SSLS07 - Thin cylinder under uniform axial loading

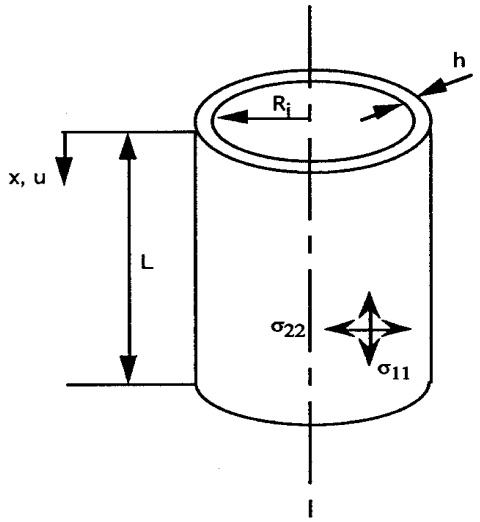
Summary:

The purpose of this test from guide VPCS (SSLS 07/89) is to validate a linear loading (FORCE_POUTRE) in axisymmetric modeling.

One will use for that the 2 orders: AFFE_CHAR_MECA (modeling A) and AFFE_CHAR_MECA_F (modeling B).

1 Problem of reference

1.1 Geometry



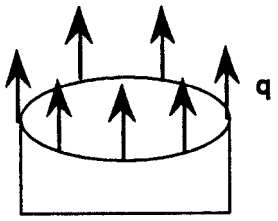
Average radius	:	$R_o = 1\text{m}$
Thickness	:	$h = 0.02\,m$
Height	:	$L = 4\,m$
Internal ray	:	$R_i = R_o - h/2$

1.2 Material properties

Young modulus	:	$E = 2.1 \times 10^{11}\,Pa$
Poisson's ratio	:	$\nu = 0.3$

1.3 Boundary conditions and loadings

- Axial displacement no one at the low end ($u = 0$) + conditions of symmetry
- Uniform axial loading per unit of length $q = 10000\,N/m$, applied at the high end



1.4 Initial conditions

Without object for the static analysis.

2 Reference solution

2.1 Method of calculating used for the reference solution

Axial stress: $\sigma_{11}=\frac{q}{h}$

Circumferential constraint: $\sigma_{22}=0$

Lengthening of the cylinder: $U_x=\frac{qL}{Eh}$

Radial displacement: $U_r=-\frac{q\nu R_0}{Eh}$

2.2 Results of reference

$\sigma_{11}=5\times10^5 Pa$
$U_x=9.52\times10^{-6} m$
$U_r=-7.14\times10^{-7} m$

2.3 Uncertainty on the solution

Analytical solution.

2.4 Bibliographical reference

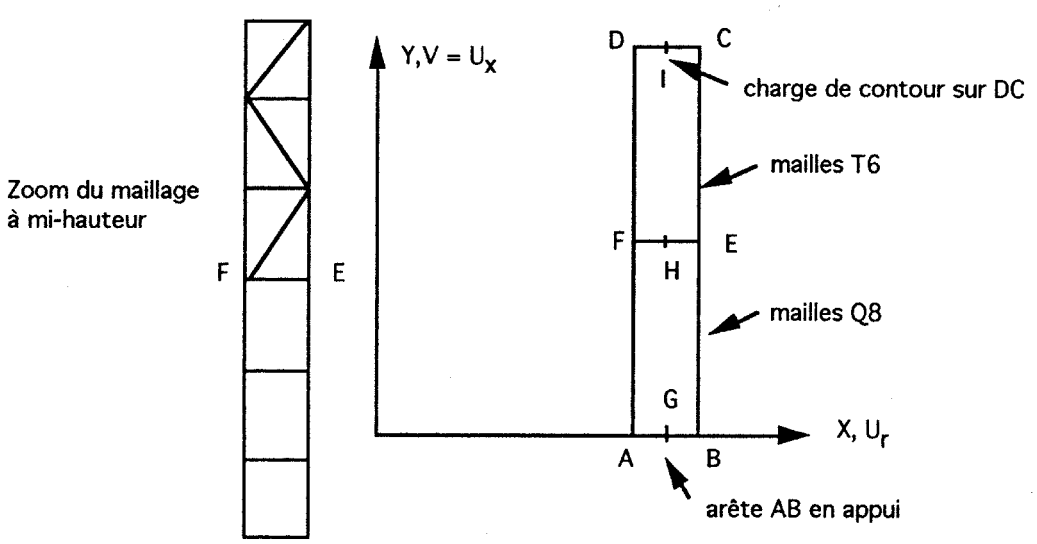
1) Guide VPCS – Edition 1990 (SSLS 07/89)

