SSNV101 - Traction test shears with the model of Summarized

Chaboche:

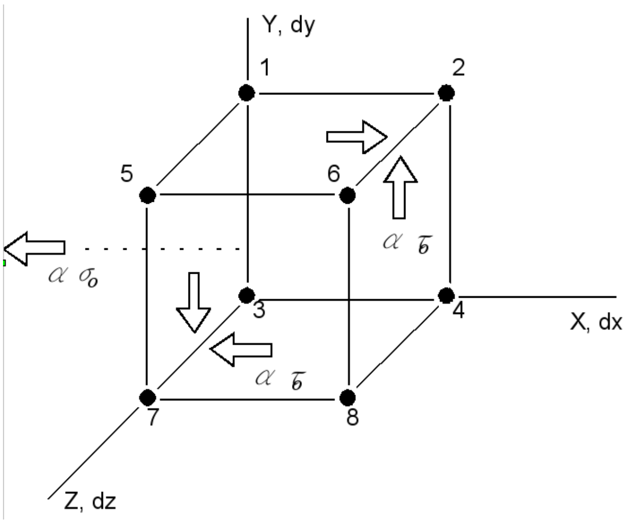
Problem of quasi static evolution nonlinear of structural mechanics.

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

There are 4 modelizations:
Modelization a: test 3D with VMIS_CIN2_CHAB
Modelization b: test C_PLAN with VMIS_CIN2_CHAB
Modelization C: test 3D with VISC_CIN1_CHAB and VISC_CIN2_CHAB
Modelization D: test D_PLAN with VISC_CIN1_CHAB and VISC_CIN2_CHAB

1 Problem of reference

1.1 Geometry



FACE YZ : $(1,3,5,7)$
FACE XZ : $(3,4,7,8)$
FACE $1YZ$: $(2,4,6,8)$
FACE $1XZ$: $(1,2,5,6)$

$\alpha\tau_0$ shears $\begin{cases} FACE\,1XZ \\ FACE\,1YZ \end{cases}$

$\alpha\tau_0$ pressure $FACE\,YZ$

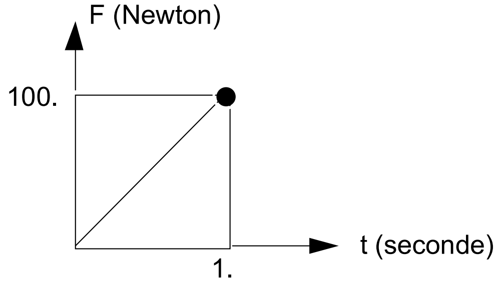
$\alpha(t)$ function isotropic

1.2 force

Materials properties elasticity	$E=145\,200.\,MPa$	$\nu=0.3$
plasticity Chaboche	$R_o=87.\,MPa$	$C1_I=187.*341.$
	$R_i=151.\,MPa$	$C2_I=29.*17184.$
	$b=2.3$	$G1_0=341.$
	$K=0.43$	$G2_0=17184.$
	$W=6.09$	

1.3 Boundary conditions and loadings

$N04$	$dx=dy=0.$	Face YZ :	$FX=FY=-F(t)$
$N08$	$dx=dy=dz=0.$	Face XZ :	$FX=-F(t)$
$N02$, $N06$	$dx=0.$	Face $1YZ$:	$FY=F(t)$
		Face $1XZ$:	$FX=F(t)$



1.4 Forced

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

2 Reference solution

2.1 Méthode de calcul used for the reference solution

In the cas particulier of tension imposed shears

$$\sigma(t)=\alpha(t)\begin{bmatrix}\sigma_0 & \tau_0 & 0\\ \tau_0 & 0 & 0\\ 0 & 0 & 0\end{bmatrix},\ X_i=\alpha(t)\begin{bmatrix}x_i & y_i & 0\\ y_i & -x_i/2 & 0\\ 0 & 0 & -x_i/2\end{bmatrix}\text{ and }\varepsilon=\begin{bmatrix}\varepsilon & \gamma & 0\\ \gamma & \varepsilon_t & 0\\ 0 & 0 & \varepsilon_t\end{bmatrix}\quad i=1,2$$

(X_i forced kinematic hardening)

one can write the model of Chaboche (VISC_CIN2_CHAB) in the form of a system of 7 ordinary differential equations in $\begin{cases}y=(\varepsilon,\gamma,x_1,x_2,y_1,y_2,p)\\ F(y,t)\dot{y}=g(y,t)\end{cases}$.

