SSNL129 – Validation of models VISC_ISOT_TRAC and VISC_ISOT_LINE on a Summarized

traction test:

This test consists in applying to a ground volume a loading of tension. Three loading rates are modelled.

The modelizations A, B and C make it possible to validate constitutive law VISC_ISOT_TRAC (DEFORMATION=' SIMO_MIEHE') in 3D, D_PLAN and AXIS. For that, the got results are compared with the viscous model of Rousselier ROUSS_VISC and degenerated DEFORMATION=' PETIT_REAC' so that the evolution of porosity is negligible. The modelizations D, E and F make it possible to validate the integration of model VISC_ISOT_LINE (DEFORMATION=' SIMO_MIEHE') in 3D, D_PLAN and AXIS. For that, the got results are compared with those given by model VISC_ISOT_TRAC for the same linear hardening.

1 Problem of reference

1.1 Geometry

It acts to test 2 viscoplastic constitutive laws VISC_ISOT_TRAC and VISC_ISOT_LINE on an Elementary Volume representative R of dimension 1mm, that is to say a cube in 3D, the equivalent of a bar in plane strains or a cylinder into axisymmetric.

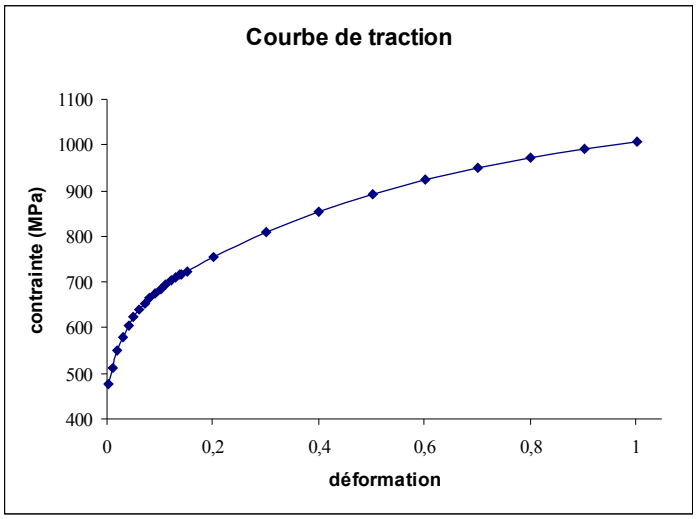
1.2 Properties of the isotropic

material Elasticity

Young Modulus: $E = 215000\,\text{MPa}$

Poisson's ratio: $\nu = 0.3$

Curve of tension (MOD. A, B and C)



linear Hardening (MOD. D, E and F)

$\sigma_y = 477.1267117\,\text{MPa}$

$E_T = 529.853045\,\text{MPa}$

Coefficient for viscous model VISC_SINH

$\sigma_0 = 6176\,\text{MPa}$

$\varepsilon_0 = 3.31131121483\ 10^{13}$

$m = 6.76$

Coefficients of the model of Rousselier used to obtain the reference solution (MOD. A, B and C)

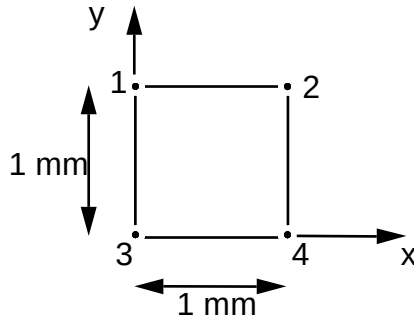
$f_0 = 5\,10^{-9}$

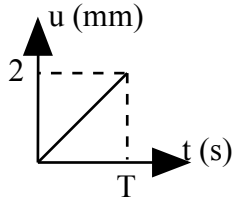
$D = 0.0001$

$\sigma_1 = 1575\,\text{MPa}$

1.3 Boundary conditions and loadings

the volume element is subjected to a homogeneous simple traction test. It is thus blocked in x on the face [3,4] and in y on the face [1,3] (and possibly in the direction z) and subjected to a displacement $u(t)$ in the direction Oy on the face [1, 2].
3 values of T are used $2000\,s$, $0.2\,s$ and $0.002\,s$, corresponding to strainrates $\dot{\varepsilon}$ of $10^{-3}s^{-1}$, $10\,s^{-1}$ and $10^{3}s^{-1}$.





1.4 Forced

initial conditions and null strains with $t=0$.

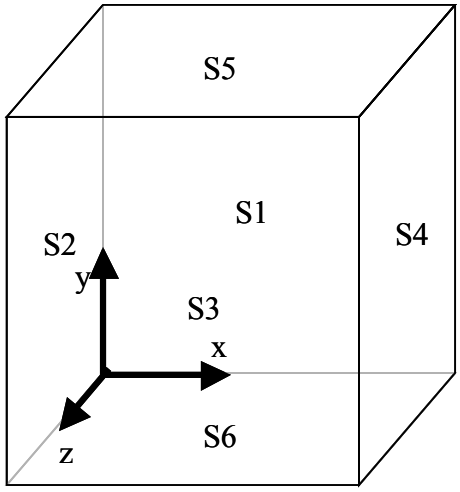
2 Results of reference

For the model VISC_ISOT_TRAC which one tests in the modelizations A, B and C, the validation is done by comparison with the results got with the model ROUSS_VISC whose parameters were selected in order to make negligible the evolution of porosity and thus to be reduced to the plastic model visco - “classic”.
For the model VISC_ISOT_LINE tested in the modelizations D, E and F, one compares the solution obtained with VISC_ISOT_TRAC for which one defined a linear hardening (one does not preserve that the points ends of the curve used to validate this model).

