SSNA120 – notched Test-tube axisymmetric (AE) with model CZM_TRA_MIX

Summarized:

This test of nonlinear static mechanics makes it possible to make sure of non regression of a functionality of Code_Aster in fracture mechanics and to compare it with a local approach (Rousselier). The functionality tested is the cohesive model for the ductility fracture: CZM_TRA_MIX [R7.02.11].

A notched axisymmetric test-tube is requested in tension. The evolution of the force and the diametrical contraction during the propagation of the ductility fracture is calculated. The modelization of the test-tube is realized with elements 2D (QUA8).

1 Problem of reference

1.1 Geometry and loading

One considers a notched axisymmetric test-tube of type $AE4$. The cohesive zone represented by elements of interface is positioned on line AB .

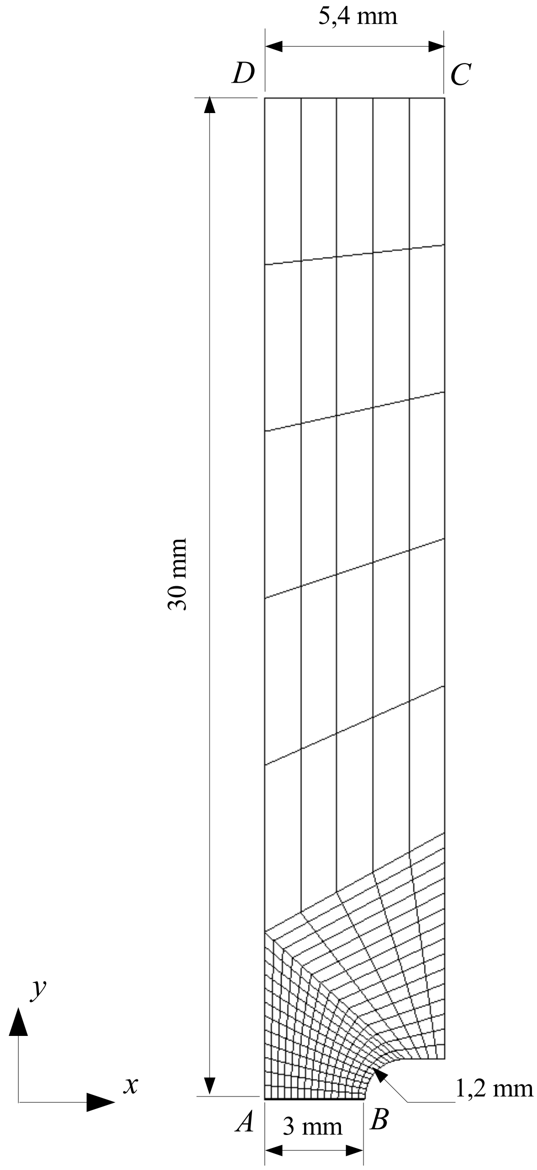

Figure 1 : Geometry of the test-tube $AE4$.

1.2 Properties of the material

to describe the behavior of the material of the axisymmetric test-tube (voluminal material), one uses one with an isotropic hardening elastoplastic constitutive law (model VMIS_ISOT_TRAC).
One takes: $E=207\ GPa$ and $\nu=0.3$ the curve of hardening retained is given below:

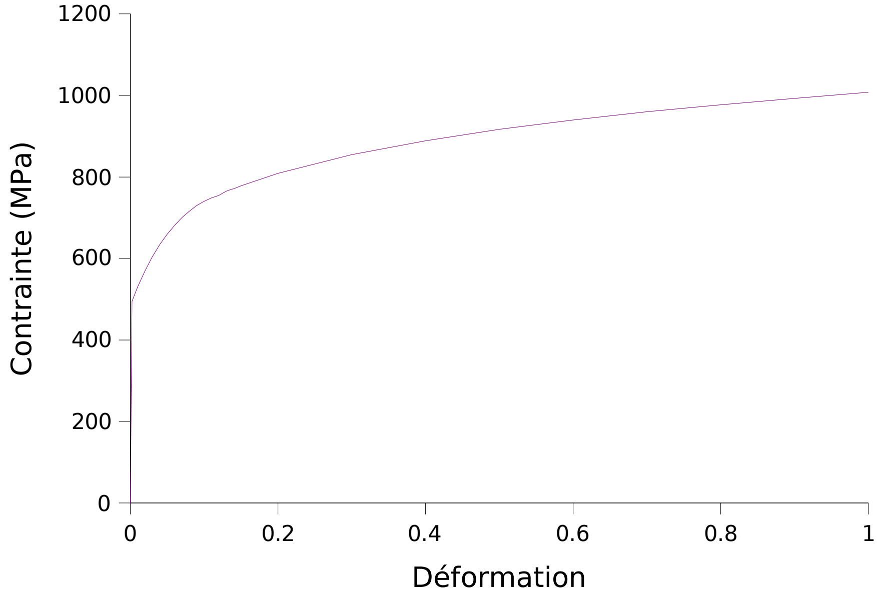

Figure 2 : Isotropic curve of hardening of the voluminal material.