$$\begin{cases}\dot{\varepsilon}-\dot{\alpha}\dfrac{\sigma_o}{E}=\dot{p}\left(\alpha\sigma_o-\dfrac{3}{2}(x_1+x_2)\right)\Big/R(p)\\[2mm]
\dot{\gamma}-\dot{\alpha}\dfrac{\tau_o}{2\mu}=\dfrac{3}{2}\dot{p}\left(\alpha\tau_o-(y_1+y_2)\right)/R(p)\\[2mm]
\dot{x}_i=\left(\dfrac{2}{3}C_i\left(\dot{\varepsilon}-\dot{\alpha}\dfrac{\sigma_o}{E}\right)-\gamma_i x_i\dot{p}\right) & i=1,2\\[2mm]
\dot{y}_i=\left(\dfrac{2}{3}C_i\left(\dot{\gamma}-\dot{\alpha}\dfrac{\tau_o}{2\mu}\right)-\gamma_i y_i\dot{p}\right) & i=1,2\\[2mm]
0=\left(\dot{\alpha}\sigma_o-\dfrac{3}{2}(\dot{x}_1+\dot{x}_2)\right)\left(\alpha\sigma_o-\dfrac{3}{2}(x_1+x_2)\right)\\
\quad+3\left(\dot{\alpha}\tau_o-(\dot{y}_1+\dot{y}_2)\right)\left(\dot{\alpha}\tau_o-(y_1+y_2)\right)-\dot{p}R(p)\dfrac{\partial R}{\partial p}\end{cases}$$

with, with $t=0$:

$$\begin{cases}\alpha_0 &=& R_0/\sqrt{\sigma_o^2+3\tau_0^2} & \text{car seuil } f=0\\ \varepsilon_0 &=& \alpha_0\sigma_0/E\\ \gamma_0 &=& \alpha_0\tau_0/2\mu\\ x_{1o} &=& x_{2o}=y_{1o}=y_{2o}=p_o=0\end{cases}$$

and one imposes $\alpha(t)=\alpha_0+t$. This system is solved numerically by a “Backward difference formulated” using the scientific library NAG (modelizations A and B).
The modelization C and D do not have a reference solution (non regression).

2.2 Results of reference

With the imposed loading, one A. $\alpha_0=0.435$ One compares the values of reference of ε, γ, p, which must be identical to the solution Code_Aster in all the nodes at time $t=1.435\,sec$.

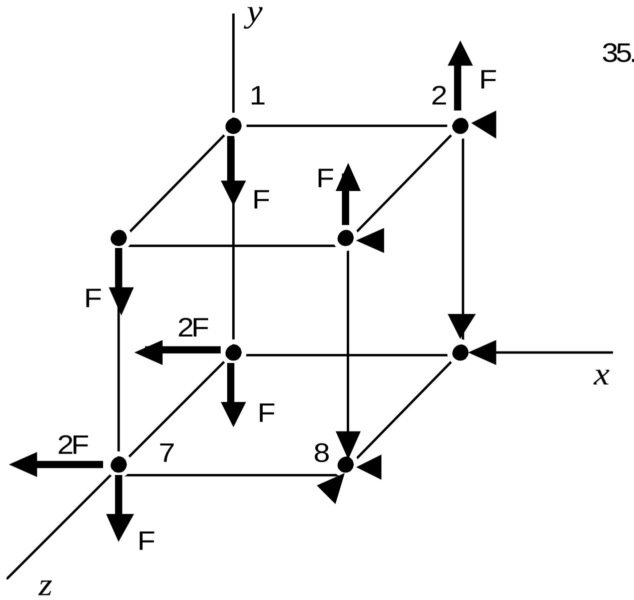
2.3 Uncertainty on the solution

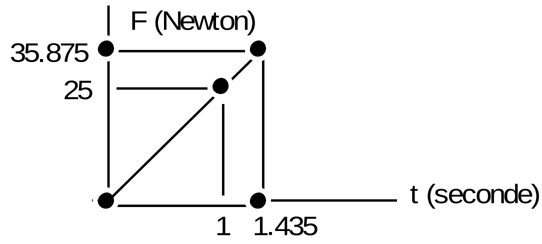
Uncertainty of NAG: the resolution is carried out with 218 automatically calculated increments.

3 Modelization A

3.1 Characteristic of the modelization

Modelization `3D` **:**





3.2 Characteristics of mesh

1 `HEXA8`.

