MFRON05 – Test of the interface *Code_Aster-MFront:* for laws with damage

Summary:

This test validates certain behaviors (for example metals) with damage defined using *MFront* by comparison with behavior similar of *Code_Aster* .

Modeling a: this modeling makes it possible to validate the model élasto-visco-plastic with damage of Hayhurst and implicit integration, by comparison with model HAYHURST of the test SSNV225C on a material point.

Modeling b: this modeling makes it possible to validate the model élasto-visco-plastic with damage of Hayhurst and explicit integration, by comparison with model HAYHURST of the test SSNV225A on a material point.

Modeling C: this modeling makes it possible to validate the model with damage of Gurson.

Modeling D: this modeling makes it possible to validate the model of cohesive zone of Tvergaard.

1 Modeling A

1.1 Characteristics of modeling

- Behavior tested: ImplicitHayhurstwill.mfront. Law viscoplastic with damage, similar to law HAYHURST [cf R5.03.13].
- Modeling and data similar to those of test SSNV225A [V6.04.225]

The coefficients of the Mfront behavior are, for modeling a:

Young	145000
Fish	0.3
K	9.691
eps0	5,82516E-11
sig0	27.9317
h1	3, E4
H2	-280
H1*	0.33
H2*	1
A0	9.707593E-08
AlphaD	0.5
DELTA1	1.
DELTA2	0

1.2 Sizes tested and results

Comparison with SSNV225C (even reference solution: SSNV225A)

Identification	Moments (h)	Reference	Tolerance
$EPYY$	2000	0.020968	1%
$EPYY$	4000	0.05093	4 %
$V11(endo)$	2000	0.0323	1 %
$V11(endo)$	4000	0.06808	0.5 %
$dEPYY/dt$	1520	6,6539E-006	1.5 %

2 Modeling B

2.1 Characteristics of modeling

Modeling not material with explicit integration, comparable to SSNV225A, but in small deformations.

- Behavior tested: Hayhurstwill.mfront. Viscoplastic law with damage, similar to law HAYHURST [cf R5.03.13], with integration clarifies by Runge-Kutta.

- Modeling and data similar to those of test SSNV225A [V6.04.225]

2.2 Sizes tested and results

Comparison with SSNV225A (the results differ by the type of deformation, and are provided as an indication)

Identification	Moments (H)	Reference	Tolerance
$EPYY$	2000	0.020968	15%
$V11(endo)$	2000	0.0323	12%
$dEPYY/dt$	1520	6,6539E-006	21 %

3 Modeling C

3.1 Characteristics of modeling

- Behavior tested: GursonTvergaardNeedlemanPlasticFlow_NumericalJacobian.mfront

  Elastoplastic law with damage of Gurson (model GTN in the literature).

  Ref.: “Analysis of the cup cone fractures in has tensile round bar”.
  V.Tvergaard, A.Needleman, Acat Metallurgica 32 (1984) 157-169

  the criterion is form (F is porosity)

$$F(\sigma, f)=(\frac{\sigma_{eq}}{\sigma_0})^2+2q_1 f\cosh(\frac{3}{2}q_2\frac{\sigma_h}{\sigma_0})-1-(q_1 f)^2\leq 0$$

- Work hardening isotope is modified in the following way (

$$R(p)=R0+Q_1(1-e^{-b_1 p})+Q_2(1-e^{-b_2 p})$$

- Modeling: material not subjected to imposed deformations:

