

## ZZZZ363 – Dynamic damage of a notched sample in AXIS

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### Summary:

This test represents a dynamic calculation of damage of a notched sample. It allows the validation of modeling `GRAD_VARI` into axisymmetric, who allows to carry out the calculations of damage regularized by the gradient of the damage, by taking into account degrees of freedom of displacement and damage to the nodes. Modeling `GRAD_VARI` carry out a local resolution, points of Gauss by points of Gauss. One validates on modeling `AXIS_GRAD_VARI` a law of behavior `ENDO_SCALAIRE`.

Modeling and laws of endommangeant behavior tested:

- **Modeling A** : Modeling `AXIS_GRAD_VARI` with the law of behavior `ENDO_SCALAIRE`

## 1 Problem of reference

### 1.1 Geometry

One considers a notched sample height  $10\text{ dm}$ . Of width  $3\text{ dm}$  and of ray of notch  $1\text{ dm}$ .

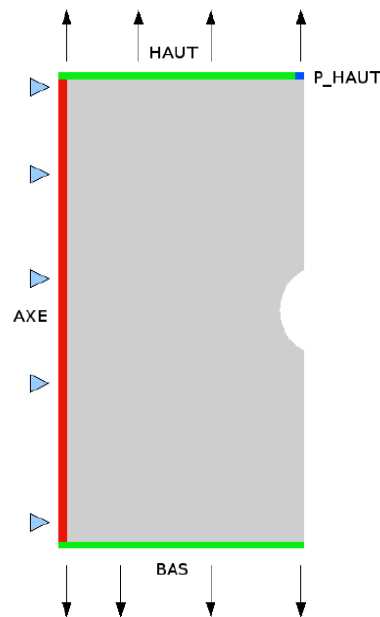


Figure 1 : Representation of the problem

### 1.2 Common properties of material

The material considered is compared to the concrete (one works on a decimetre scale):

Characteristics rubber bands:

$$E = 3.E10\text{ Pa} = 3.E8\text{ N/dm}^2$$

$$\nu = 0.2$$

Elastic limit in traction of the law of damage:

$$SY = 3.E4\text{ N/dm}^2 = 3.E6\text{ Pa}$$

Rate of refund of energy by surface of crack (constant of Griffith):

$$G_f = 10\text{ N/dm} = 100\text{ J/m}^2$$

Density:

$$Rho = 2300\text{ Kg/m}^3 = 2.3\text{ Kg/dm}^3$$

### 1.3 Boundary conditions and loadings

**Blocking** :  $DX = 0$  on the nodes which belong the axis of symmetry has ( $x = 0.$ ), in order to ensure the maintenance of the structure (in red on Figure 1).

**Loading** : One imposes a displacement on the parts high and low of the notched sample (in green on Figure 1).

## 2 Reference solution

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This case test is a case of nonregression. It is about a study, which quickly passes from a state slightly damaged to a state of rupture (damage equal to 1).

The loadings are not analytical. The values of imposed displacements are simply empirical. In the same way, values of damage are found associated which are not exact values. Not having no value of reference for this kind of modeling, one checks on this case test only the not-regression of the code.

## 3 Modeling A

### 3.1 Characteristics of modeling

A modeling of damage is considered GRAD\_VARI, which is a Lagrangian mixed formulation of damage regularized by the gradient of the damage. She takes into account besides the degrees of freedom of displacement and damage to the nodes, the coefficients of Lagrange.

### 3.2 Characteristics of the grid

The grid contains 1034 elements TRIA6 and 462 elements QUAD8. The grid in the center of the test-tube is directed except symmetry.

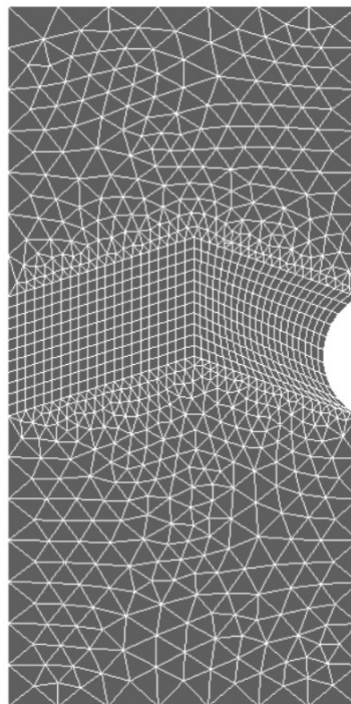


Figure 2 : Representation of the grid

### 3.3 Law of damage: material ENDO\_SCALAIRE

Characteristics standards of the concrete are defines previously.  
Characteristics related to the not-local law of damage:

$c=1.875 \text{ N} ; p=1.5 ; m=10$  what corresponds to the zone of damage 1D equalize with  
 $D=0.5 \text{ dm}$

The correspondence with the physical parameters is the following one:

$$c=3/8 D G_f ; m=\frac{3 E G_f}{2 D \cdot SY^2} ; p=m/4-1 ;$$

## 3.4 Boundary conditions and loadings

### Loading :

One imposes a rate of normal travel of  $-5SY/E = -5E-04$  on the high part and of  $+5SY/E = 5e-04$  on the low part of the notched sample in way has what the test-tube works in compression.

The loading in imposed displacement is applied during 1.2 sec .

## 3.5 Sizes tested and results

This case test is validated only in not-regression:

- Test of nonregression on displacement at the point P\_HAUT .
- Test of nonregression on the stress field at the point of gauss 1 of the mesh M160 .
- Test of nonregression on the field of constrained at the point of gauss 1 of the mesh M1324 .
- Test of nonregression on the maximum of constraint in the test-tube.
- Test of nonregression on the nodal reaction at the point P\_HAUT .

## 4 Summary of the results

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This test makes it possible to check in nonregression:

- Modeling AXIS\_GRAD\_VARI with the law of behavior ENDO\_SCALAIRE in dynamics.