SSNP147 – Modeling of the starting of crack with the model ENDO_HETEROGENE

Summary:

This test represents the starting of a crack in a plate made up of materials heterogeneous. This plate undergoes a loading in the form of a slope of imposed displacements. Starting is modelled by the law ENDO_HETEROGENE using regularized constraints. This test aims to validate modeling D_PLAN_GRAD_SIGM and the law ENDO_HETEROGENE. It is about a case two-dimensional test of nonregression realized on a rectangular grid then triangular.

1 Problem of reference

1.1 Geometry

One represents a square of with dimensions $l=1\mathrm{m}$.

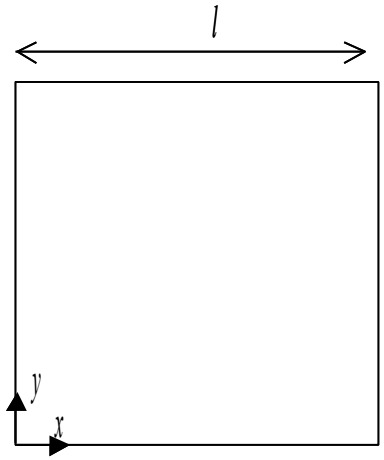

Illustration 1: Geometry of the case test

1.2 Properties of materials

Material:

Parameters of elasticity:
Young modulus $E_1=20.10^9 MPa$, Poisson's ratio $\nu_1=0,25$

Parameters of the law ENDO_HETEROGENE :
Yield stress $\sigma_y=5\,MPa$
Module of Weibull $m=6$
Tenacity $K_c=1\,MPa.m^{1/2}$
Thickness of the sample $ep=1\mathrm{m}$
Seed $GR=121$

Parameter of the nonlocal model:
Characteristic length $l_c=0,2\,m$

1.3 Boundary conditions and loading

The lower edge is blocked in displacement according to the vertical direction, the side edges are subjected to a field of displacement which varies linearly in the height. That is to say:

In bottom:
$u_y(x\,,\,y=0)=0$

On the right
$u_y(x=l\,,\,y)=c.u_d(1-y/l)$
with $u_d=0,0001$
On the right
$u_y(x=0,\,y)=-u_y(x=l\,,\,y)$

c corresponds to a variable loading ramp between 0 and 1 over the time of simulation (1s).

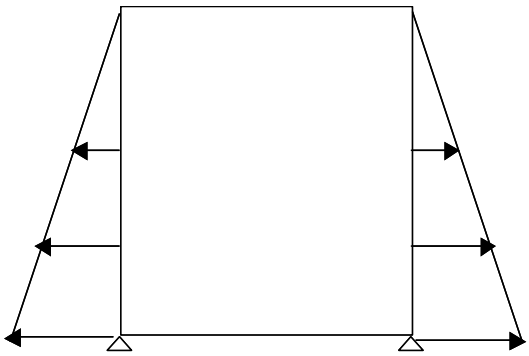

Illustration 2: Diagrams of the boundary conditions

1.4 Reference solution

There is no here reference solution and the test is of type not regression. It use the mixing rate ENDO_HETEROGENE, it even based on the regularized constraints.

The result is thus purely qualitative. It is a question of observing here the starting of a crack following the side loadings.

2 Modeling A

2.1 Characteristics of modeling

The totality of the field is with a grid in quadrangular elements with 8 nodes. The grid comprises 225 rectangles and 30 segments.
1 time of $1s$ is modelled.

2.2 Results

One traces on the figures 4 and 3 respectively horizontal displacements DX and the criterion of damage (variable internal V1) at the end of $1\mathrm{s}$.

One sees a crack which starts with $2/3$ field (when V1 is equal to 1, the material is broken).