2) R.J. ROARK and W.C. YOUNG: Formulated for stress and strain, 5ème edition, New York, Mc Graw-Hill, 1975

3 Modeling A

3.1 Characteristics of modeling

AXIS, T6 meshs and Q8



Position of the points:

- E , F with middle height
- G , H , I remotely R_o axis

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

Limiting conditions: $DY = 0$
on AB

Loading: Force distributed = 500,000
on CD

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 Characteristics of the grid

Many nodes: 553
Many meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

3.3 Values tested

Localization	Type of value	Reference
Points G , H , I	$u_r(m)$	$-7.14\ 10^{-7}$
Points C , D , I	$u_x(m)$	$9.52\ 10^{-6}$

Points A, B, C, D, E, F, G	$\sigma_{22}(Pa)$	0.
Points A, B, C, D, E, F, G	$\sigma_{11}(Pa)$	5. 10^{-5}

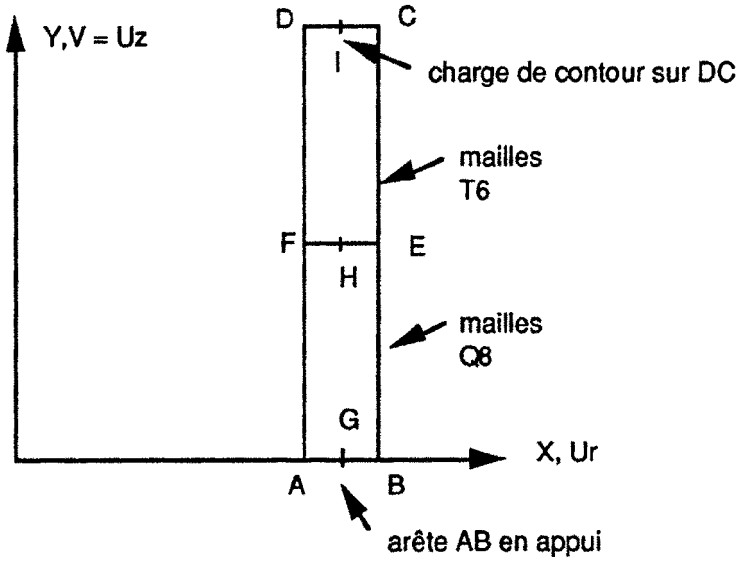
3.4 Notice

The value Fy provided corresponds to the pressure $p = q/h$.

4 Modeling B

4.1 Characteristics of modeling

AXIS, T6 meshs and Q8



Position of the points:

- E, F with middle height
- G, H, I remotely R_o axis

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

The load is broken up in the following way:

- load $q1$ varying linearly from 0 in D with $10000\,N/m$ in C : field of displacements $\mathbf{U1}$
- load $q2$ varying linearly $10000\,N/m$ in D to 0 in C : field of displacements $\mathbf{U2}$

The results are given separately for each field $\mathbf{U1}$ and $\mathbf{U2}$.

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 Characteristics of the grid

Many nodes: 557
Many meshs and types: 50 QUAD8, 100 TRIA6, 204 SEG3

4.3 Values tested

Fields	Localization	Type of value	Reference
$\mathbf{U1}$	Not $G(N51)$	$u_r(m)$	– 3.583. 10^{-7}
	Not $H(N202)$		– 3.583. 10^{-7}
	Not $I(N503)$		– 1.012. 10^{-6}

	Not $C(N452)$	$u_x(m)$	4.896. 10^{-6}
	Not $D(N504)$		4.658. 10^{-6}
	Not $I(N503)$		4.777. 10^{-6}
U2	Not G	$u_r(m)$	– 3.559. 10^{-7}
	Not H		– 3.559. 10^{-7}
	Not I		2.973. 10^{-7}
	Not $C(N452)$		4.627. 10^{-6}
	Not $D(N504)$		4.865. 10^{-6}
	Not $I(N503)$		4.746. 10^{-6}

5 Summary of the results

The keyword FORCE_CONTOUR used starting from the two orders AFFE_CHAR_MECA and AFFE_CHAR_MECA_F provides right results.