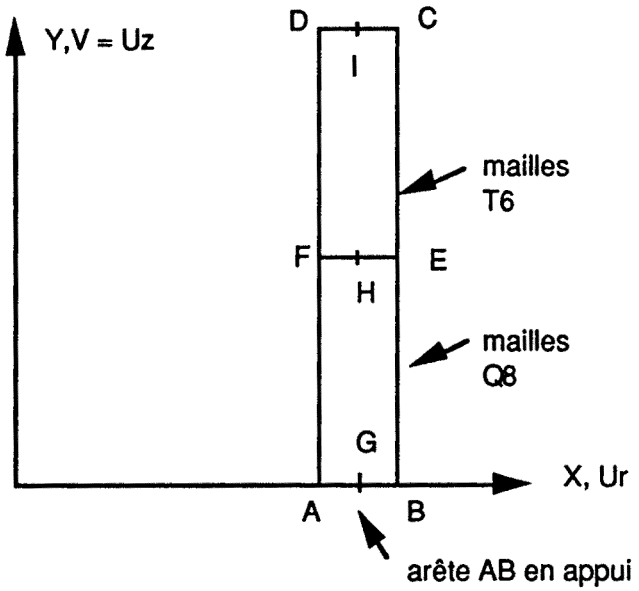
2.4 Bibliographical reference

•Guide VPCS – Edition 1990 (SSLS 09/89)
•R.J. ROARK and W.C. YOUNG: Formulated for stress and strain, 5th edition, New York, Mc Graw-Hill, 1975

3 Modelization A

3.1 Characteristic of modelization

AXIS, meshes T6 and Q8



Position of the points:

- E , F with remote
- G , H , I middle height R of the axis

Cutting: 100 elements according to height
1 element in the thickness

limiting Conditions: $DY = 0$ on AB

Loading: Constant volume force equalizes with - 78500.

Name of the nodes:

Not $A = N1$ Not $C = N452$ Not $E = N201$ Not $G = N51$ Not $I = N503$
Not $B = N101$ Not $D = N504$ Not $F = N203$ Not $H = N202$

3.2 Characteristic of the mesh

Many nodes: 553
Number of meshes and types: 50 QUAD8, 100 TRIA6, 204 SEG3

3.3 Values tested

Standard	Localization of value	Reference
Items C , D , I	$u_x(m)$	2.99 10-6
Point G	$u_r(m)$	– 4.49 10-7
Point G	$\sigma_{11}(Pa)$	– 3.14 105

Items A, B, G	$\sigma_{22}(Pa)$	0.

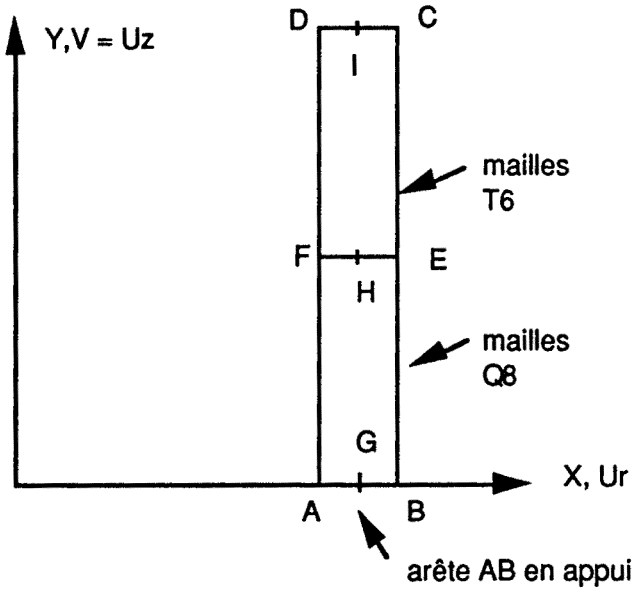
3.4 Remarks

1) the values of σ_{22} data are not significant.
2) Taking into account the mesh (1 element in the thickness), the results are completely satisfactory.

