

HPLP300 - Plate with Young modulus function of temperature

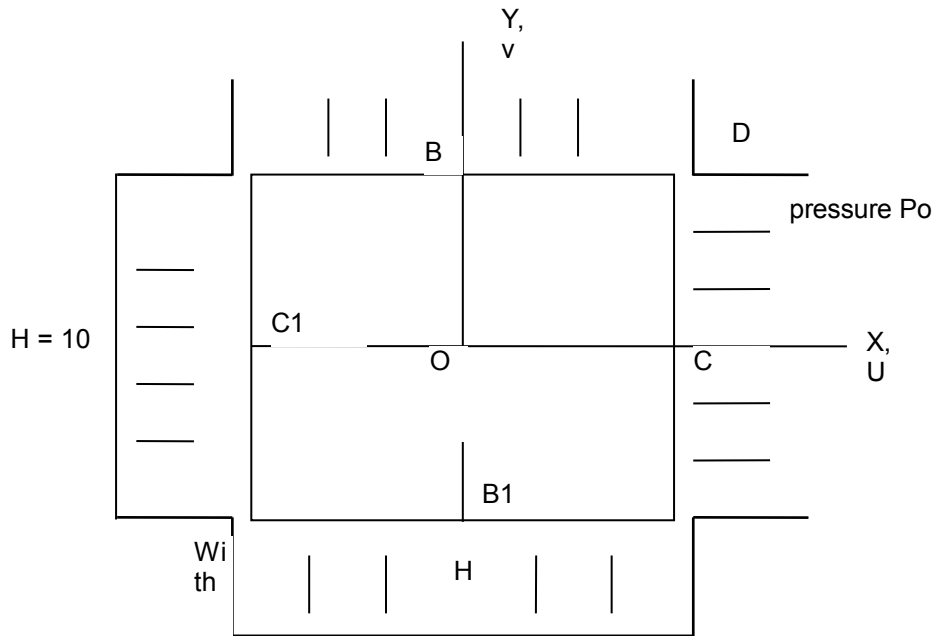
Summary:

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 describes 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: $E = \frac{10000}{8000 - T}$, $T = \text{température}$

Poisson's ratio: $\nu = 0.3$

1.3 Boundary conditions and loadings

1.3.1 Thermics

$$T(0) = 40$$

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

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

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

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

1.3.2 Mechanics

Not O blocked ($u=v=0$)

Following displacement x blocked in B

Uniform pressure p_0 being exerted normally on contour: $p_0 = 1$.

2 Reference solution

2.1 Method of calculating used for the reference solution

The field of temperature is given by:

$$T = -4X - 3Y + 40$$

The field of displacements is given by:

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

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

$$\text{where } B=0.003 \quad C=0.004 \quad D=0.76 \quad p = \frac{1-\nu}{\nu} p_0$$

The field of deformations is given by:

$$\varepsilon = \varepsilon_{xx} = \varepsilon_{yy} = -\nu p (By + Cx + D) \quad \varepsilon_{xy} = 0$$

The stress field is given by:

$$\sigma = \sigma_{xx} = \sigma_{yy} = \frac{E}{1-\nu} \varepsilon = -\frac{1000}{800-T} \frac{\nu p}{1-\nu} (0.004x + 0.003y + 0.76) = -\frac{\nu}{1-\nu} p = -p_0$$

2.2 Results of reference

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

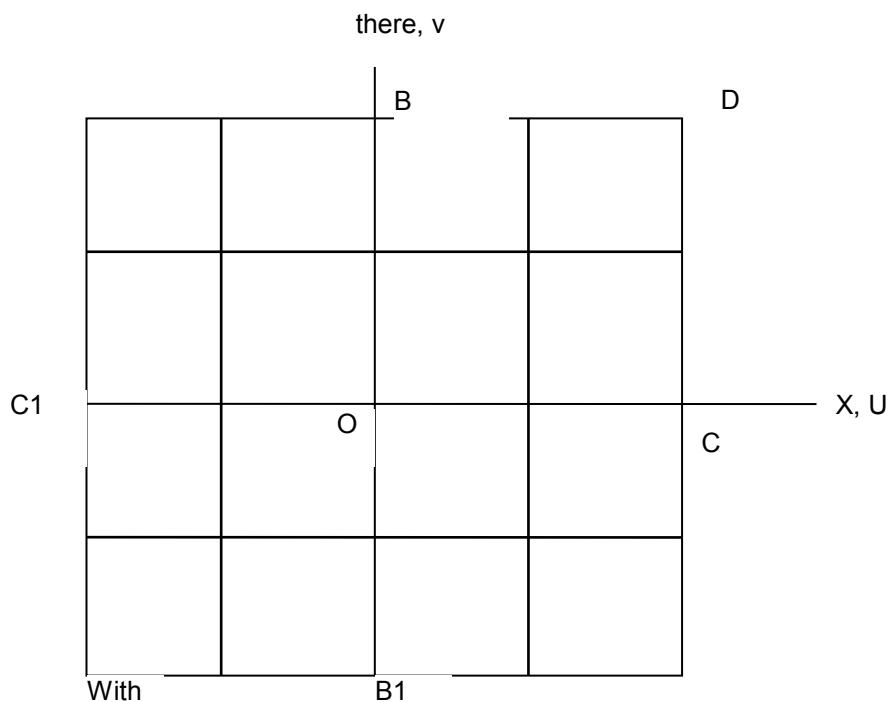
2.3 Uncertainty on the solution

Analytical solution.

3 Modeling A

3.1 Characteristics of modeling

It is about a modeling in plane constraints.



Cutting: 4×4 elements

Limiting conditions:

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

3.2 Characteristics of the grid

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 Sizes tested and results

Localization	Type of value	Reference
Not A	T	75.
Not B	T	25.
Not C	T	20.
Not D	T	5.
Not $B1$	T	55.
Not $C1$	T	60.
Not O	T	40.
Not A	u	2.68975
	v	2.55
Not B	u	0.
	v	-2.65125
Not C	u	-2,695
Not D	u	-2.7002
	v	-2,695
Not $B1$	u	0.0700
	v	2.59875
Not $C1$	u	2,625

3.4 Remarks

It is necessary to discretize the function finely $E(t)$ 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

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