

## SSNP05 - Plate in traction-shearing: viscoelasticity of Lemaître

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### Summary:

This test of nonlinear quasi-static mechanics consists in charging in traction-shearing a square plate. One thus validates the relation of nonlinear behavior of viscoelasticity of Lemaître (in 3D ) for a nonradial loading. This test is drawn from guide VPCS of the French company of Mechanics.

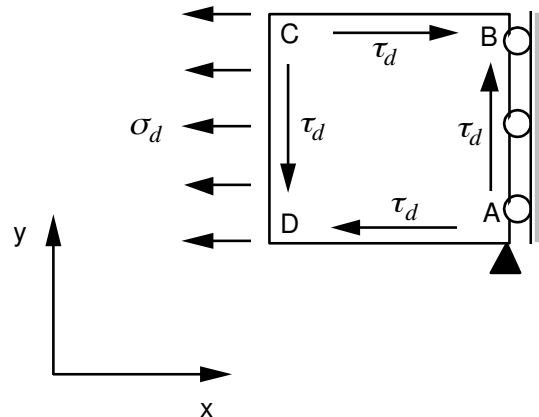
The plate is modelled by a voluminal element (HEXA8).

Results got by *Code\_Aster* are very close to the reference solution.

## 1 Problem of reference

### 1.1 Geometry

Square plate



### 1.2 Material properties

$$E = 178\,600 \text{ MPa}$$

$$\nu = 0.3$$

Viscoelastic relation of behavior of Lemaître

$$n = 11 \quad \frac{1}{K} = 3.28410^{-4} \quad (K = 3045) \quad \frac{1}{m} = 0.17857 \quad (m = 5.6)$$

### 1.3 Boundary conditions and loadings

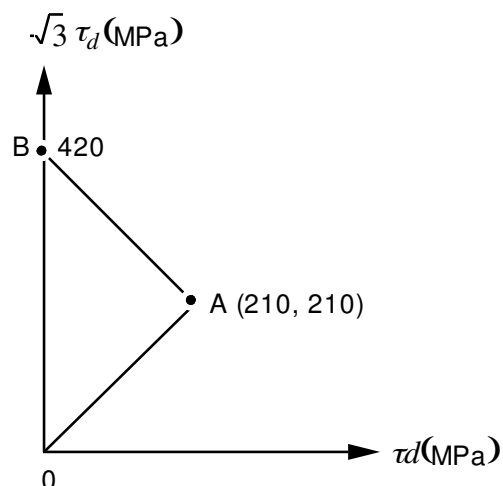
On  $A$  :  $u_x = u_y = 0$

On the side  $AB$  :  $u_x = 0$

Loading below:

Ways  $OA$  and  $AB$ , of duration 30 seconds,

Time of maintenance in  $A$  and  $B$  from 3600 seconds



## 2 Reference solution

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### 2.1 Method of calculating used for the reference solution

Calculation carried out with various codes of finite elements using various explicit algorithms, semi - implicit or implicit.

### 2.2 Results of reference

$\varepsilon_{v_{xx}}$  and  $\varepsilon_{v_{xy}}$  at the moments  $t=30 s$ ,  $t=3630 s$ ,  $t=3660 s$  and  $t=3720 s$

### 2.3 Uncertainty on the solution

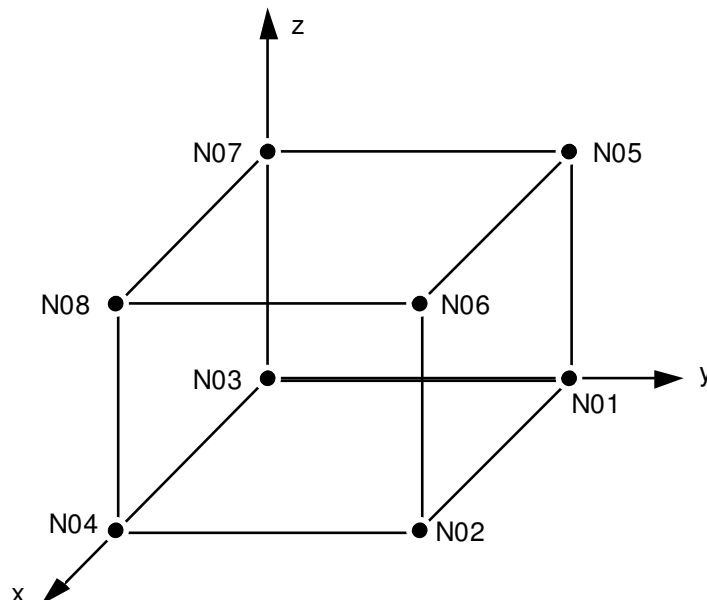
Uncertainty lower than 0.01% .

### 2.4 Bibliographical references

- Card SSNP05/89 of Commission VPCS

## 3 Modeling A

### 3.1 Characteristics of modeling



The loading and the boundary conditions are modelled by:

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DDL_IMPO: (NODE: N04, DX: 0. , DY: 0.)
DDL_IMPO: (NODE: N08, DX: 0. , DY: 0. , DZ: 0.)
DDL_IMPO: (NODE: N02, DX: 0.)
DDL_IMPO: (NODE: N06, DX: 0.)

FORCE_NODALE: (NODE: (N01 N03 N05 N07), FX: - $\frac{1}{4}\sigma_d(t)$  , FY: - $\frac{1}{4}\tau_d(t)$  )

FORCE_NODALE: (NODE: (N03 N04 N07 N08), FX: - $\frac{1}{4}\tau_d(t)$  )

FORCE_NODALE: (NODE: (N02 N04 N06 N08), FY:  $\frac{1}{4}\tau_d(t)$  )

FORCE_NODALE: (NODE: (N01 N02 N05 N06), FX:  $\frac{1}{4}\tau_d(t)$  )
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### 3.2 Characteristics of the grid

Many nodes: 8  
Many meshes and types: 1 HEXA8

## 3.3 Sizes tested and results

Variables	Moments ( <i>s</i> )	Reference	Aster	% difference
$\mathcal{E}_{v_{xx}}$	30	2,465 10 <sup>-4</sup>	2,457 10 <sup>-4</sup>	0,333%
$\mathcal{E}_{v_{xy}}$	30	2,135 10 <sup>-4</sup>	2,128 10 <sup>-4</sup>	0,333%
$\mathcal{E}_{v_{xx}}$	3630	2,867 10 <sup>-3</sup>	2,876 10 <sup>-3</sup>	0,316%
$\mathcal{E}_{v_{xy}}$	3630	2,483 10 <sup>-3</sup>	2,491 10 <sup>-3</sup>	0,326%
$\mathcal{E}_{v_{xx}}$	3660	2,879 10 <sup>-3</sup>	2,889 10 <sup>-3</sup>	0,337%
$\mathcal{E}_{v_{xy}}$	3660	2,565 10 <sup>-3</sup>	2,562 10 <sup>-3</sup>	- 0,101%
$\mathcal{E}_{v_{xx}}$	3720	2,879 10 <sup>-3</sup>	2,889 10 <sup>-3</sup>	0,337%
$\mathcal{E}_{v_{xy}}$	3720	3,272 10 <sup>-3</sup>	3,271 10 <sup>-3</sup>	- 0,037%

## 4 Summary of the results

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The precision necessary for this test was fixed at 0.5% instead of 0.1% not to lengthen the computing time too much. However, it is checked that by refining the discretization in time, the mistake made compared to the reference solution tends towards zero.