SSNV118 - Traction test shears with the model viscoplastic of Summarized

Chaboche:

Nonlinear quasi-static problem of structural mechanics out of transient.

Response of a volume element analyzes with a loading of tension-shears which impose a state of uniform stress-strain.

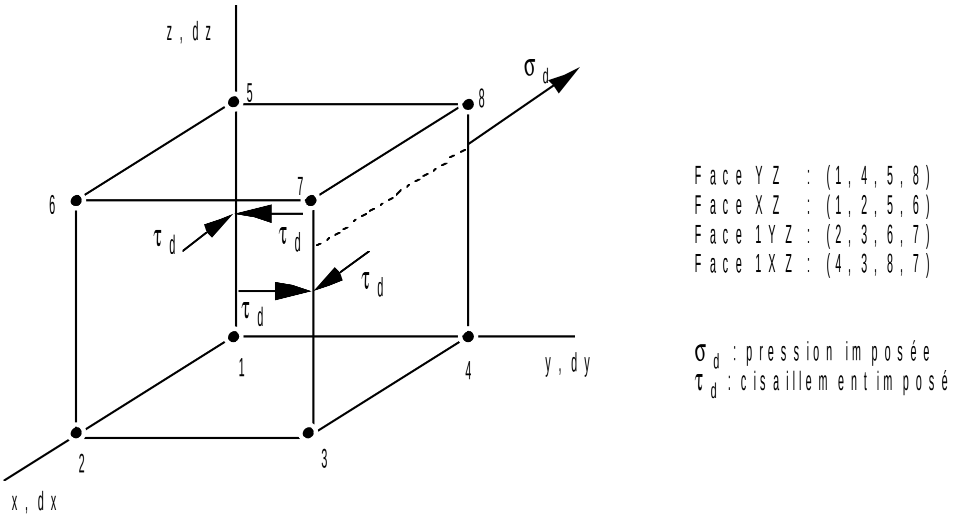
On an identical problem, one carries out 4 modelizations:

- the first tests behavior VISCOCHAB with implicit integration and constant coefficients material with a coherent tangent matrix with each iteration,
- the second tests the behavior VISCOCHAB with implicit integration and coefficients material depend on the temperature and integration with an elastic matrix,
- the third test behavior VISCOCHAB with an explicit integration and constant coefficients,
- the fourth compares behaviors VISCOCHAB and VISC_CIN2_MEMO, with implicit integration and coherent tangent matrix.

This test thus validates in particular the elastoviscoplastic numerical integration of the model of behavior of Chaboche taking into account the phenomenon of memorizing of hardening, for two models VISCOCHAB and VISC_CIN2_MEMO.

1 Problem of reference

1.1 Geometry



1.2 Material properties

isotropic Elasticity $E=145\,000\,MPa$ $\nu=0.3$
model Viscoplasticity VISCOCHAB

k	$35\,MPa$	B	12	ETA	0.04
A_K	1.	M_R	2	$C1$	$1950\,MPa$
A_R	0.65	G_R	$2\,10^{-7}$	M_1	4
K_0	$70\,MPa\,S^{1/N}$	MU	19	$D1$	$0.397\,10^{-3}$
N	24	Q_M	460	G_{X1}	$2.\,10^{-13}\,MPa^{-m1}\,S^{-1}$
ALP	$0\,MPa$	Q_0	$40\,MPa$	$G1_0$	$50\,MPa$
		QR_0	$200\,MPa$		

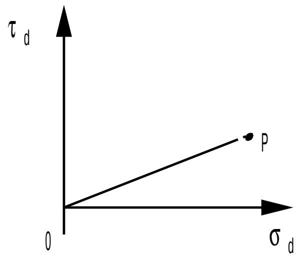
$C2$	$65000\,MPa$
M_2	4
$D2$	$0.552\,10^{-1}$
G_{X2}	$1.10^{-12}\,MPa^{-m1}\,S^{-1}$
$G2_0$	$1300\,MPa$
A_I	0.5

1.3 Boundary conditions and loadings

$N6$	$dx=dy=dz=0$	Face XZ : $FX=-\tau_d/4$
$N7$	$dx=dy=0$	Face YZ : $FY=-\tau_d/4, FX=-\sigma_d/4$
$N2$, $N3$	$dy=0$	Face $1XZ$: $FX=\tau_d/4$
$N2$ $N3$ $N6$, $N7$	$dx=0$	Face $1YZ$: $FY=\tau_d/4, FZ=\sigma_d/4$

1.4 Forced

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



$\sigma_d(t)$ and $\tau_d(t)$ linear, the point P being reached in $10\,s$ with $\sigma_d(10)=150\,MPa$ and $\tau_d(10)=60\,MPa$.

2 Reference solution

2.1 Method of calculating used for the reference solution

One uses to establish the reference solution the software SIDOLO which allows the simulation and the identification of constitutive laws.

The equations of the model are written by the user in FORTRAN in the form of a system of equations first order differentials, solved by a method of Runge Kutta of order 4 with adaptive step.

