HPLP300 - Plate with Young modulus function of the temperature

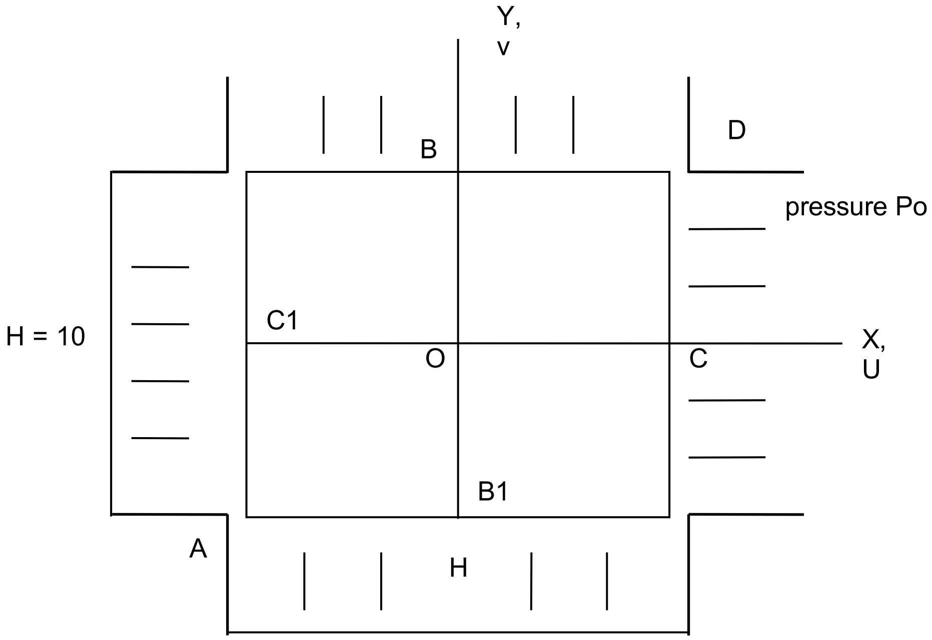
Summarized:

This thermoelastic test makes it possible to compare the solution obtained by *Code_Aster* with an analytical solution, when the Young modulus varies in a nonlinear way compared to the temperature.

This test is deduced from the test $3D$ HPLV100 described in [V7.03.100] (parallelepiped whose Young modulus is function of the temperature).

1 Problem of reference

1.1 Geometry



1.2 Material properties

thermal Conductivity: $\lambda=1$

Young modulus: $E=\frac{10000}{8000-T}$, $T=température$

Poisson's ratio: $\nu=0.3$

1.3 Boundary conditions and loadings

1.3.1 Thermal

$T(0)=40$

$\lambda\frac{\partial T}{\partial n}=-4$ on edge $x=h/2$

$\lambda\frac{\partial T}{\partial n}=+4$ on edge $x=-h/2$

$\lambda \frac{\partial T}{\partial n} = -3$ on edge $y = h/2$

$\lambda \frac{\partial T}{\partial n} = +3$ on Mechanical $y = -h/2$

1.3.2 edge

- Point O blocked ($u = v = 0$)
- following Displacement x blocked in B
- uniform Pressure po being normally exerted on contour: $po = 1$.

2 Reference solution

2.1 Method of calculating used for the reference solution

- the field of temperature is given by:

$$T = -4\mathrm{X} - 3\mathrm{Y} + 40$$

- The field of displacements is given by:

$$u = -Vp\left[Bxy + \frac{C}{2}\left(x^2 - y^2\right) + Dx + \frac{Ch}{4}y \right]$$

$$v = -Vp\left[\frac{B}{2}\left(y^2 - x^2\right) + Cxy + Dy - \frac{Ch}{4}y \right]$$

where $B = 0.003$ $C = 0.004$ $D = 0.76$ $p = \frac{1-v}{v}po$

- the strain field is given by:

$$\varepsilon = \varepsilon_{xx} = \varepsilon_{yy} = -vp\left(By + Cx + D\right) \quad \varepsilon_{xy} = 0$$

