SSNP151 – Test-tube Compact (CT) Tension in 2D and 3D 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. The functionality tested is the model of ductility fracture: CZM_TRA_MIX [R7.02.11].

A test-tube Compact Tension (CT) is requested in tension. The evolution of the force during the propagation of the ductility fracture is calculated.

The modelization of the test-tube is realized with elements $2D$ (QUA8) or 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.

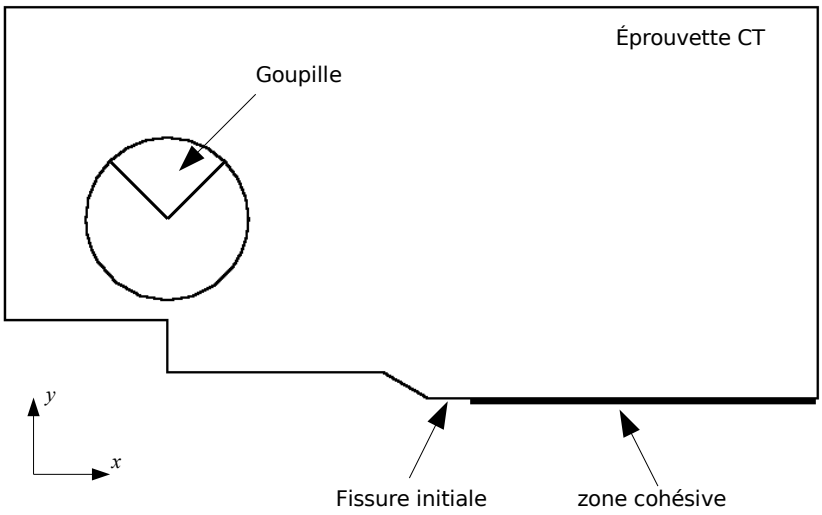

Figure 1 : Geometry

1.2 Properties of 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:

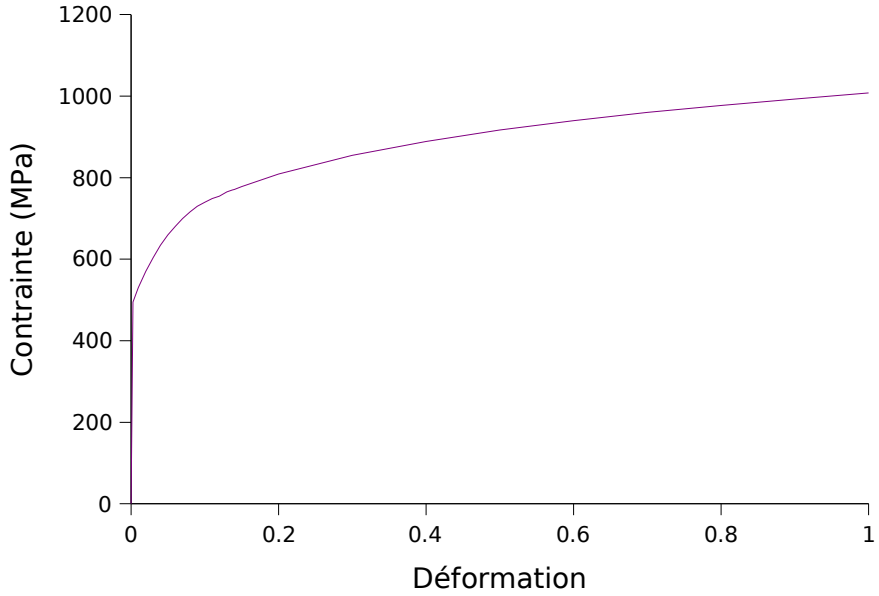

Figure 2 : Isotropic curve of hardening of the voluminal material.

For the elements of interface the following parameters are used in model CZM_TRA_MIX :
$\sigma_c=1800\ \ MPa\ \ G_c=150\ \ MPa\cdot mm\ \ \delta_e=0.01\ \ mm\ \ \delta_p=0.06\ \ mm$, $\delta_c=0.117\ \ mm$

the model which results from this is schematized below.

