

SSNL129 – Validation of the laws VISC_ISOT_TRAC and VISC_ISOT_LINE on a tensile test

Summary:

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

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

1 Problem of reference

1.1 Geometry

It is a question of testing the 2 viscoplastic laws of behavior VISC_ISOT_TRAC and VISC_ISOT_LINE on a representative Ground volume R of dimension 1mm, that is to say a cube in 3D, the equivalent of a bar in plane deformations or a cylinder into axisymmetric.

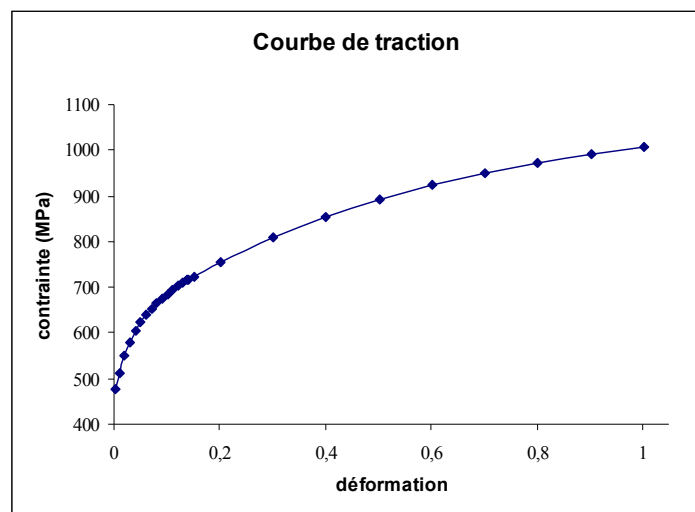
1.2 Properties of material

Isotropic elasticity

Young modulus: $E = 215000$ MPa

Poisson's ratio: $\nu = 0.3$

Traction diagram (MOD. With, B and C)



Linear work hardening (MOD. D, E and F)

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

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

Coefficient for viscous law VISC_SINH

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

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

$$m = 6.76$$

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

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

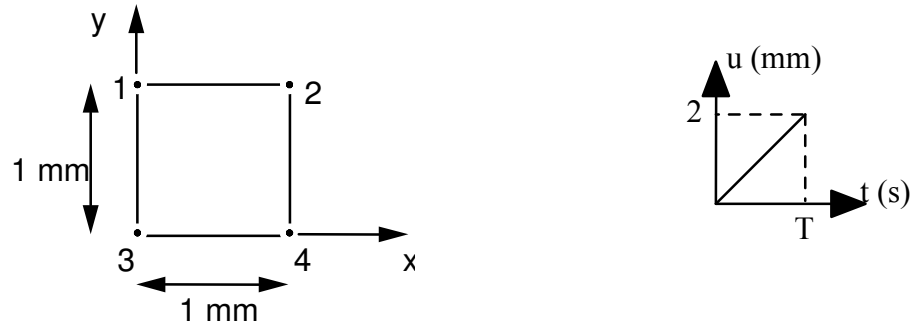
$$D = 0.0001$$

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

1.3 Boundary conditions and loadings

The element of volume is subjected to a homogeneous simple tensile 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 speeds of deformations $\dot{\epsilon}$ of $10^{-3} s^{-1}$, $10 s^{-1}$ and $10^3 s^{-1}$.



1.4 Initial conditions

Worthless constraints and deformations with $t=0$.

2 Results of reference

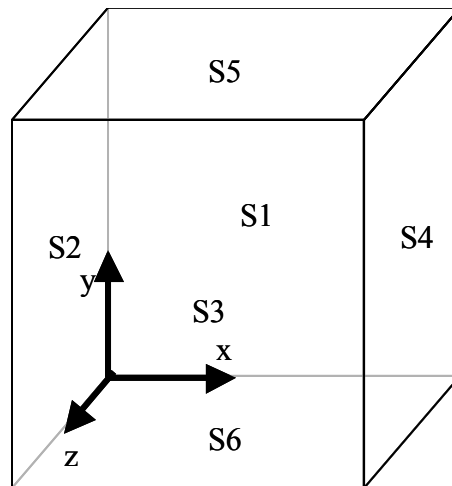
For the model `VISC_ISOT_TRAC` that one tests in modelings A, B and C, the validation is done by comparison with the results got with the model `ROUSS_VISC` whose parameters were selected in order to make negligible the evolution of porosity and thus to be reduced to the plastic model visco - "classic".

For the model `VISC_ISOT_LINE` tested in modelings D, E and F, one compares the solution obtained with `VISC_ISOT_TRAC` for which one defined a linear work hardening (one preserves only the points ends of the curve used to validate this model).

