

SSNP302 - Element charged in thermal - Appearance of the secondary stresses

Summarized:

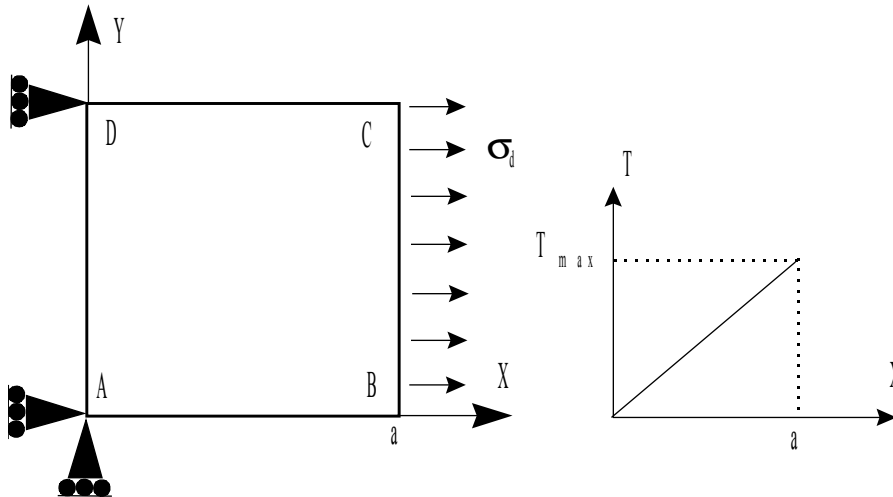
This test of linear quasi-static mechanics 2D consists in charging in thermal a shell element with degree 1, by applying a field of temperature which varies linearly on the element and by fixing a side of the element.

This element being of degree 1, the total mechanical strain will be constant in the element. The fields thermal imposing a linear strain in the element, it will be necessary to take a coefficient of thermal expansion and a sufficiently large heat gradient to make the strain mechanical total sensitive to the imposed thermal field.

The plate is modelled by a plane element (MECPQU4).

1 Problem of reference

1.1 Geometry



Length $a = 1$

1.2 Material properties

isotropic elastic Material:

$$E = 200000 \text{ Mpa}$$

$$\nu = 0.$$

$$\alpha = 1\text{E-}6 / ^\circ\text{C}$$

1.3 Boundary conditions and loadings

Point: A $u_x = 0.$

$$u_y = 0.$$

On the side AD : $u_x = 0.$

On the side BC : $\sigma_D = 100 \text{ MPa}$

Application of a field of temperature which varies linearly on the element with $T_{max} = 1000^\circ\text{C}$.

2 Reference solution

2.1 Method of calculating used for the analytical reference solution

Solution.

2.2 Results of reference

the mechanical strain is worth:

$$\begin{aligned}\varepsilon^{mec} &= \varepsilon - \varepsilon^{th} \\ &= \varepsilon - \alpha T\end{aligned}$$

With an element with the degree one and a diagram 2×2 of integration one will have:

$$\begin{aligned}\varepsilon^{mec} &= \frac{u_{xB} - u_{xA}}{a} - \alpha \left[\frac{1+\xi}{2} T_{max} \right] \\ &= \frac{\sigma_d}{E} + \frac{1}{2} \alpha T_{max} - \alpha \left[\frac{1+\xi}{2} T_{max} \right]\end{aligned}$$

The stress in the test will be worth:

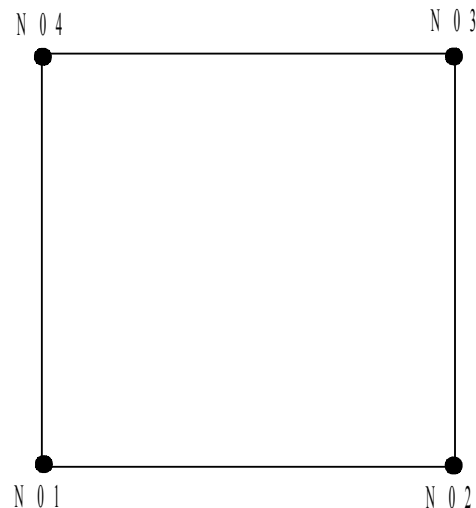
$$\sigma = E \varepsilon^{mec} \text{ with } \varepsilon^{mec} = 10^{-3} - \alpha \left[\frac{1+\xi}{2} T_{max} \right]$$

2.3

the thermal component of the stress Notices depending on the intrinsic coordinate, the solution is to consider an average temperature by element.

3 Modelization A

3.1 Characteristic of the modelization A



Modelization in plane stresses: C_PLAN

the loading and the boundary conditions are modelled by:

- DDL_IMPO (Node *NO1* $DX=0$
 $DY=0$)
(Node *NO4* $DX=0$)

- of the nodal forces imposed on the nodes *NO2* and *NO3*

- of the temperatures imposed on the nodes

$$\begin{aligned} NO1 \ NO4 : T=0^\circ \\ NO2 \ NO3 : T=1000^\circ \end{aligned}$$

3.2 Characteristics of the mesh

Many nodes: 4

Number of meshes and types: 1 MECPQU4 with diagram of integration 2×2

3.3 Quantities tested and results

Identification	Reference
<i>SIXX</i> (<i>NO1</i>)	200
<i>SIXX</i> (<i>NO4</i>)	200
<i>SIXX</i> (<i>NO2</i>)	0
<i>SIXX</i> (<i>NO3</i>)	0

4 Summary of the results

the results provided by Code_Aster are very satisfactory.