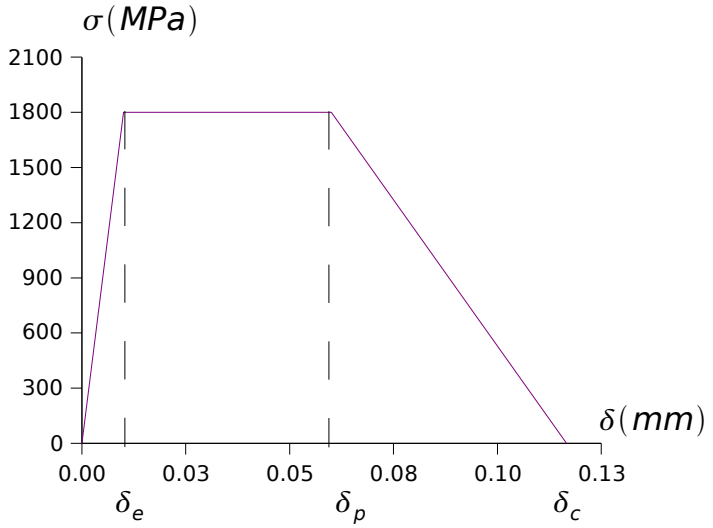

Figure 3 : Constitutive law of the elements of interface.

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

Lastly, the rigid pin has an elastic behavior (model ELAS) with: $E=1\times10^9 \ MPa$, $\nu=0.3$

1.3 Boundary conditions and loading

the boundary conditions imposed on the pin are the following ones:
•displacement in X blocked,
•displacement imposed l according to the direction Y.

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

Time $[s]$	0.0,4
Displacement l $[mm]$	the 0.1,6

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 formula imposed on the two lips of the cohesive zone,
•displacement in Y blocked on the lower lip.

2 Quantities and

2.1 result reference solution of reference

the applied force on test-tube (REAC_NODA) was calculated.
The results calculated in this case test result from a former execution of *Code_Aster*, it acts of a case test of NON-regression.

3 Modelization A

Modelization in plane strains.

3.1 Characteristics of the modelization

The modelization of the ductility fracture is carried out with the modelization PLAN_INTERFACE and model CZM_TRA_MIX. The volume elements are modelled in plane strains D_PLAN.

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: 2357
Numbers of elements for the test-tube CT : 663 QUAD8 and 42 TRIA6
Many elements for the pin: 20 TRIA6.
Many elements of interface: 40 QUAD8 .

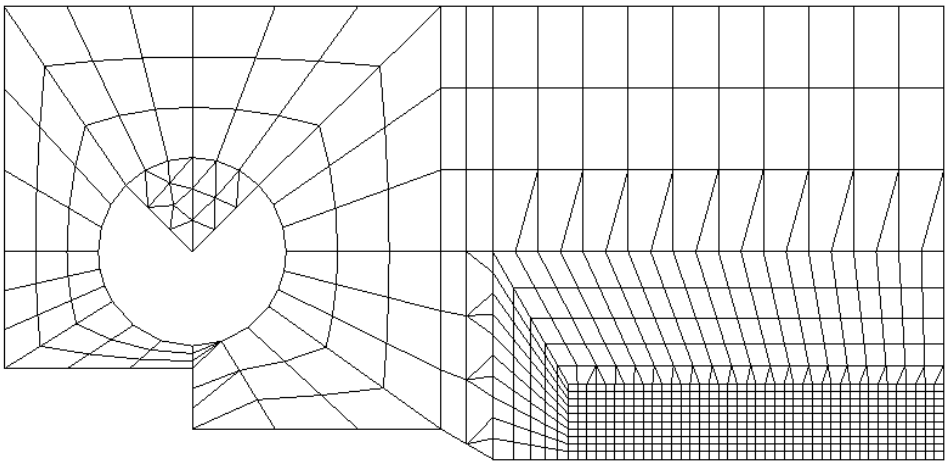

Figure 4 : Mesh of test-tube CT in 2D.

3.3 Quantities tested and Test

results of non regression : Tensile force (resulting DY) on the pin according to displacement DY pin.

