SSNV220 - Validation of modeling GVNO and the law of behavior ENDO_CARRE in 3D

This test allows the validation of modeling GVNO in $3D$, which makes it possible to carry out the calculations of damage regularized by the gradient of the damage, by taking into account only degrees of freedom of displacement and damage to the nodes. The resolution of the criterion is total, unlike modeling GRAD_VARI who carries out a local resolution, points of Gauss by points of Gauss. One validates simultaneously the law of behavior ENDO_CARRE, of quadratic formulation in damage, which is for the moment the law that one can use with modeling GVNO.

1 Problem of reference

1.1 Tally theoretical

The unknown factors of the problem are the degrees of freedom of nodal displacement and damage. It is then a question of minimizing an energy of the form:

$$\phi(u,\alpha)=\frac{1}{2}A(d)E\epsilon^2+\psi(d)+\frac{c}{2}\nabla\alpha.\nabla\alpha$$

Where E is the Young modulus of material, $A(d)$ the function of rigidity, $\psi(d)$ dissipation and c the nonlocal coefficient.

In the case of the law ENDO_CARRE:

$$A(d)=(1-d)^2 \quad \text{and} \quad \psi(d)=\frac{\sigma_y^2}{E}d$$

The criterion corresponding to the law ENDO_CARRE, for a homogeneous solution ($\nabla\alpha=0$), is thus written:

$$d=1-\left(\frac{W_y}{W_{el}}\right)$$

Where W_{el} is the elastic deformation energy and:

$$W_y=\frac{\sigma_y^2}{2E}$$

1.2 Geometry

A cube on side is considered $L=1\,\mathrm{m}$.

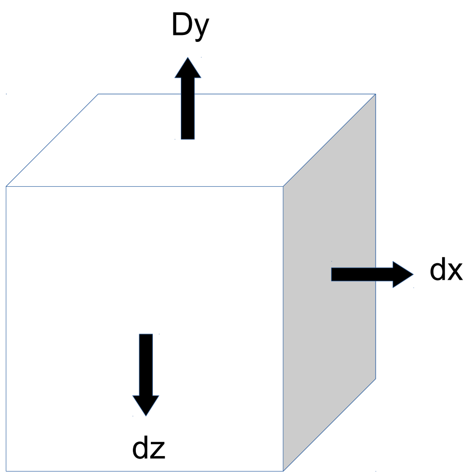

Figure 1 : Representation of the problem

1.3 Properties of material

Law of damage: material `ENDO_CARRE`

Characteristics rubber bands:
$E=1\,\mathrm{Pa}$
$\nu=0.$

Characteristics related to the law of damage:
Elastic limit:
$SY=0.01\,\mathrm{Pa}$

Not-local characteristics:
$c=1.0\,\mathrm{N}$

1.4 Boundary conditions and loadings

Embedding : Worthless imposed displacements `DY = 0` m . on the face of bottom ($y=0.$), `DX = 0` m . on the left face ($x=0.$) and `DZ = 0` m . on the face postpones ($z=0.$) . See figure 1.

Loading 1 : Imposed linear displacement U_1 on the right face ($x=1.$) :
$U_1=0.0\,\mathrm{m}$ for `INST=0`, $U_1=0.02\,\mathrm{m}$ for `INST=1.0`.
Loading 1 : Imposed linear displacement U_2 on the right face ($y=1.$) :
$U_2=0.0\,\mathrm{m}$ for `INST=0`, $U_2=0.02\,\mathrm{m}$ for `INST=1.0`.
Loading 1 : Imposed linear displacement U_3 on the right face ($z=1.$) :
$U_3=0.0\,\mathrm{m}$ for `INST=0`, $U_3=0.02\,\mathrm{m}$ for `INST=1.0`.

2 Reference solution

The imposed loadings enable us to obtain a homogeneous solution. The principal directions being clean directions of the tensor of the deformations, elastic energy results from the loadings defined previously in the following way:

$$W_{el}=\frac{\left(U_1^2+U_2^2+U_3^2\right)}{2L^2}$$

One extracts the associated values of damage analytically from them:

$$d=1-\left(\frac{2W_y L^2}{U_1^2+U_2^2+U_3^2}\right)$$

It is considered whereas the test is checked if Newton returns us well the same values of damage, with a precision of 10^{-6} .

3 Modeling

3.1 Characteristics of modeling

A modeling is used 3D_GVNO.

3.2 Characteristics of the grid

The grid contains 64 elements HEXA20.

3.3 Results

NUMBER	TYPE_REFERENCE	VALE_REF	SHEET
1	'ANALYTICAL'	0.1	1.0E-4%
2	'ANALYTICAL'	0.5	1.0E-4%
3	'ANALYTICAL'	0.7	1.0E-4%
4	'ANALYTICAL'	0.85	1.0E-4%

Table 1: Comparison of eigenvalues in room and not-room

4 Summary of the results

We get the results of references, with the precision requested, which validates modeling GVNO and the law of behavior ENDO_CARRE in 3D.