2.2 Results of reference

$\sigma_{xx}, \sigma_{xy}, \varepsilon_{xx}, \varepsilon_{xy}, X1_{xx}, X2_{xx}, p, R, q, \xi_{xx}$ to time $P(t=10\,s)$ when $X1$ and $X2$ are the variables of kinematic hardening, p the cumulated plastic strain, $R(p,q)$ the isotropic variable of hardening and ξ the local variable allowing the taking into account of the memory of hardening.

2.3 Uncertainty on the solution

Uncertainty of SIDOLO.

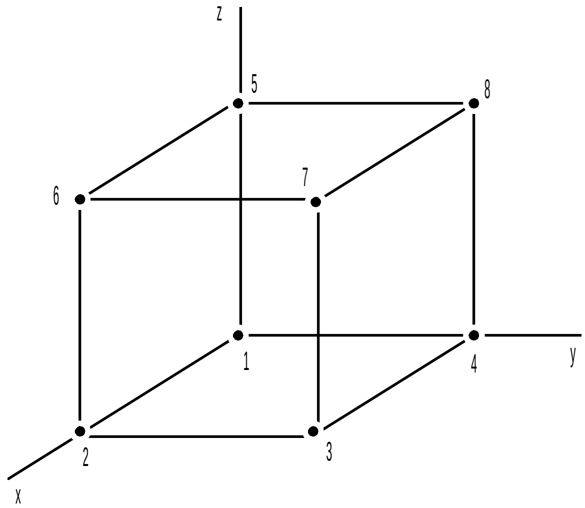
2.4 Bibliographical references

[1] SIDOLO, version 2.3, Note of use, École Nationale Supérieure of the Mines of Paris, Center of the Materials, September 1995.

3 Modelization A

3.1 Characteristic of the modelization

Modelization 3D, 1 hexa8



3.2 Quantities tested and results

Identification	Reference
σ_{xx}	150
σ_{xy}	60
ε_{xx}	1.49455 E-2
ε_{xy}	0.888452 E-2
$X1_{xx}$	12.4955
$X2_{xx}$	30.0352
p	1.69335 E-2
R	8.36836
q	6.76633 E-4
ξ_{xx}	1.33485 E-2

3.3 Remarks

One uses only 11 increments of time in *Aster*, but time step is redécoupé by 10 for the local integration of the equations of the model. SIDOLO uses several hundreds of time step, calculated automatically.

4 Modelization B

4.1 Characteristic of the modelization

This modelization is identical to the modelization A, but with coefficients material defined as functions (constant) of the temperature, and the use of an elastic matrix instead of the tangent matrix.

4.2 Quantities tested and results

Identification	Reference
σ_{xx}	150
σ_{xy}	60
ε_{xx}	1.49455 E-2
ε_{xy}	0.888452 E-2
$X1_{xx}$	12.4955
$X2_{xx}$	30.0352
p	1.69335 E-2
R	8.36836
q	6.76633 E-4
ξ_{xx}	1.33485 E-2

4.3 Remarks

the accuracy of the results is of the same order as for the modelization A with an elastic tangent matrix and a smaller recutting of time step for the local integration of the equations of the model.

5 Modelization C

5.1 Characteristic of the modelization

Like the modelization A, but with an explicit integration (RUNGE_KUTTA).
The loading is this time at imposed displacement following Z on the face $FACE1XY$, such as:

0. time 4s, $DZ=0.01\text{mm}$
1. time 7s, $DZ=-0.01\text{mm}$

On the sides $FACEXY$ and $FACE1XY$ $DX=DY=0$.

5.2 Quantities tested and results

For this modelization, they are tests of non regression.

Identification	*Code_Aster*
σ_{xx}	1147.8
σ_{yy}	1147.8
σ_{zz}	1329.4
ε_{zz}	1.0 E-2

6 Modelization D

6.1 Characteristic of the modelization

The modelization is the same one as the modelization A, but with 2 different behaviors (both integrated in an implicit way): VISCOCHAB and VISC_CIN2_MEMO, to validate the taking into account of the memory of greatest hardening.

6.2 Quantities tested and results

Identification	Reference Aster (VISCOCHAB)	*Aster (VISC_CIN2_MEMO)*
σ_{xx}	150.150	
σ_{yy}	60	60
ε_{xx}	1.67695E-2	1.676947E-2
ε_{xy}	9.978948E-3	9.978922E-3
p	1.914249E-2	1.9142436E-2
R	9.506173	9.506146
q	7.656996E-04	7.656974E-04
ξ_{xx}	1.5074149E-02	1.510558E-02

6.3 Remarks

the two behaviors give identical results on all the components, except for the local variable ξ_{xx} (difference of 0.2%). This variation decreases when the temporal discretization is refined.

7 Summary of the results

the equations of the model being strongly nonlinear, it is necessary to use increments of small times to obtain a precise solution.

On this test presenting a geometry and simple boundary conditions, the recutting of time step at the local level makes it possible to improve the accuracy of the results without increasing the computing time too much.