Quantity tested	Standard of Reference	Code_Aster	Tolerance (%)
B Forces for a displacement $0,5\,mm$	of "NON_REGRESSION	"	4269.54
0.10 Force for a displacement $1\,mm$	of "NON_REGRESSION	"	4767.59
0.10 Force for a displacement $1,5\,mm$	of "NON_REGRESSION	"	5109.77
0.10 Force for a displacement $2\,mm$	of "NON_REGRESSION	"	5383.76

4 0.10 Modelization

Modelization in 3D.

4.1 Characteristics of the modelization

The modelization of the ductility fracture is carried out with the modelization 3D_INTERFACE and model CZM_TRA_MIX. The volume elements are modelled with the model 3D.

4.2 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: 7160
Numbers of elements for the test-tube CT : 1130 HEXA20 and 120 PRIS15
Many elements for the pin: 100 PRIS15
Many elements of interface: 100 HEXA20.

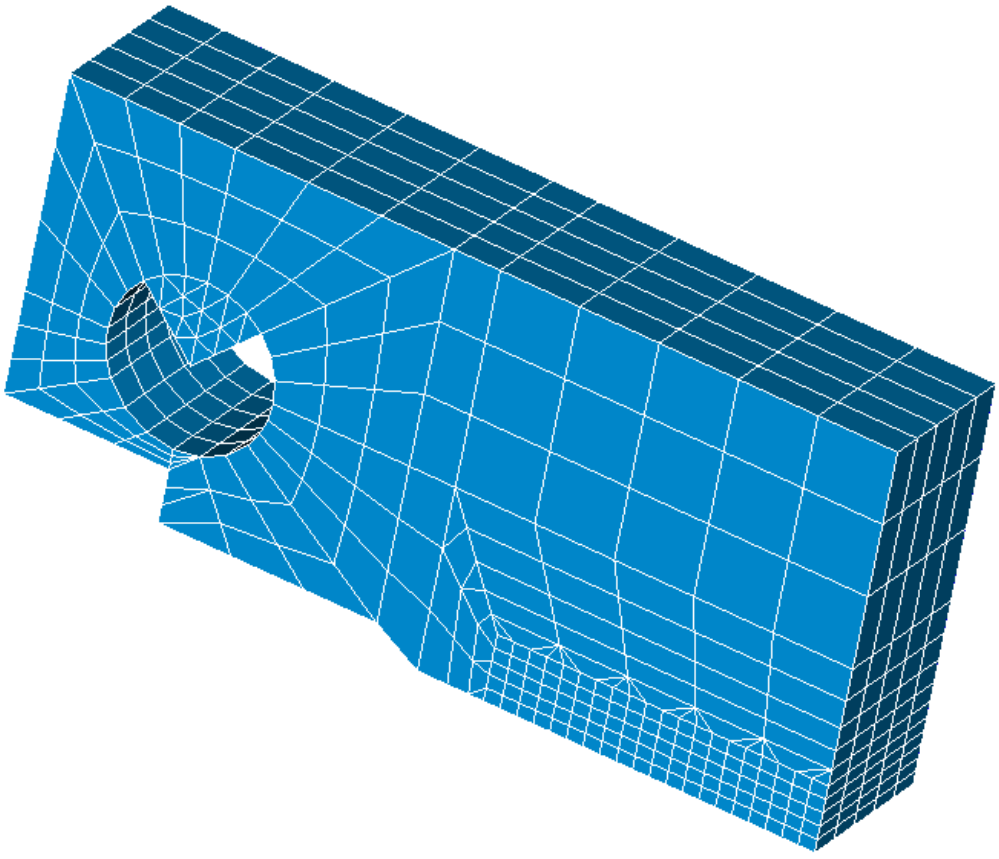

Figure 5 : Mesh of test-tube CT in 3D.

4.3 Quantities tested and Test

results of non regression : Tensile force (resulting DY) on the pin according to displacement DY pin.

Quantity tested	Standard of Reference	Code_Aster	Tolerance (%)
Forces 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

Alone of the values of non regression are tested.