# SSLS07 - Thin cylinder under uniform axial loading

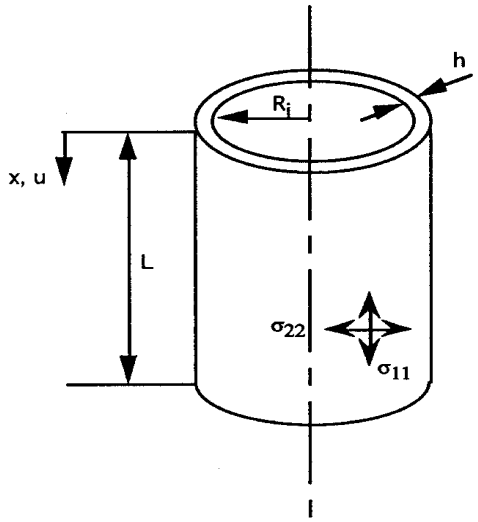
**Summary:**

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



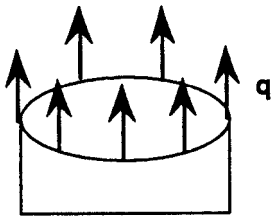

| | | |
|---|---|---|
| Average radius | : | $R_o = 1\text{m}$ |
| Thickness | : | $h = 0.02\,m$ |
| Height | : | $L = 4\,m$ |
| Internal ray | : | $R_i = R_o - h/2$ |

## 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

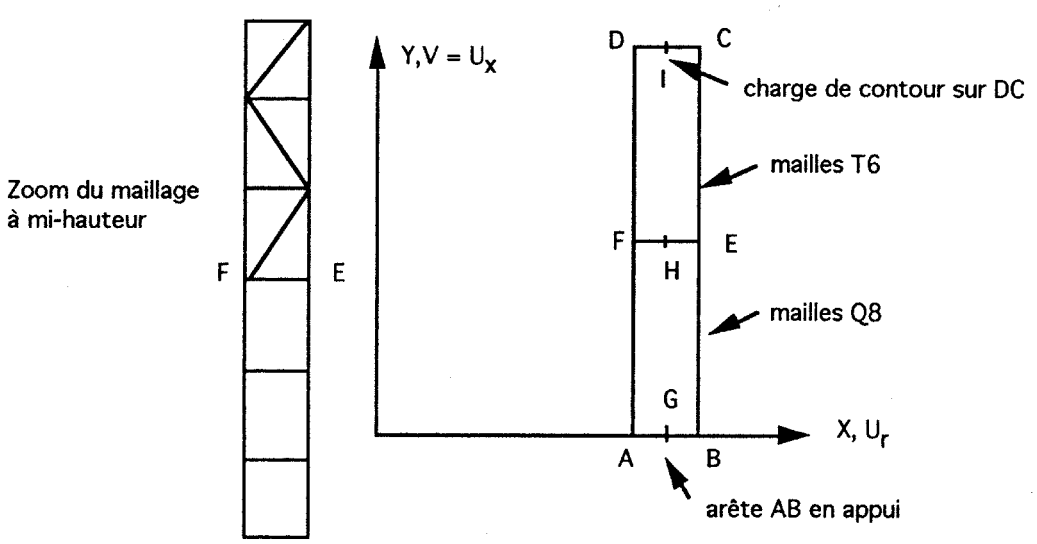
1) Guide VPCS – Edition 1990 (SSLS 07/89)

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. $10^{-5}$ |

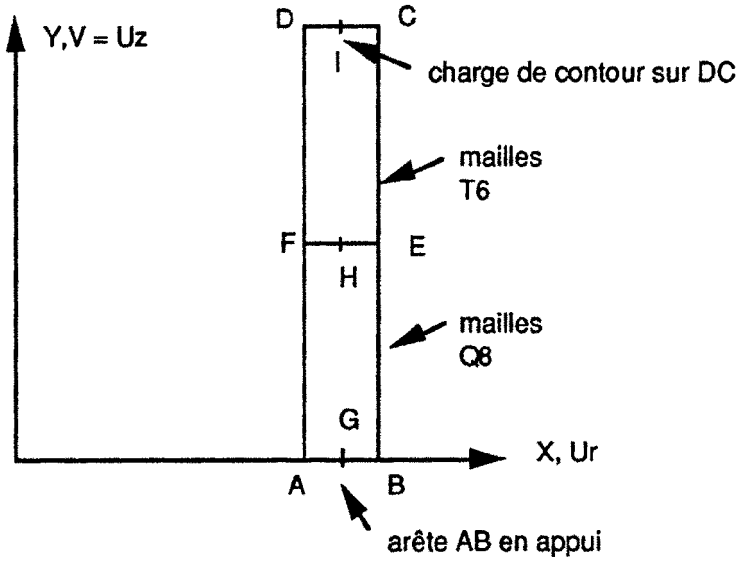
## 3.4 Notice

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 |
|---|---|---|---|
| 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.