3.3 Quantities tested and results

ε γ, p and σ_{11} are values initially with Gauss points, then transferred by element to nodes (`ELNO`):

Identification	Reference	Test	Tolerance
ε on node *NO1* for `NUME_ORDRE= 1 3`	9.7090E-002	`NON_DEFINI`	1,1% (relative)
γ on node *NO1* for `NUME_ORDRE= 1 3`	1.4540E-001	`NON_DEFINI`	1,1% (relative)
σ_{11} on node *NO1* for `NUME_ORDRE= 1 3`	1.4350E+002	`NON_DEFINI`	0,1% (relative)
p on node *NO1* for `NUME_ORDRE= 1 3`	1.9220E-001	`NON_DEFINI`	1,1% (relative)

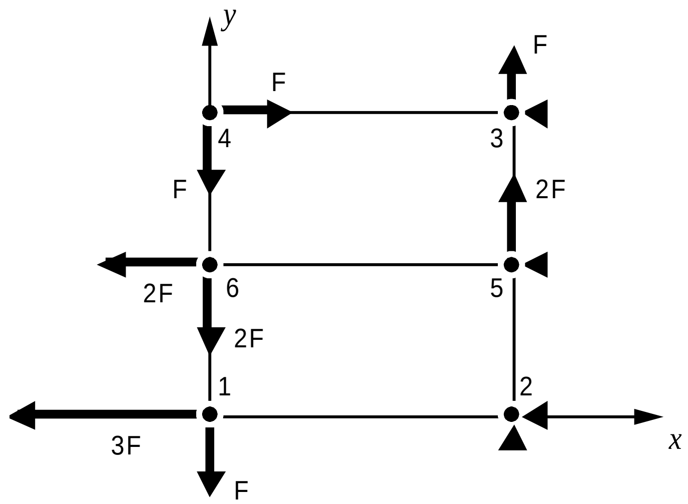
One also tests the parameters of the data structure results:

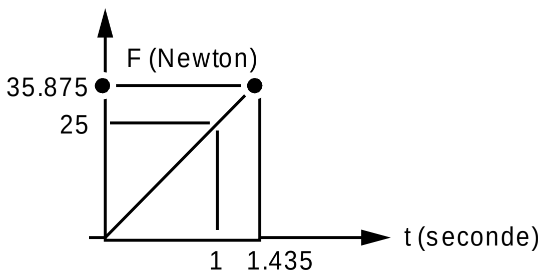
Identification	Reference	Test	Tolerance
`INST` for `NUME_ORDRE= 1 3`	1.435000	`NON_DEFINI`	0,10%

4 Modelization B

4.1 Characteristic of the modelization

Modelization in plane stresses





4.2 Characteristic of the mesh

2 meshes QUAD4.

4.3 Quantities tested and results

ε , γ and σ_{11} are values initially with Gauss points, then transferred by element to nodes (ELNO):

Identification	Reference	Test	Tolerance
ε on node $NO1$ for $INST=1{,}435$	9.7090E-002	NON_DEFINI	2,0% (relative)
ε on node $NO5$ for $INST=1{,}435$	9.7090E-002	NON_DEFINI	2,0% (relative)
γ on node $NO1$ for $INST=1{,}435$	1.4540E-001	NON_DEFINI	1,1% (relative)
γ on node $NO5$ for $INST=1{,}435$	1.4540E-001	NON_DEFINI	1,1% (relative)
σ_{11} on node $NO1$ for $INST=1{,}435$	1.4350E+002	NON_DEFINI	0,1% (relative)
σ_{11} on node $NO5$ for $INST=1{,}435$	1.4350E+002	NON_DEFINI	0,1% (relative)

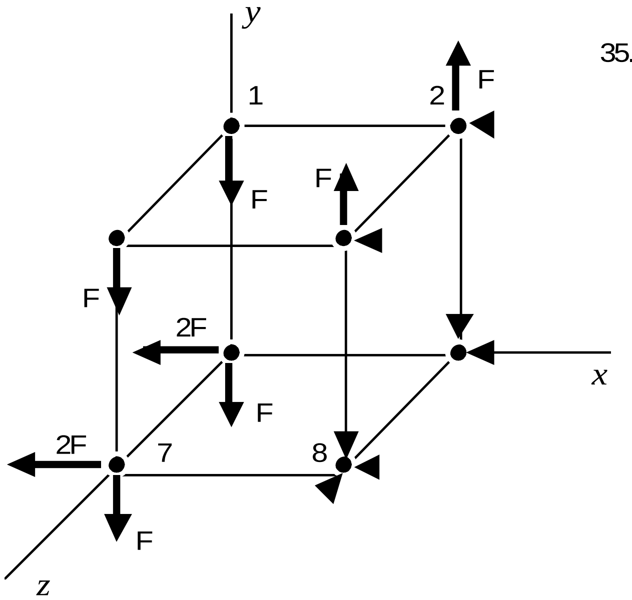
4.4 Remarks

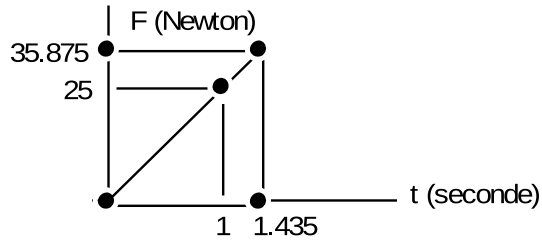
the values of the shears are multiplied by $\sqrt{2}$ in the display of the results of the local variables.

