HSNV133 - Thermoplastic traction in great deformations VMIS_ISOT_PUIS

Summary:

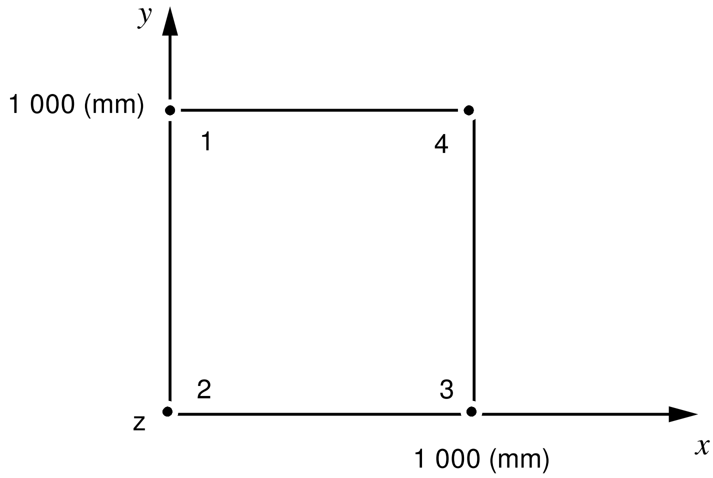
This quasi-static thermomechanical test consists in uniformly heating a bar of rectangular section (homogeneous stress and strain states) then to subject it to a traction.

In the same way, that in test HSNV121 [V7.22.121], one thus validates the kinematics of the great deformations in elastoplasticity (order STAT_NON_LINE, keyword deformation: 'SIMO_MIEHE'or'PETIT_REAC') for a relation of behavior of the type Von Mises with definite isotropic work hardening is by a point by point given traction diagram (VMIS_ISOT_TRAC); maybe by a law in power (VMIS_ISOT_PUIS).

The bar is modelled by a voluminal element (HEXA20, modeling A).

1 Problem of reference

1.1 Geometry



1.2 Properties of material

The material obeys a law of behavior in great plastic deformations with isotropic work hardening defined by a traction diagram (point by point or law in power).
The traction diagram is given in the plan deformation logarithmic curve - rational constraint.

$$\sigma=\frac{F}{S}=\frac{F}{S_o}\cdot\frac{l}{l_o}$$

$$R(p)=\sigma_y+\sigma_y\left(\frac{E}{a\sigma_y}p\right)^{1/n}$$

$\nu \quad =0.3$

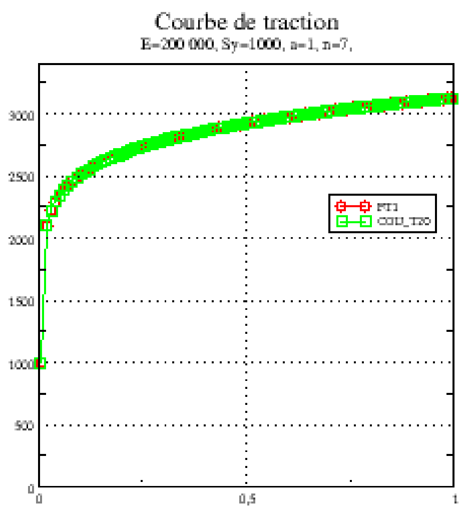
$\alpha \quad =10^{-4}K^{-1}$

$\sigma_y \quad =1000\,MPa$

$E \quad =200000\,MPa$

$n \quad =7$

$a \quad =1$

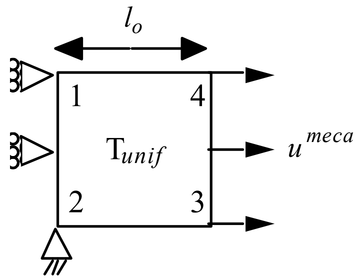


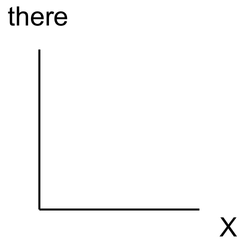
l_o and l are, respectively, the initial length and the current length of the useful part of the test-tube.

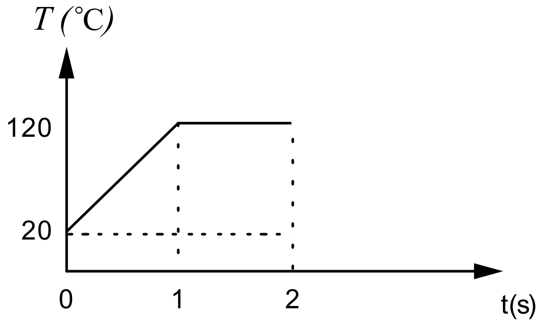
S_o and S are, respectively, surfaces initial and current. Between the temperatures $20°C$ and $120°C$, the characteristics are interpolated linearly.