- The stress field is given by:

$$\sigma = \sigma_{xx} = \sigma_{yy} = \frac{E}{1-v}\varepsilon = -\frac{1000}{800-T}\frac{vp}{1-v}\left(0.004x + 0.003y + 0.76\right) = -\frac{v}{1-v}p = -po$$

2.2 Results of reference

Temperature to the points $O, A, B, C, D, B1, C1$
Displacements at the points $A, B, C, D, B1, C1$

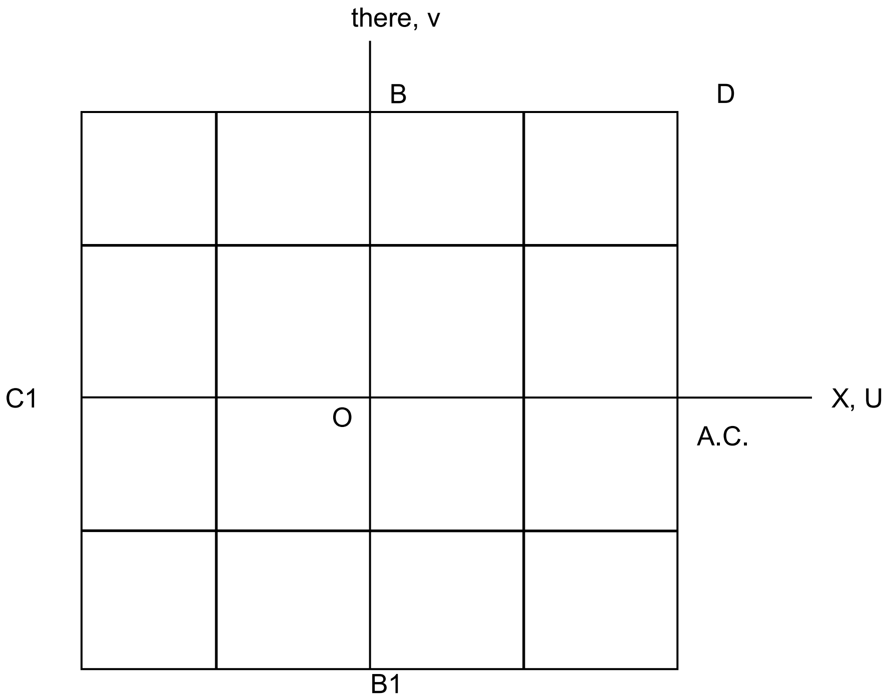
2.3 Uncertainty on the analytical

solution Solution.

3 Modelization A

3.1 Characteristic of the modelization

It acts of a modelization in plane stresses.



Cutting: 4×4 limiting

elements Conditions:

1) in O $u=v=0$
2) B , $u=0$

3.2 Characteristic of the mesh

Many nodes: 65

Number of meshes and type: 16 QUAD8

Name of the nodes

$O=N38$ $A=N1$ $B=N23$ $C=N16$ $D=N3$ $B1=N9$ $C1=N30$

3.3 Quantities tested and Standard

Localization	results of value	Reference	*Aster*	% difference
Point A	T	75.	75.	0.
Point B	T	25.	25.	0.
Point C	T	20.	20.	0.
Point D	T	5.	5.	0.
Point $B1$	T	55.	55.	0.
Point $C1$	T	60.	60.	0.
Point O	T	40.	40.	0.
Point A	u	2.68975	2.64249	-1.75
	v	2.55	2.55502	0.197
Item B	u	0.	1.13 10.-17.1.3	10.-17
	v	-2.65125	-2.68625	-1.32
Item C	u	-2.695	-2.694997	-1.21 10^{-4}
Item D	u	-2.7002	-2.74751	-1.749
	v	-2.695	-2.69503	9.67 10^{-4}
Item $B1$	u	0.0700	0.0699585	-0.059
	v	2.59875	2.63376	1.347
Point $C1$	u	2.625	2.62501	4.73 10^{-4}

3.4 Remarks

It is necessary to finely discretize the function $E(t)$ to get satisfactory results. One took for this test 160 points of discretization, for the interval of temperatures [5. , 75.].

4 Summary of the results

the results got with *Code_Aster* are in concord with the analytical solution.