SSNV226 – Validation of the rupture criterion in critical stress

Summarized:

The problem is quasi-static nonlinear in structural mechanics (one has nevertheless a modelization in nonlinear dynamics by preoccupations with a validation).

One analyzes the response of a volume element, with a loading in tension and imposed displacement. As soon as the maximum principal stress in the element reaches a critical stress, the stiffness of the element is decreased and the forced are quasi cancelled.

The modelization A allows to validate the rupture criterion with model VISCOCHAB in a case where hardening is isotropic, for a simple tension.

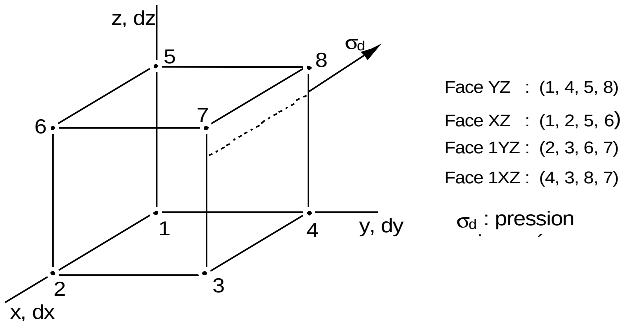
The modelization B allows to validate the rupture criterion with model VMIS_ISOT_TRAC in a case where hardening is purely isotropic, for a simple tension.

The modelization C allows to validate the rupture criterion with model VISC_ISOT_TRAC in viscoplasticity in a case where hardening is purely isotropic, for a simple tension.

The modelization D to the modelization C by means of the nonlinear operator of dynamics DYNA_NON_LINE begins again.

1 Problem of reference

1.1 Geometry



1.2 Properties of the materials

isotropic Elasticity $E=2.E^{11} Pa \quad \nu=0.3$

model Viscoplasticity VISCOCHAB (modelization A), without kinematic hardening:

k	$626.423911 E^6 Pa$	Q_M	$3.982809551 E^8 Pa$	C2	0
A_K	0.215443469	Q_0	$3.982809551 E^8 Pa$	C1	0
B	11.53016	K_0	$k \times 0.21544 Pa S^{1/N}$	G1_0	0
		N	12	G2_0	0

Elastoplasticity with isotropic hardening (modelization B): model isotropic

VMIS_ISOT_TRAC Hardening
R_0$=Sy$ $\quad 750 E \ Pa$
Curve of tension

ϵ_0	Sy/E	σ	Sy
ϵ	1.	σ	$1500 E \ Pa$

Viscoplasticity (modelization C): model isotropic

VISC_ISOT_TRAC Hardening
R_0$=Sy$ $\quad 750 E \ Pa$
VISC_SINH

SIGM_0	$6167 E \ Pa$	EPSI_0	$3.31131121483 E^{13} Pa$
M	6.76		

Curve of tension

ϵ_0	Sy/E	σ	Sy
ϵ	1.	σ	$1500 E \ Pa$

Materials parameters under CRIT_RUPT :

Critical stress: SIGMA_C$=7.8 E^8 Pa$, $COEF=10000.$ 3

1.3 Boundary conditions and loadings

imposed Strain:

ϵ_{max}	0.05	velocity	$1.E^{-4}$

Loading according to time:

$t_0=0.$	$\epsilon=0$	$tmax=\epsilon_{max}/vitesse$	$\epsilon=\epsilon_{max}$

Tension: $FACEYZ$ $Dz=1$

Blocking: $FACEXZ$ $Dy=0$ $FACEXY$ $Dz=0$
$FACEYZ$ $Dx=0$

2 Reference solution

2.1 Results of reference

As the stress state is uniform and uniaxial, it is checked simply that the volume element will break as soon as σ_{zz} is higher than $\mathrm{SIGMA\_C}=7.8\,E^8\,Pa$.

2.2 Bibliographical references

[1] R5.03.04 “Behaviors élasto-visco-plastics of J.L.Chaboche”. R5.03.02 “

[2] Integration of the elastoplastic behavior models of von Mises” R5.03.21 “

[3] elastoviscoplastic Modelization with isotropic hardening in large deformations” A.Dahl “

[4] experimental Study and local approach of the crack stop of cleavage in a bainitic steel” Thesis ECP January 2012 Modelization