3 Modelization A

3.1 Characteristic of the modelization

Modelization 3D : 1 HEXA20



the imposed loading is the following:

- The face $S6$ is blocked according to the direction y,
- the face $S2$ is blocked according to the direction x,
- the face $S1$ is blocked according to the direction z
- the face $S5$ undergoes a displacement of $2\,mm$ in $2000\,s$, $0.2\,s$ or $0.002\,s$ 100 increments.

The constitutive law tested is model VISC_ISOT_TRAC.

3.2 Quantities tested and results

One tests the force of reaction on the face $S5$ for the 3 strainrates for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U=0.1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	639.207	639.294	0.014
Mean velocity	697.092	697.070	-0.003
fast Velocity	772.983	772.885	-0.013

Displacement $U=1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	484.913	484.672	-0.050
Mean velocity	516.997	513.863	-0.606
fast Velocity	555.633	552.167	-0.624

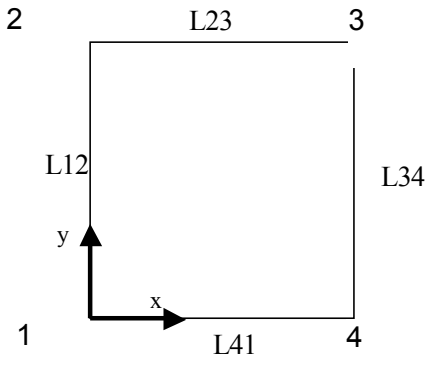
Displacement $U=2\,mm$

Identification	Reference	Aster	% difference
slow Velocity	347.473	347.661	0.054
Mean velocity	369.458	365.992	-0.938
fast Velocity	393.799	390.046	-0.953

4 Modelization B

4.1 Characteristic of the modelization

Modelization D_PLAN : 1 QUAD8



the imposed loading is the following:

- On the east side $L41$ blocked in the direction y,
- on the east side $L12$ blocked in the direction x,
- the side $L23$ undergoes a displacement of $2\,mm$ in $2000\,s$, $0.2\,s$ or $0.002\,s$ 100 increments.

The constitutive law tested is model VMIS_ISOT_TRAC_V.

4.2 Quantities tested and results

One tests the force of reaction on the face $L23$ for the 3 strainrates for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U=0.1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	752.473	750.523	-0.259
Mean velocity	820.703	818.465	-0.273
fast Velocity	910.274	907.610	-0.293

Displacement $U=1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	575.182	572.674	-0.436
Mean velocity	609.788	607.023	-0.453
fast Velocity	655.218	652.093	-0.477

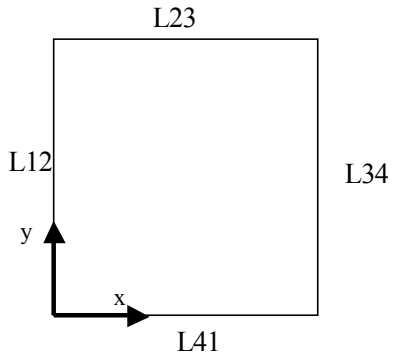
Displacement $U=2\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	413.295	411.243	-0.496
Mean velocity	435.051	432.815	-0.514
fast Velocity	463.612	461.120	-0.538

5 Modelization C

5.1 Characteristic of the modelization

Modelization AXIS : 1 QUAD8



the imposed loading is the following:

- On the east side $L41$ blocked in the direction y,
- the side $L23$ undergoes a displacement of $2\,mm$ in $2000\,s$, $0.2\,s$ or $0.002\,s$ 100 increments.

The constitutive law tested is model VISC_ISOT_TRAC.

5.2 Quantities tested and results

One tests the force of reaction on the face $L23$ for the 3 strainrates for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U=0.1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	319.604	319.647	0.013
Mean velocity	348.483	348.535	0.015
fast Velocity	386.388	386.442	0.014

Displacement $U=1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	242.457	242.336	-0.050
Mean velocity	257.078	256.931	-0.057
fast Velocity	276.269	276.084	-0.067

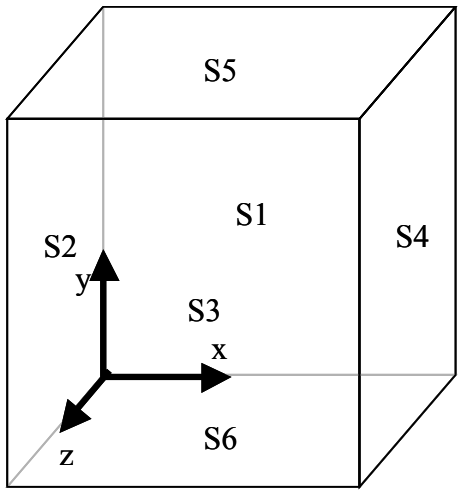
Displacement $U=2\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	174.061	173.831	-0.132
Mean velocity	183.251	182.996	-0.139
fast Velocity	195.314	195.023	-0.149