4 Modelization B

4.1 Characteristic of modelization

AXIS, meshes T6 and Q8



Position of the points:

- E, F with remote
- G, H, I middle height R of the axis

Cutting: 100 elements according to height
1 element in the thickness

limiting Conditions: $DY=0$ on AB

Loading: Volume force in the form of a constant function defined in $y=0,3,6$.

Name of the nodes:

Not $A=N1$ Not $C=N452$ Not $E=N201$ Not $G=N51$ Not $I=N503$
Not $B=N101$ Not $D=N504$ Not $F=N203$ Not $H=N202$

4.2 Characteristic of the mesh

Many nodes: 553
Number of meshes and types: 50 QUAD8, 100 TRIA6, 204 SEG3

4.3 Values tested

Standard	Localization of value	Reference
Items C, D, I	$u_x(m)$	2.99 10-6
Point G	$u_r(m)$	– 4.49 10-7
Point G	$\sigma_{11}(Pa)$	– 3.14 105

Items A, B, G	$\sigma_{22}(Pa)$	0.

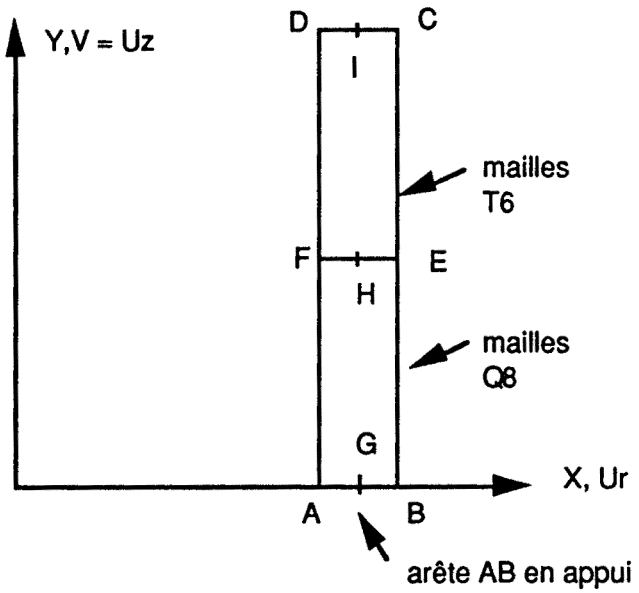
4.4 Remarks

1) the values of σ_{22} data are not significant.
2) The results are identical to those of modelization A.

5 Modélisation C

5.1 Characteristic of modelization

AXIS_INCO, meshes T6 and Q8



Position of the points:

- E , F with remote
- G , H , I middle height R of the axis

Cutting: 100 elements according to height
1 element in the thickness

limiting Conditions: $DY = 0$ on AB

Loading: Gravity

Name of the nodes:

Not $A = N1$ Not $C = N452$ Not $E = N201$ Not $G = N51$ Not $I = N503$
Not $B = N101$ Not $D = N504$ Not $F = N203$ Not $H = N202$

5.2 Characteristic of the mesh

Many nodes: 553
Number of meshes and types: 50 QUAD8, 100 TRIA6, 204 SEG3

5.3 Values tested

Standard	Localization of value	Reference
Items C , D , I	$u_x(m)$	2.99 10-6
Point G	$u_r(m)$	– 4.49 10-7
Point G	$\sigma_{11}(Pa)$	– 3.14 105
Items A , B , G	$\sigma_{22}(Pa)$	0.

5.4 Remarks

1) the values of σ_{22} found are not significant.
2) The results are identical to those of the modelization A and B.

6 Summary of the results

the use of a function for the definition of a constant density of volume charge is valid: the results are identical, that one uses one or the other of 2 commands AFFE_CHAR_MECA or AFFE_CHAR_MECA_F. An equivalent loading gravity gives the same results.
Moreover, the incompressible elements give the same results (modelization C).