SSNP05 - Plate in traction-shearing: viscoelasticity of Lemaître

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.

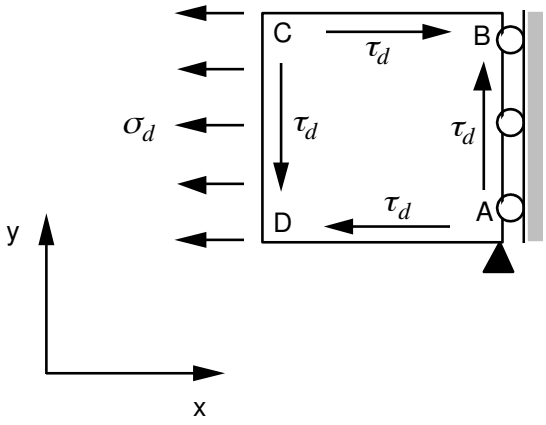
The plate is modelled by a voluminal element (HEXA8).

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

$E = 178\,600\,MPa$

$\nu = 0.3$

Viscoelastic relation of behavior of Lemaître

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

1.3 Boundary conditions and loadings

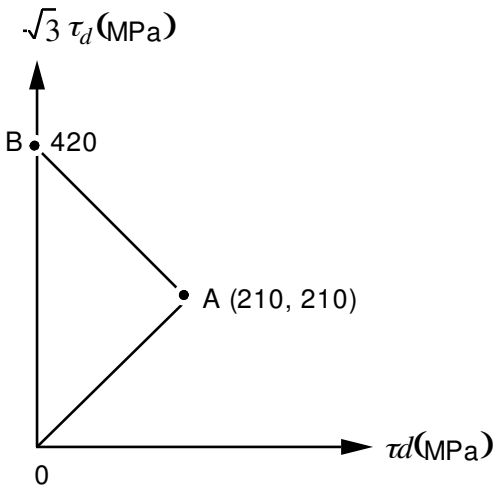
On A : $u_x = u_y = 0$

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

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

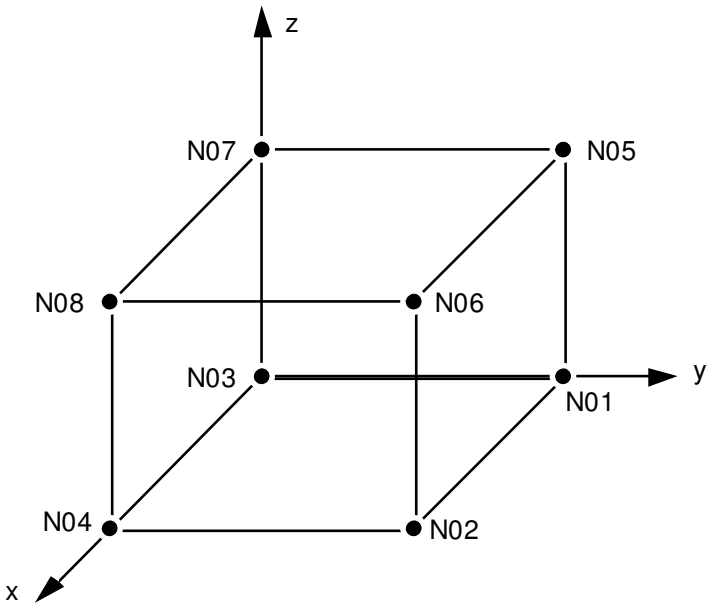
Uncertainty lower than 0.01% .

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.)
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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: $\frac{1}{4}\tau_d(t)$)

3.2 Characteristics of the grid

Many nodes:	8
Many meshs and types:	1 HEXA8

3.3 Sizes tested and results

Variables	Moments (s)	Reference	*Aster*	% difference
$\varepsilon_{v_{xx}}$	30	2,465 10^{-4}	2,457 10^{-4}	0,333%
$\varepsilon_{v_{xy}}$	30	2,135 10^{-4}	2,128 10^{-4}	0,333%
$\varepsilon_{v_{xx}}$	3630	2,867 10^{-3}	2,876 10^{-3}	0,316%
$\varepsilon_{v_{xy}}$	3630	2,483 10^{-3}	2,491 10^{-3}	0,326%
$\varepsilon_{v_{xx}}$	3660	2,879 10^{-3}	2,889 10^{-3}	0,337%
$\varepsilon_{v_{xy}}$	3660	2,565 10^{-3}	2,562 10^{-3}	– 0,101%
$\varepsilon_{v_{xx}}$	3720	2,879 10^{-3}	2,889 10^{-3}	0,337%
$\varepsilon_{v_{xy}}$	3720	3,272 10^{-3}	3,271 10^{-3}	– 0,037%

4 Summary of the results

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.