

SSNP151 – Test-tube Compact Tension (CT) in 2D and 3D with the law CZM_TRA_MIX

Summary:

This test of mécanique nonlinear statics makes it possible to make sure of nonthe regression of a functionality of *Code_Aster* EN breaking process. The functionality tested is the ductile law of rupture: CZM_TRA_MIX [R7.02.11].

A test-tube Compact Tension (*CT*) is solicited in traction. The evolution of the force during the propagation of the ductile rupture is calculated.

The modeling of the test-tube is carried out with elements 2D (QUA8) or of the elements 3D (HEXA20).

1 Problem of reference

1.1 Geometry and loading

One considers a test-tube Compact Tension (CT) of thickness 25 mm . The geometry understands a rigid pin to which the loading is applied.

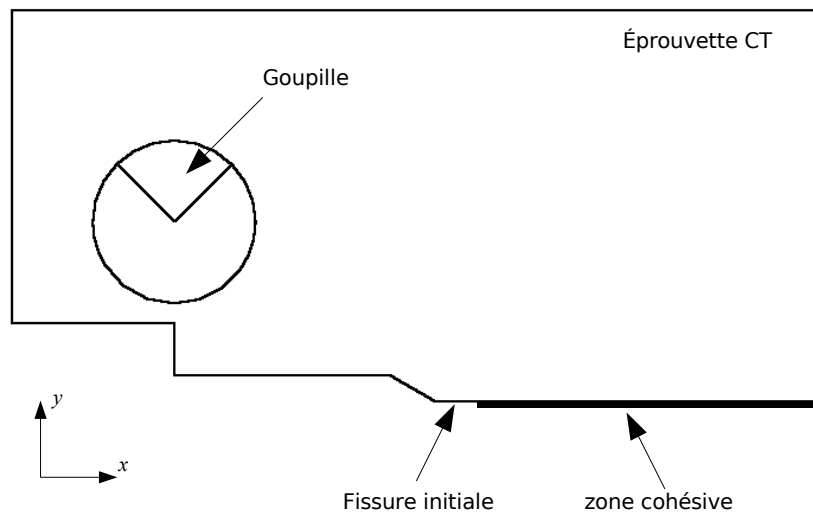


Figure 1 : Geometry

1.2 Properties of material

To describe the behavior of material of the axisymmetric test-tube (voluminal material), one uses an elastoplastic law of behaviour with an isotropic work hardening (law VMIS_ISOT_TRAC).

One takes: $E=207\text{ GPa}$ and $\nu=0.3$ and the curve of work hardening retained is given below:

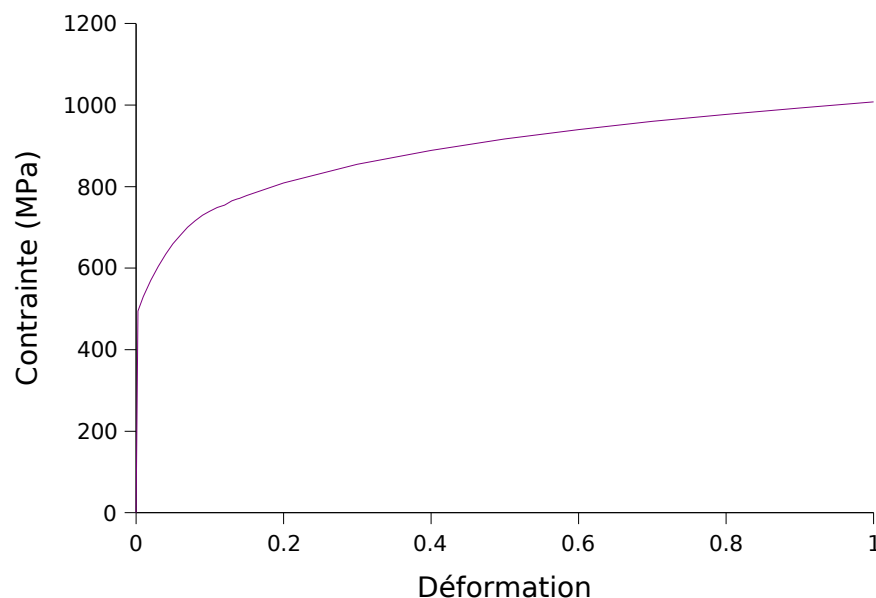


Figure 2 : Isotropic curve of work hardening of voluminal material.

For the elements of interface the following parameters are used in the law CZM_TRA_MIX :

$$\sigma_c=1800\text{ MPa}, G_c=150\text{ MPa}\cdot\text{mm}, \delta_e=0.01\text{ mm}, \delta_p=0.06\text{ mm}, \delta_c=0.117\text{ mm}$$

The law which results from this is schematized below.