3 A Characteristic

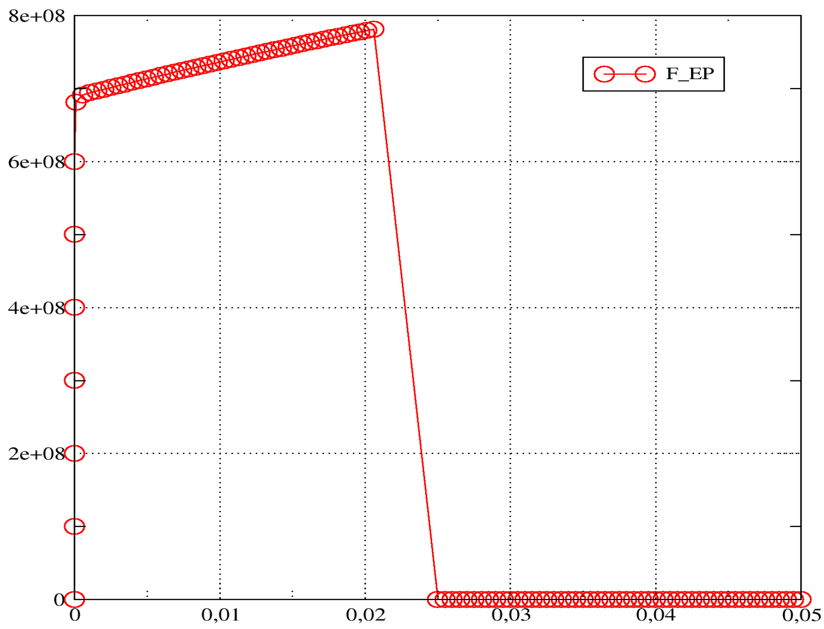
3.1 from the modelization Modelization

3D, 1 hexa `8.` Simple `tension` with imposed curve of tension. Quantities tested

3.2 and results the values

tested are the maximum values of the principal stresses before and after the criterion is reached. Time Identification

Reference	245. 250. Note:
σ_{zz}	$7.81319\,E^{8}$
σ_{zz}	$1.\,E^{4}$



the value SIGMA_C = `formula` $7.8\,E^{8}\,Pa$ is slightly exceeded because of explicit character of the criterion. By refining
time step (the 200 steps instead of 100) maximum value of formula is σ_{zz} Modelization $7.8045\,E^{8}$

4 B Characteristic

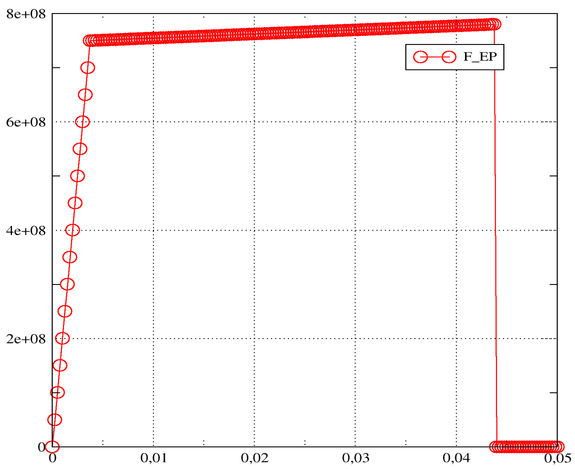
4.1 of the modelization Modelization

3D, 1 hexa `8`. Simple `tension` with imposed curve of tension. Quantities tested

4.2 and results the values

tested are the maximum values of the principal stresses before and after the criterion is reached. Time Identification

	Reference	437.5. 440.
Modelization	σ_{zz}	$7.80113 E^8$
	σ_{zz}	5000.0



5 C Characteristic

5.1 from the modelization Modelization

3D, 1 hexa `8`. Simple `tension` with imposed curve of tension. Quantities tested

5.2 and results the values

tested are the maximum values of the principal stresses before and after the criterion is reached. Time Identification

	Reference	250. 255. Modelization
	σ_{zz}	$780.304\,E^{8}$
	σ_{zz}	$8.77866\,E^{4}$

6 D Characteristic

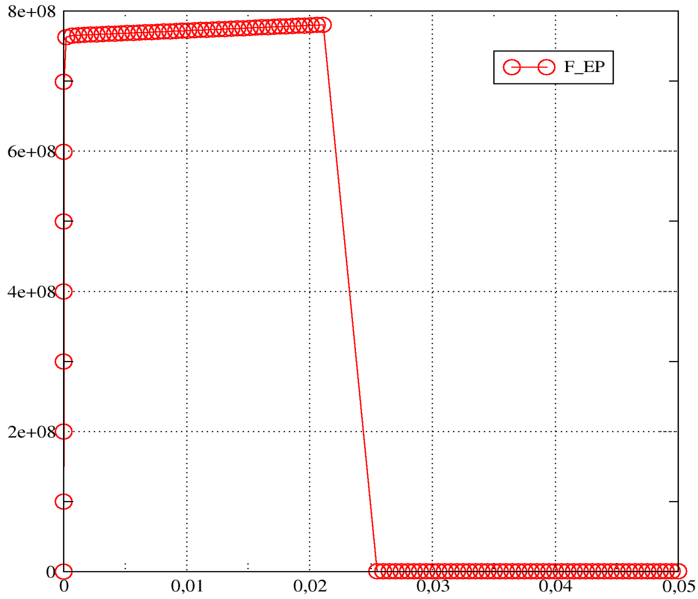
6.1 from the modelization Modelization

3D, 1 hexa `8`. Simple `tension` with imposed curve of tension. Nonlinear dynamics. Quantities tested

6.2 and results the values

tested are the maximum values of the principal stresses before and after the criterion is reached. Time Identification

	Reference	250. formula
formulates	σ_{zz}	$780.304\,E^{8}$
formula	σ_{zz}	$8.77866\,E^{4}$



7 the results the four

modelizations allow to validate, on a voluminal element, the rupture criterion in critical stress with viscoplastic behaviors VISCOCHAB, VISC_ISOT_TRAC and elastoplastic VMIS_ISOT_TRAC , into quasi-static and dynamics.