3 Modeling A

3.1 Characteristics of modeling

Modeling 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 $S5$ a displacement undergoes of 2 mm in 2000 s , 0.2 s or 0.002 s in 100 increments.

The law of behavior tested is the law VISC_ISOT_TRAC.

3.2 Sizes tested and results

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

Displacement $U = 0.1\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	639,207	639,294	0,014
Mean velocity	697,092	697,070	-0,003
Fast speed	772,983	772,885	-0,013

Displacement $U = 1\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	484,913	484,672	-0,050
Mean velocity	516,997	513,863	-0,606
Fast speed	555,633	552,167	-0,624

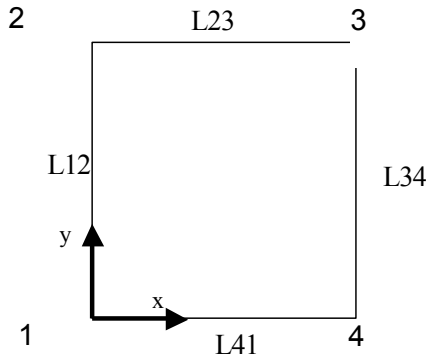
Displacement $U = 2\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	347,473	347,661	0,054
Mean velocity	369,458	365,992	-0,938
Fast speed	393,799	390,046	-0,953

4 Modeling B

4.1 Characteristics of modeling

Modeling **D_PLAN** : 1 QUAD8



The imposed loading is the following:

- The side *L41* is blocked in the direction *y*,
- The side *L12* is blocked in the direction *x*,
- The side *L23* a displacement undergoes of *2 mm* in *2000 s*, *0.2 s* or *0.002 s* in 100 increments.

The law of behavior tested is the law **VMIS_ISOT_TRAC_V**.

4.2 Sizes tested and results

One tests the effort of reaction on the face *L23* for 3 speeds of deformation for the values of displacement: *0.1 mm*, *1 mm* and *2 mm*.

Displacement $U = 0.1 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	752,473	750,523	-0,259
Mean velocity	820,703	818,465	-0,273
Fast speed	910,274	907,610	-0,293

Displacement $U = 1 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	575,182	572,674	-0,436
Mean velocity	609,788	607,023	-0,453
Fast speed	655,218	652,093	-0,477

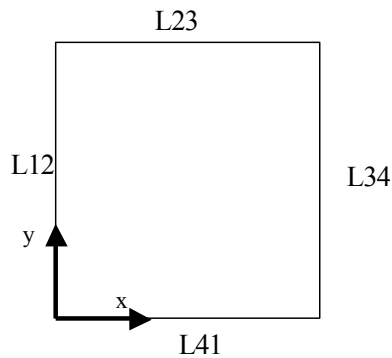
Displacement $U = 2 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	413,295	411,243	-0,496
Mean velocity	435,051	432,815	-0,514
Fast speed	463,612	461,120	-0,538

5 Modeling C

5.1 Characteristics of modeling

Modeling **AXIS** : 1 QUAD8



The imposed loading is the following:

- The side *L41* is blocked in the direction *y*,
- The side *L23* a displacement undergoes of *2 mm* in *2000 s*, *0.2 s* or *0.002 s* in 100 increments.

The law of behavior tested is the law `VISC_ISOT_TRAC`.

5.2 Sizes tested and results

One tests the effort of reaction on the face *L23* for 3 speeds of deformation for the values of displacement: 0.1mm, 1mm and 2mm.

Displacement $U = 0.1 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	319,604	319,647	0,013
Mean velocity	348,483	348,535	0,015
Fast speed	386,388	386,442	0,014

Displacement $U = 1 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	242,457	242,336	-0,050
Mean velocity	257,078	256,931	-0,057
Fast speed	276,269	276,084	-0,067

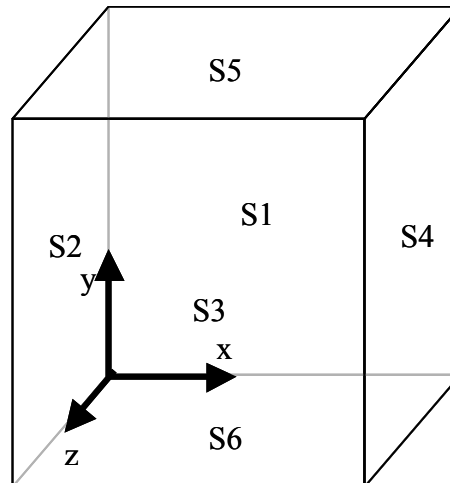
Displacement $U = 2 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	174,061	173,831	-0,132
Mean velocity	183,251	182,996	-0,139
Fast speed	195,314	195,023	-0,149

6 Modeling D

6.1 Characteristics of modeling

Modeling 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 $S5$ a displacement undergoes of 2 mm in 2000 s , 0.2 s or 0.002 s in 100 increments.