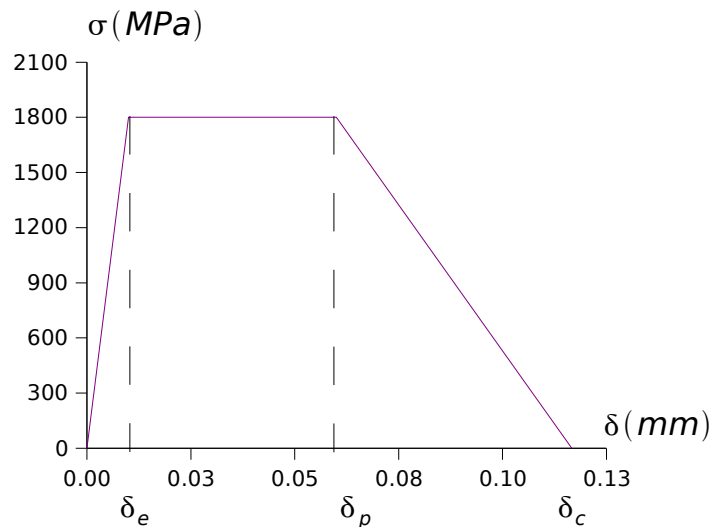


Figure 3 : Law of behavior of the elements of interface.

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

Lastly, the rigid pin has an elastic behavior (law ELAS) with: $E = 1 \times 10^9 \text{ MPa}$, $\nu = 0.3$

1.3 Boundary conditions and loading

The boundary conditions imposed on the pin are the following ones:

- displacement in X blocked,
- imposed displacement l according to the direction Y .

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

Time [s]	0	0.4
Displacement l [mm]	0	1.6

The cohesive zone is represented by the elements of interface on the ligament of the test-tube. The boundary conditions on the elements of interface are:

- displacement in X imposed identical on the two lips of the cohesive zone,
- displacement in Y blocked on the lower lip.

2 Reference solution

2.1 Sizes and results of reference

The force applied to the test-tube (REAC_NODA) was calculated.

The results calculated in this case test result from a former execution DE *Code_Aster*, it acts of a case test of not-regression.

3 Modeling A

Modeling in plane deformations.

3.1 Characteristics of modeling

The modeling of the ductile rupture is carried out with modeling `PLAN_INTERFACE` and the law `CZM_TRA_MIX`. The elements of volume are modelled EN plane deformations `D_PLAN`.

3.2 Characteristics of the grid

The grid of entry is linear. It is transformed into a quadratic grid by `LINE_QUAD` in `CREA_MAILLAGE`. After the transformation its characteristics are the following ones:

Many nodes: 2357

Many elements for the test-tube `CT` : 663 `QUAD8` and 42 `TRIA6`

Many elements for the pin: 20 `TRIA6`.

Many elements of interface: 40 `QUAD8`.

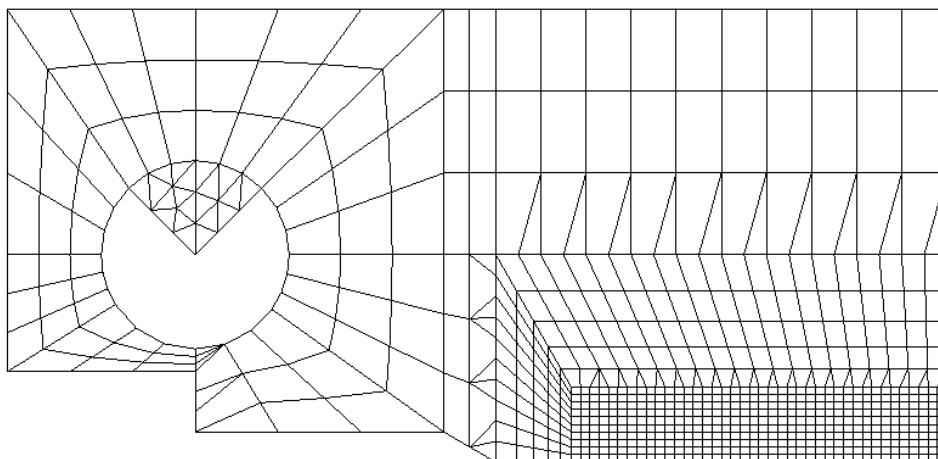


Figure 4 : Grid of test-tube CT in 2D.

3.3 Sizes tested and results

Test of nonregression : Force of traction (resulting DY) on the pin according to displacement DY pin.