5 Modelization C

5.1 Characteristic of the modelization

Modelization `3D` **:**





5.2 Characteristics of mesh

1 `HEXA8`.

5.3 Quantities tested and Reference

results: non regression, and intercomparison `VISC_CIN1_CHAB – VISC_CIN2_CHAB`. A temporal discretization data, the results are identical:

σ_{11} γ , p and σ_{11} are values initially with Gauss points, then transferred by element to nodes (`ELNO`). Case of model `VMIS_CIN1_CHAB` :

Identification	Reference	Test	Tolerance
ε on node $NO1$ `for` $INST=1,435$	5.1250E-002	`NON_DEFINI`	0,1% (relative)
γ on node $NO1$ `for` $INST=1,435$	7,6677 E-00 2	`NON_DEFINI`	0,1% (relative)
σ_{11} on node $NO1$ `for` $INST=1,435$	1.4350E+002	`NON_DEFINI`	0,1% (relative)
p on node $NO1$ `for` $INST=1,435$	1,00523 E-001	`NON_DEFINI`	0,1% (relative)

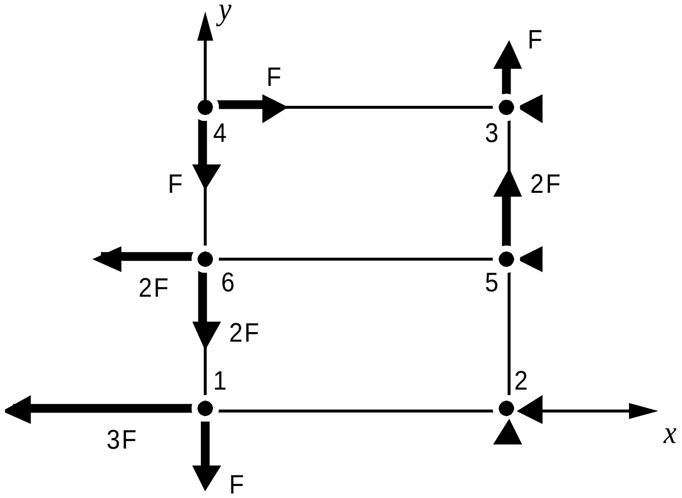
One tests then model VMIS_CIN1_CHAB with $C2_I = 0.$ and $G2_0 = 0.$, which is equivalent to the model

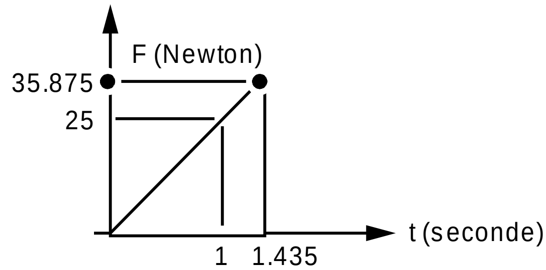
Identification	Reference	Test	Tolerance
ε on node $NO1$ for $INST = 1{,}435$	9,7090E-002	NON_DEFINI	0,1% (relative)
ε on node $NO5$ for $INST = 1{,}435$	9,7090E-002	NON_DEFINI	0,1% (relative)
γ on node $NO1$ for $INST = 1{,}435$	1,4540E-001	NON_DEFINI	2,0% (relative)
γ on node $NO5$ for $INST = 1{,}435$	1,4540E-001	NON_DEFINI	2,0% (relative)
σ_{11} on node $NO1$ for $INST = 1{,}435$	1.4350E+002	NON_DEFINI	1,1% (relative)
σ_{11} on node $NO5$ for $INST = 1{,}435$	1.4350E+002	NON_DEFINI	1,1% (relative)

6 Modelization D

6.1 Characteristic of the modelization

Modelization in plane strains





6.2 Characteristic of the mesh

2 meshes `QUAD4`.

6.3 Quantities tested and Test

results of non regression.

Identification	Reference	*Aster*	% difference
ε	0.015329	0.015329	0
γ	0.030066	0.030066	0
p	0.037161	0.037161	0
σ_{11}	143.5000	143.5	0

6.4 Remarks

the values of the shears are multiplied by $\sqrt{2}$ in the display of the results of the local variables.

7 Summary of the results

Good accuracy (modelization A and B) at the time of the comparison of the results, in spite of the number of very different increments for NAG (218) and *Code_Aster* (12).

For the modelizations C and D, one checks the coherence of the models between them.