6 Modelization D

6.1 Characteristic of the modelization

Modelization 3D : 1 HEXA20



the imposed loading is the following:

- The face $S6$ is blocked according to the direction y,
- the face $S2$ is blocked according to the direction x,
- the face $S1$ is blocked according to the direction z
- the face $S5$ undergoes a displacement of $2\,mm$ in $2000\,s$, $0.2\,s$ or $0.002\,s$ 100 increments.

The constitutive law tested is model VISC_ISOT_LINE.

6.2 Quantities tested and results

One tests the force of reaction on the face $S5$ for the 3 strainrates for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U=0.1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	498.936	499.026	0.018
Mean velocity	556.844	556.945	0.018
fast Velocity	632.832	362.948	0.018

Displacement $U=1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	433.411	433.422	0.003
Mean velocity	462.578	462.591	0.003
fast Velocity	500.853	500.868	0.003

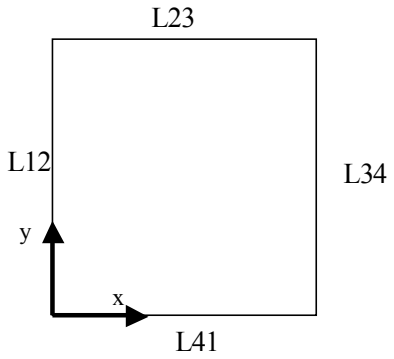
Displacement $U=2\,mm$

Identification	Reference	Aster	% difference
slow Velocity	360.757	360.740	-0.005
Mean velocity	379.083	379.066	-0.005
fast Velocity	403.131	403.113	-0.004

7 Modelization E

7.1 Characteristic of the modelization

Modelization D_PLAN : 1 QUAD8



the imposed loading is the following:

- On the east side $L41$ blocked in the direction y,
- the side $L23$ undergoes a displacement of $2\,mm$ in $2000\,s$, $0.2\,s$ or $0.002\,s$ 100 increments.

The constitutive law tested is model VISC_ISOT_LINE.

7.2 Quantities tested and results

One tests the force of reaction on the face $L23$ for the 3 strainrates for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U=0.1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	583.729	583.873	0.025
Mean velocity	651.843	652.008	0.025
fast Velocity	741.214	741.406	0.026

Displacement $U=1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	530.975	531.065	0.017
Mean velocity	565.249	565.350	0.018
fast Velocity	610.221	610.335	0.019

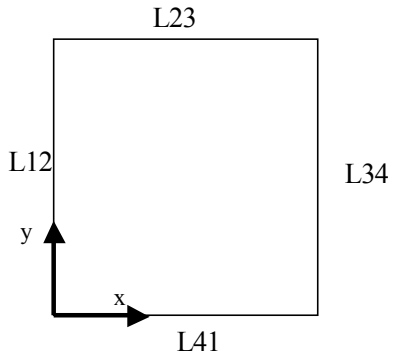
Displacement $U=2\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	448.942	449.007	0.014
Mean velocity	470.456	470.528	0.015
fast Velocity	498.687	498.767	0.016

8 Modelization F

8.1 Characteristic of the modelization

Modelization AXIS: 1 QUAD8



the imposed loading is the following:

- On the east side $L41$ blocked in the direction y,
- the side $L23$ undergoes a displacement of $2\,mm$ in $2000\,s$, $0.2\,s$ or $0.002\,s$ 100 increments.

The constitutive law tested is model VMIS_ISOT_LINE

8.2 Quantities tested and results

One tests the force of reaction on the face $L23$ for the 3 strainrates for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U=0.1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	249.468	249.513	0.018
Mean velocity	278.422	278.473	0.018
fast Velocity	316.416	316.474	0.018

Displacement $U=1\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	216.706	216.711	0.002
Mean velocity	231.289	231.296	0.003
fast Velocity	250.426	250.434	0.003

Displacement $U=2\,mm$

Identification	Reference	*Aster*	% difference
slow Velocity	180.379	180.370	-0.005
Mean velocity	189.542	189.533	-0.005
fast Velocity	201.566	201.557	-0.005

9 Summary of the results

With less 1% of difference between the model ROUSS_VISC (degenerated) and the model VISC_ISOT_TRAC whatever the rate loading applied, one can admit that the addition of the viscous component in the model VISC_ISOT_TRAC is correct.

In addition the very weak variations (lower than 0.02%) observed between the solutions obtained with VISC_ISOT_LINE and VISC_ISOT_TRAC for a linear hardening, also make it possible to validate the model VISC_ISOT_LINE installation of .

In all the cases, less than 10 local iterations are necessary to reach convergence (accuracy 10^{-9}).