Size tested	Type of Reference	Code_Aster	Tolerance (%)
Force for a displacement of 0,5 mm	'NON_REGRESSION'	4269.54	0.10
Force for a displacement of 1 mm	'NON_REGRESSION'	4767.59	0.10
Force for a displacement of 1,5 mm	'NON_REGRESSION'	5109.77	0.10
Force for a displacement of 2 mm	'NON_REGRESSION'	5383.76	0.10

4 Modeling B

Modeling in 3D.

4.1 Characteristics of modeling

The modeling of the ductile rupture is carried out with modeling `3D_INTERFACE` and the law `CZM_TRA_MIX`. The elements of volume are modelled with the model 3D.

4.2 Characteristics of the grid

The grid of entry is linear. It is transformed into a quadratic grid by `LINE_QUAD` in `CREA_MAILLAGE`. After the transformation its characteristics are the following ones:

Many nodes: 7160

Many elements for the test-tube `CT` : 1130 `HEXA20` and 120 `PRIS15`

Many elements for the pin: 100 `PRIS15`

Many elements of interface: 100 `HEXA20`.

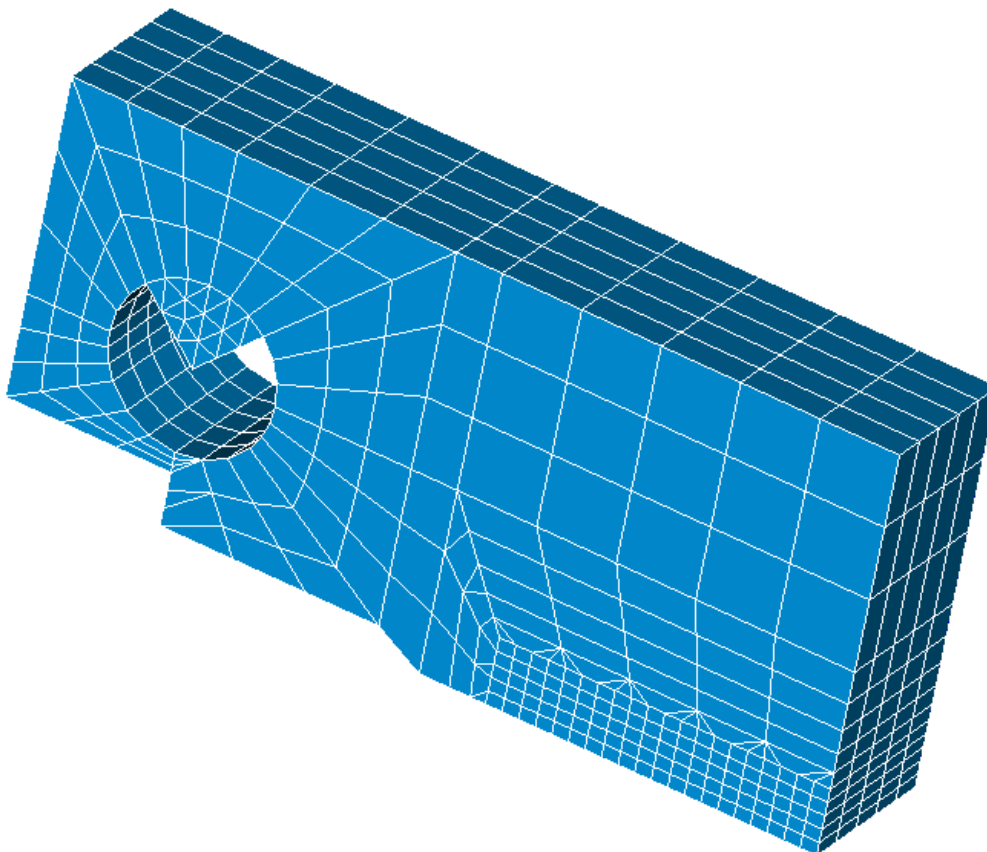


Figure 5 : Grid of test-tube CT in 3D.

4.3 Sizes tested and results

Test of nonregression : Force of traction (resulting DY) on the pin according to displacement DY pin.

Size tested	Type of Reference	Code_Aster	Tolerance (%)
Force for a displacement of 0,4 mm	'NON_REGRESSION'	4.47132E+04	0.10
Force for a displacement of 0,8 mm	'NON_REGRESSION'	5.09591E+04	0.10
Force for a displacement of 1,2 mm	'NON_REGRESSION'	5.22155E+04	0.10
Force for a displacement of 1,6 mm	'NON_REGRESSION'	5.32126E+04	0.10

5 Summary of the results

Only values of nonregression are tested.