SSNP101 - Plate in tension-shears: viscoelasticity of Lemaître (D_PLAN)

Summarized:

This test of nonlinear quasi-static mechanics consists in charging in tension-shears a square plate.

One thus validates the behavior models of nonlinear viscoelasticity in plane strains for a nonradial loading.

The modelization A validates in 2D D_PLAN the model of Lemaître and the model VISC_ENDO_LEMA, for which the parameters are adjusted so that the damage is null.

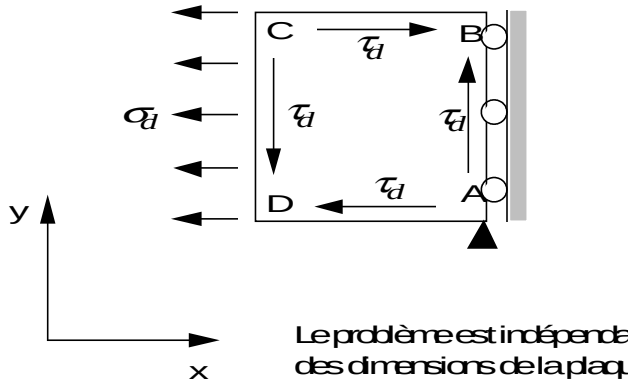
The modelization B validates model VISC_TAHERI in 2D D_PLAN, in which the parameters are adjusted so that the effect of plasticity and ratchet are destroyed

the results got by Code_Aster are very close to the reference solution.

1 Problem of reference

1.1 Geometry

Plates square



1.2 Material properties

the isotropic elastic parameters of the model are:

$E=178\,600\,MPa \quad \nu=0.3$

Viscoelastic behavior model of Lemaître

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

Behavior model VISC_ENDO_LEMA (not of damage) $A_D=100000.0$

Behavior model VISC_TAHERI (not of plasticity)

$R_0=0.001 \quad \alpha=0 \quad M=1 \quad A=0 \quad B=0 \quad C_1=0 \quad C_{INF}=0 \quad , \quad S=900$

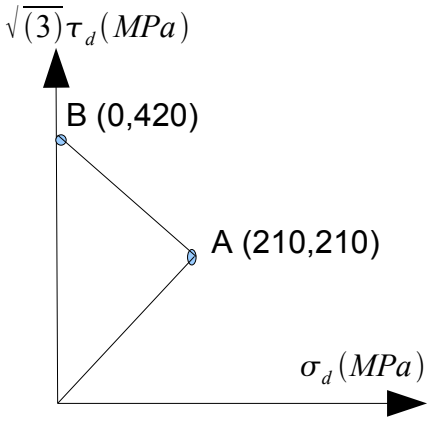
1.3 Boundary conditions and loadings

In A : $u_x=u_y=0$

On the side AB : $u_x=0$

Loading below: Ways OA and AB , of period 30 seconds,

Time of maintenance in A and B 3600 seconds.



2 Reference solution

2.1 Méthode de calcul used for the reference solution

Computation 3D of Code_Aster carried out with an element HEXA8 of which all the nodes have a displacement imposed no one according to Oz. That makes it possible to constitute a reference for the case of the plane strains (in the plane (Ox, Oy)), where one does not have of an analytical solution or of results other computer codes.

Operation in $3D$ nonlinear viscoelasticity of Lemaître itself was validated using test SSNP05A.

2.2 Results of reference

$\varepsilon_{v_{xx}}$ and $\varepsilon_{v_{xy}}$ with times $t=30\,s$ $t=3630\,s$, $t=3660\,s$ and $t=3720\,s$

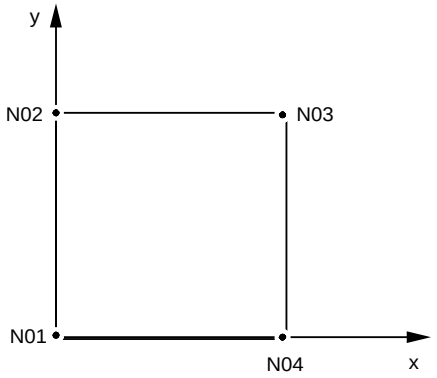
2.3 Uncertainty on the solution

Uncertainty lower than 0.5%

3 Modelization A

3.1 Characteristic of the modelization

Only one element leaning on a mesh QUAD4, in D_PLAN.



The loading and the boundary conditions are modelled by:

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DDL_IMPO: (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT
PROFILE OF THE EXCLU TYPE NODE: N04, DX: 0. , DY: 0.)
DDL_IMPO: (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT
PROFILE OF THE EXCLU TYPE NODE: N03, DX: 0.)
FORCE_NODALE: (NOEUD; (N01 N02), FX: -1/2 σd(t) , FY: -1/2 τd(t) )
FORCE_NODALE: (NOEUD; (N01 N04), FX: -1/2 τd(t) )
FORCE_NODALE: (NOEUD; (N03 N04), FY: 1/2 τd(t) )
FORCE_NODALE: (NOEUD; (N02 N03), FX: 1/2 τd(t) )
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where $\sigma_d(t)$ and $\tau_d(t)$ are the higher definite positive functions [§1.3].

3.2 Quantities tested and results

Behavior LEMAITRE (THETA=0.5)

Variable	Times (S)	Reference	*Tolerance*
$\varepsilon_{v_{xx}}$	30	1.7620 10-4	0.5%
$\varepsilon_{v_{xy}}$	30	1.81585 10-4	0.5%
$\varepsilon_{v_{xx}}$	3630	1.9030 10-3	0.5%
$\varepsilon_{v_{xy}}$	3630	2.0789 10-3	0.5%
$\varepsilon_{v_{xx}}$	3660	1.9130 10-3	0.5%
$\varepsilon_{v_{xy}}$	3660	2.1906 10-3	0.5%
$\varepsilon_{v_{xx}}$	3720	1.8740 10-3	0.5%
$\varepsilon_{v_{xy}}$	3720	3.1813 10-3	0.5%

Behavior VISC_ENDO_LEMA (with a temporal discretization 10 times finer)

Variable	Times (S)	Reference	Tolerance
$\varepsilon_{v_{xx}}$	30	1.762 10-4	0.7%
$\varepsilon_{v_{xy}}$	30	1.816 10-4	0.7%

4 Modelization B

4.1 Characteristic of the modelization

Identical to modelization A. Seule the constitutive law changes: here the model is VISC_TAHERI.

4.2 Quantities tested and results

Behavior VISC_TAHERI (with a temporal discretization 10 times finer than LEMAITRE)

Variable	Times (S)	Reference	*Tolerance*
$\varepsilon_{v_{xx}}$	30	1.762 10-4	1.00%
$\varepsilon_{v_{xy}}$	30	1.816 10-4	1.00%
$\varepsilon_{v_{xx}}$	3630	1.9030 10-3	1.00%
$\varepsilon_{v_{xy}}$	3630	2.0789 10-3	1.00%
$\varepsilon_{v_{xx}}$	3660	1.9130 10-3	1.00%
$\varepsilon_{v_{xy}}$	3660	2.1906 10-3	1.00%
$\varepsilon_{v_{xx}}$	3720	1.8740 10-3	1.00%
$\varepsilon_{v_{xy}}$	3720	3.1813 10-3	1.00%

Note:: one uses the method of Brent for the resolution of the constitutive law.

5 Summary of the results

This test validates in $2D$ plane strain 3 constitutive laws LEMAITRE, VISC_ENDO_LEMA (without damage) and VISC_TAHERI (without plasticity) whose equations relating to viscosity are controls by the model of Lemaître. The differences between the models are lower than 1%.