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

Summary:

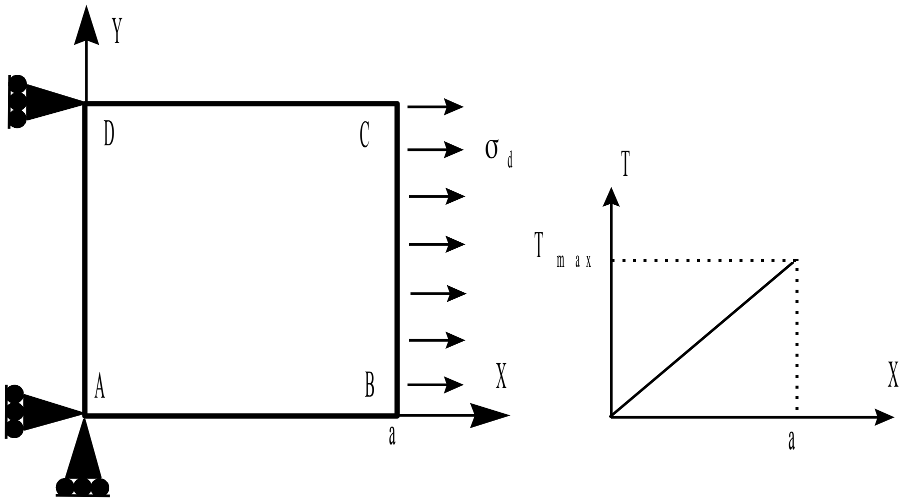
This test of linear quasi-static mechanics 2D consists in charging in thermics an element with plate to degree 1, by applying a field of temperature which varies linearly on the element and by fixing a side of the element.

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

The plate is modelled by an element plan (`MECPQU4`).

1 Problem of reference

1.1 Geometry



Length $a=1$

1.2 Material properties

Isotropic elastic material:

$E=200000\,Mpa$
$\nu=0.$
$\alpha=1E\text{-}6/°C$

1.3 Boundary conditions and loadings

Not A :	$u_x=0.$
	$u_y=0.$
On the side AD :	$u_x=0.$
On the side BC :	$\sigma_D=100\,MPa$

Application of a field of temperature which varies linearly on the element with $Tmax=1000°C$.

2 Reference solution

2.1 Method of calculating used for the reference solution

Analytical solution.

2.2 Results of reference

The mechanical deformation 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 constraint in the test will be worth:

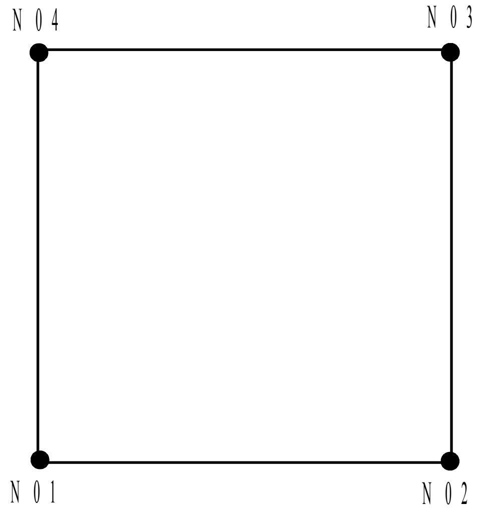
$$\sigma = E \, \varepsilon^{mec} \text{ with } \varepsilon^{mec} = 10^{-3} - \alpha \left[\frac{1+\xi}{2} T_{max} \right]$$

2.3 Notice

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

3 Modeling A

3.1 Characteristics of modeling A



Modeling in plane constraints: C_PLAN

The loading and the boundary conditions are modelled by:

- DDL_IMPO (Node $NO1$ $DX=0$
  $DY=0$)
  (Node $NO4$ $DX=0$)
- nodal forces imposed on the nodes $NO2$ and $NO3$
- temperatures imposed on the nodes
  $NO1$, $NO4$: $T=0°$
  $NO2$, $NO3$: $T=1000°$

3.2 Characteristics of the grid

Many nodes: 4
Many meshs and types: 1 MECPQU4 with diagram of integration 2×2

3.3 Sizes tested and results

Identification	Reference
$SIXX$ ($NO1$)	200
$SIXX$ ($NO4$)	200
$SIXX$ ($NO2$)	0
$SIXX$ ($NO3$)	0

4 Summary of the results

The results provided by Code_Aster are very satisfactory.