$$\varepsilon_{xx}=0,02t \ , \ \varepsilon_{yy}=0,1t \quad \varepsilon_{zz}=0$$

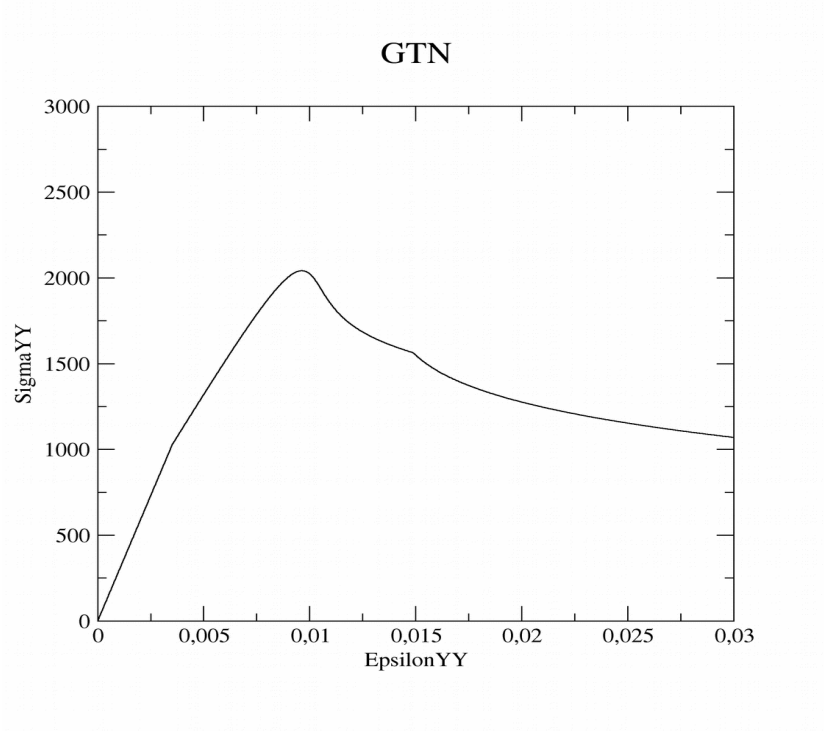
- Properties material:

Young	200000
Fish	0.3
R0	500
Q1	1 e9
b1	1 e-6
Q2	0
b2	0
f0	1 e-3
FC	1 e-2
delta	2

beta	0
CP	1.
alp	1 e-5
q1	1.5
q2	1

3.2 Sizes tested and results

The response curve $\sigma_{yy} = f(\varepsilon_{yy})$ is:



The tests are of nonregression.

Identification	Moments	Reference	Tolerance
σ_{xx}	0.3	910.12	0.1 %
σ_{yy}	0.3	1069.37	0.1 %
σ_{zz}	0.3	870,308	0.1 %

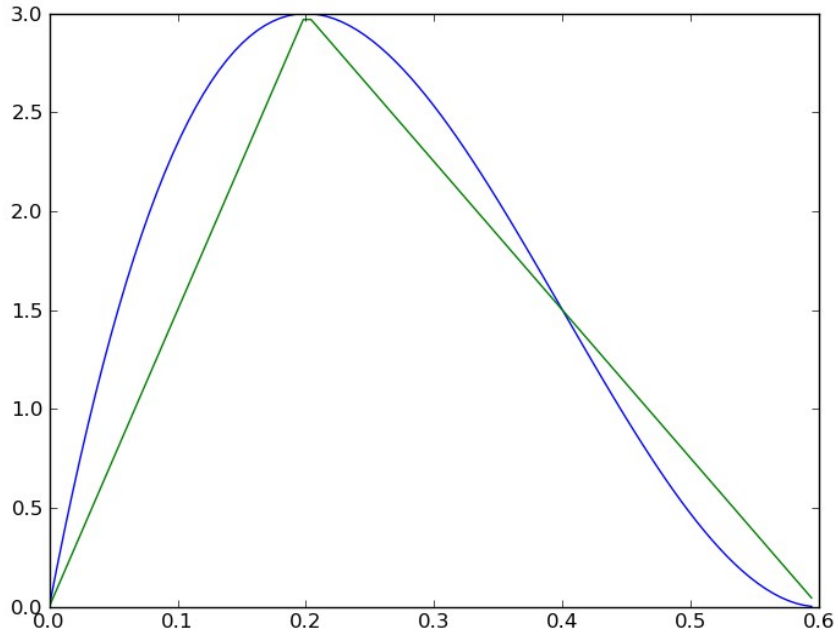
4 Modeling D

4.1 Characteristics of modeling

- Behavior tested: Tvergaard.mfront. Law of cohesive zone, regularized in comparison with law CZM_LIN_REG [R7.02.11].

  Ref.: “With modified version of the Tvergaard model.” “Tvergaard V., Effect of fibre debonding in has whisker reinforced metal,” “MATER Sci. Eng., 1990, vol. a125, pp 203-213”

- The characteristic curve normal constraint - opening is the following one:



Blue curve: Tvergaard, curved green: CZM_LIN_REG.

- Modeling: similar to test SSNP118E [V6.03.118] but with a law of Tvergaard. The tests are thus of nonregression.

4.2 Sizes tested and results

Identification	Moments	Reference
u_x	1	2.1650635257
σ_n	0.9	1.0475348752
σ_n	1	0.0030176971

5 Summary of the results

The results are satisfactory and validate the interface enters *Code_Aster* and MFRONT for behaviors with damage.