The law of behavior tested is the law `VISC_ISOT_LINE`.

6.2 Sizes tested and results

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

Displacement $U = 0.1\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	498,936	499,026	0,018
Mean velocity	556,844	556,945	0,018
Fast speed	632,832	362,948	0,018

Displacement $U = 1\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	433,411	433,422	0,003
Mean velocity	462,578	462,591	0,003
Fast speed	500,853	500,868	0,003

Displacement $U = 2\text{ mm}$

Code_Aster

Version
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Titre : SSNL129 - Validation des lois VISC_ISOT_TRAC et VI[...]
Responsable : MICHEL-PONNELLE Sylvie

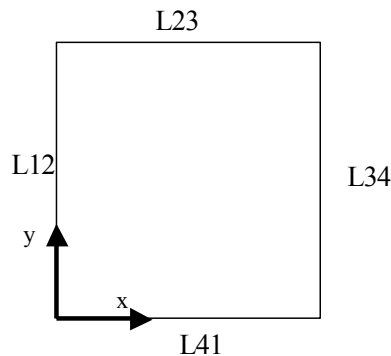
Date : 03/08/2011 Page : 11/14
Clé : V6.02.129 Révision :
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Identification	Reference	Aster	% difference
Slow speed	360,757	360,740	-0,005
Mean velocity	379,083	379,066	-0,005
Fast speed	403,131	403,113	-0,004

7 Modeling E

7.1 Characteristics of modeling

Modeling `D_PLAN` : 1 QUAD8



The imposed loading is the following:

- The side `L41` is blocked in the direction `y`,
- The side `L23` a displacement undergoes of 2 mm in 2000 s , 0.2 s or 0.002 s in 100 increments.

The law of behavior tested is the law `VISC_ISOT_LINE`.

7.2 Sizes tested and results

One tests the effort of reaction on the face `L23` for 3 speeds of deformation for the values of displacement: 0.1 mm , 1 mm and 2 mm .

Displacement $U = 0.1\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	583,729	583,873	0,025
Mean velocity	651,843	652,008	0,025
Fast speed	741,214	741,406	0,026

Displacement $U = 1\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	530,975	531,065	0,017
Mean velocity	565,249	565,350	0,018
Fast speed	610,221	610,335	0,019

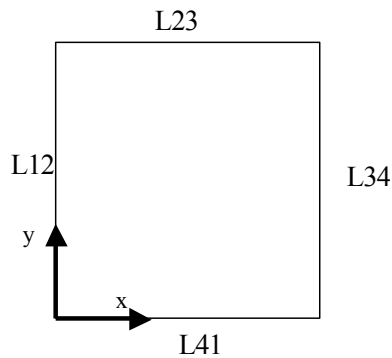
Displacement $U = 2\text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	448,942	449,007	0,014
Mean velocity	470,456	470,528	0,015
Fast speed	498,687	498,767	0,016

8 Modeling F

8.1 Characteristics of modeling

Modeling **AXIS** : 1 QUAD8



The imposed loading is the following:

- The side *L41* is blocked in the direction *y*,
- The side *L23* a displacement undergoes of *2 mm* in *2000 s*, *0.2 s* or *0.002 s* in 100 increments.

The law of behavior tested is the law `VMIS_ISOT_LINE`

8.2 Sizes tested and results

One tests the effort of reaction on the face *L23* for 3 speeds of deformation for the values of displacement: *0.1 mm*, *1 mm* and *2 mm*.

Displacement $U = 0.1 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	249,468	249,513	0,018
Mean velocity	278,422	278,473	0,018
Fast speed	316,416	316,474	0,018

Displacement $U = 1 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	216,706	216,711	0,002
Mean velocity	231,289	231,296	0,003
Fast speed	250,426	250,434	0,003

Displacement $U = 2 \text{ mm}$

Identification	Reference	Aster	% difference
Slow speed	180,379	180,370	-0,005
Mean velocity	189,542	189,533	-0,005
Fast speed	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 very weak variations (lower than 0.02%) observed between solutions obtained with VISC_ISOT_LINE and VISC_ISOT_TRAC for a linear work hardening, also allow to validate the establishment of the model VISC_ISOT_LINE.

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