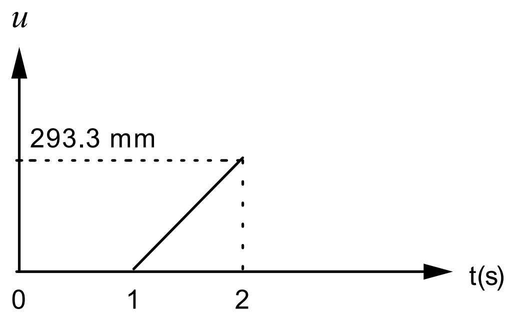
1.3 Boundary conditions and loadings

The bar, initial length l_o , blocked in the direction Ox on the face [1.2] is subjected to a uniform temperature T and with a mechanical displacement of traction u^{meca} on the face [3, 4]. The sequences of loading are the following ones:









Temperature of reference: $T_{réf}=20°C$.

Note:

Mechanical displacement is measured starting from the configuration deformed by the thermal loading ($t=1\text{s}$). To have total displacement, it is thus necessary to add the thermal displacement obtained at time $t=1\text{s}$.

2 Reference solution

2.1 Results of reference

One will adopt like results of reference displacements, the constraint of Cauchy σ and cumulated plastic deformation p obtained with the behavior VMIS_ISOT_TRAC (validated in addition with DEFORMATION=' SIMO_MIEHE').

One will compare the solutions obtained with time $t=2\ s$ ($\Delta T=100°C$, traction u)

2.2 Uncertainty on the solution

Very weak since it is about intercomparison between two behaviors formally identical. However, the discretization of the law of work hardening in power leads to an uncertainty.

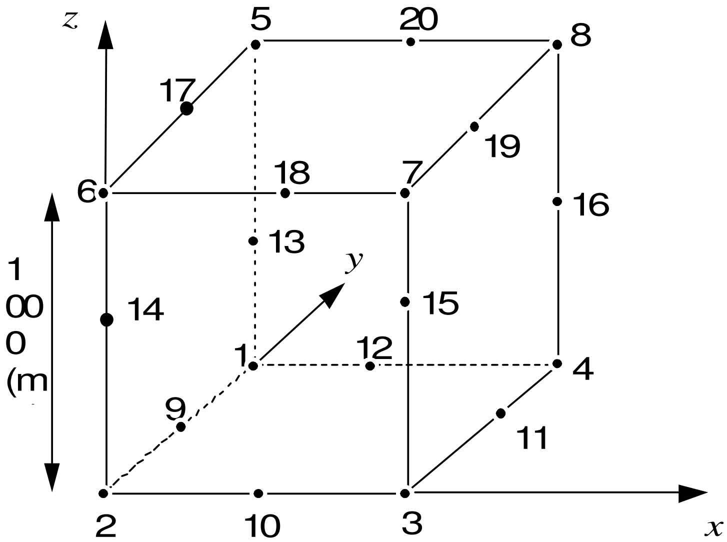
2.3 Bibliographical references

1. V. CANO, E. LORENTZ: Introduction into *Code_Aster* of a model of behavior in great deformations elastoplastic with isotropic work hardening - Note interns EDF DER HI - 74/98/006/0

3 Modeling A

3.1 Characteristics of modeling

Voluminal modeling: 1 mesh HEXA20
1 mesh QUAD8



Boundary conditions:

N2: $U_x = U_y = U_z = 0$ $N9, N13, N14, N5, N17$: $U_x = 0$

N1: $U_x = U_z = 0$

N6: $U_x = U_y = 0$

Load: Displacement imposed on the face $[3\,4\,8\,7\,11\,16\,19\,15]$ + assignment of the same temperature on all the nodes. The full number of increments is of 21 (1 increment enters $t=0\text{s}$ and 1s, 20 increments enters $t=1\text{s}$ and 2s).

Convergence is carried out if the residue is lower or equal to RESI_GLOB_RELA= 10^{-6}.

3.2 Characteristics of the grid

Many nodes: 20

Many meshs: 2

1 HEXA20
1 QUAD8

3.3 Sizes tested and results

Identification	Reference VMIS_ISOT_TRAC	*Aster* VMIS_ISOT_PUIS	% difference
$t=2$ Displacement DX ($N8$)	303.06	303.06	< 10^{-4}
$t=2$ Displacement DY ($N8$)	– 108.82	– 108.82	< 10^{-4}
$t=2$ Displacement DZ ($N8$)	– 108.82	– 108.82	< 10^{-4}
$t=2$ Constraints $SIGXX$ ($PG1$)	2651.633	2651.694	0,002
$t=2$ Variable p $VARI$ ($PG1$)	0.24556	0.24558	0,009

4 Summary of the results

Inter-validation of the behaviors VMIS_ISOT_TRAC and VMIS_ISOT_PUIS realized here watch that the curves of isotropic work hardening can be modelled in these two ways in *Code_Aster,* that it is into small or great deformations, via the model 'SIMO_MIEHE'.