For the elements of interface the following parameters are used in model CZM_TRA_MIX :
$\sigma_c = 1200 \ \ MPa \ \ G_c = 130 \ \ MPa \cdot mm \ \ \delta_e = 0.01 \ \ mm \ \ \delta_p = 0.07 \ \ mm \ \ \delta_c = 0.157 \ \ mm$,
the model which results from this is schematized below.

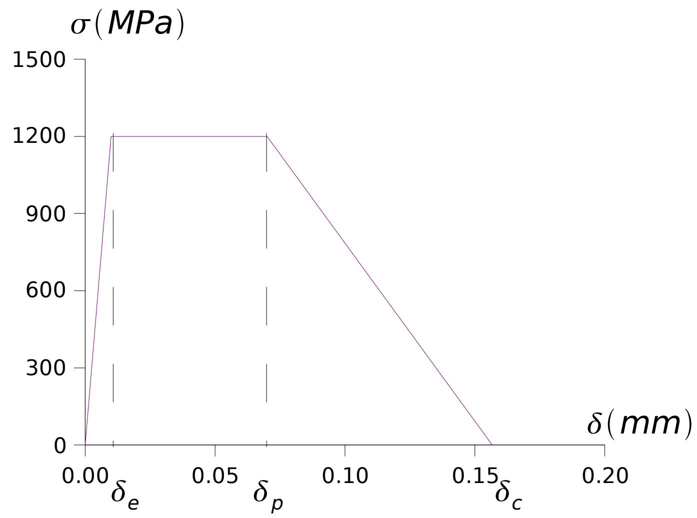

Figure 3 : Constitutive law of the elements of interface.

NB: Only half of crack is modelled thanks to symmetry of the problem, the tenacity of the material is of $2G_c$.

1.3 Boundary conditions and loading

While referring to figure 1, the boundary conditions are the following ones:

- displacement in X blocked on line AD ,
- imposed displacement l following the direction Y on line DC .

The evolution of displacement l in the course of time is given in the following table:

Time $[s]$	0	1
Displacement l $[mm]$	the 0.0,5	

cohesive zone is represented by the elements of interface on line AB . The upper lip of the elements of interface is called AB and the lower lip is called $A'B'$. The boundary conditions on the elements of interface are:

- displacement in X imposed on the lips AB and $A'B'$: $DX_{AB}=DX_{A'B'}$
- displacement in Y blocked on line $A'B'$.

2 Quantities and

2.1 result reference solution of reference

the displacement of the following B node X (DEPL) and the applied force on test-tube (REAC_NODA) were calculated.
A comparison is carried out with two different computations:

- a former execution of Code_Aster with model CZM_TRA_MIX, it acts of a case test of NON-regression;
- a former execution of Code_Aster where the ductility fracture is modelled with the model of Rousselier by model ROUSS_PR.

In the case of the modelization with the model of Rousselier, the parameters retained for this model are the following: $D=2$, $SIGM_1=460$ and $f0=0,0005$

3 Modelization A

3.1 Characteristic of the modelization

The modelization of the ductility fracture is carried out with the modelization AXIS_INTERFACE and model CZM_TRA_MIX. The volume elements are modelled with the model AXIS.

3.2 Characteristics of the mesh

The mesh of entry is linear. It is transformed into a quadratic mesh by LINE_QUAD in CREA_MAILLAGE.
After the transformation its characteristics are the following ones:
Many nodes: 962
Many elements: 280 QUAD8.
Many elements of interface: 15 QUAD8.

3.3 Quantities tested and Test

results of non regression : diametrical contraction ($-2\times DX$ of the point B), tensile force (the resultant DY of REAC_NODA on CD multiplied by 2π) according to the displacement of tension DY (on CD).

For a displacement of $0{,}3\,mm$ according to Y on CD

Quantity tested	Code_Aster	Tolerance ($\%$)
Contraction (mm)	0.605676	0.10
Force (kN)	28.8696	0.10

For a displacement of $0{,}4\,mm$ according to Y CD

Quantity tested	Code_Aster	Tolerance ($\%$)
Contraction (mm)	0.931629	0.10
Force (kN)	23.6023	0.10

Test of non regression on the computation carried out with the model of Rousselier : diametrical contraction ($-2\times DX$ of the point B), tensile force (the resultant DY REAC_NODA on CD multiplied by 2π) according to the displacement of tension (DY on CD).

For a displacement of $0{,}2\,mm$ according to Y on CD

Quantity tested	Code_Aster	Rousselier	Error ($\%$)
Contraction (mm)	0.333202	0.349885	4.8
Force (kN)	29.3851	29.3597	0.087

For a displacement of $0{,}3\,mm$ according to Y on CD

Quantity tested	Code_Aster	Rousselier	Error ($\%$)
Contraction (mm)	0.605676	0.620591	2.4
Force (kN)	28.8696	28.6069	0.92

For a displacement of $0{,}4\,mm$ according to Y on CD

Quantity tested	Code_Aster	Rousselier	Error ($\%$)

Contraction (mm)	0.931629	0.954683	2.4
Force (kN)	23.5744	22.6731	04/01/00

4 Summary of the results

Of the values of non regression are tested as well as tests of comparison with the model of Rousselier.