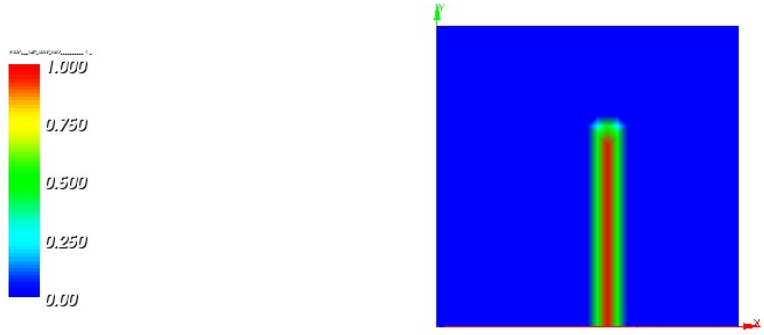

Illustration 3: Variable of damage (VI), $t=1\mathrm{s}$

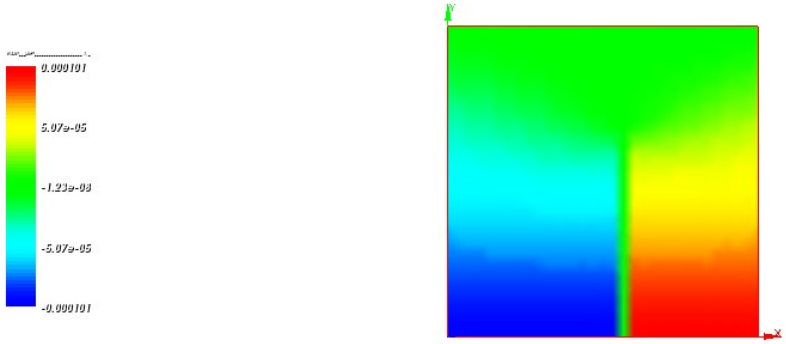

Illustration 4: Horizontal displacements DX, $t=1\mathrm{s}$

2.3 Values tested

The value of displacement is tested at the point *testpn* correspondent with a node which is with $2/3$ length of with dimensions of the plate.

Place	Component	moment	Value of nonregression	Tolerance (%)
testpn	DX	1	1.0138E-4	1.E-3

3 Modeling B

3.1 Characteristics of modeling

The totality of the field is with a grid in triangular elements with 6 nodes. The grid comprises 620 triangles and 64 segments.

1 pas de time of 1 S is modelled.

3.2 Results

One traces on the figures 5 and 6 respectively horizontal displacements DX and the criterion of damage (variable internal V1) at the end of $1\mathrm{s}$.

One sees a crack which starts with $1/3$ field (when V1 is equal to 1, the material is broken).
The form of the results is logically dependent on the grid.

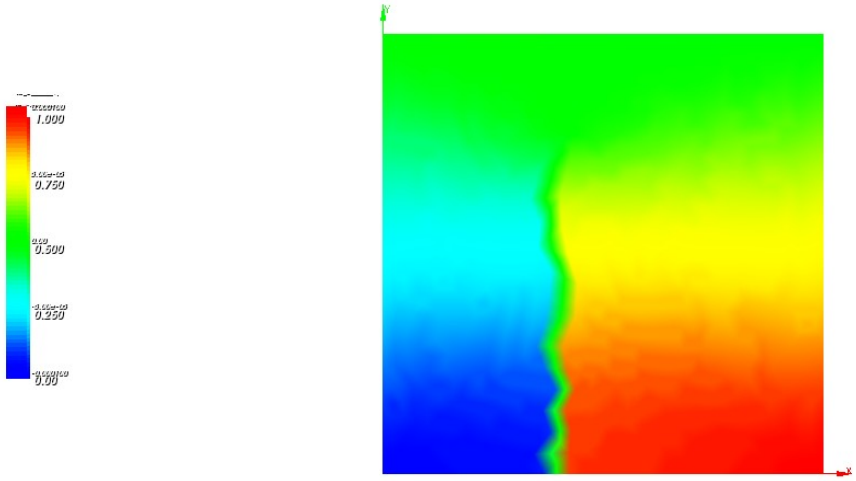

Illustration 5: : Horizontal displacements DX, $t=1\mathrm{s}$

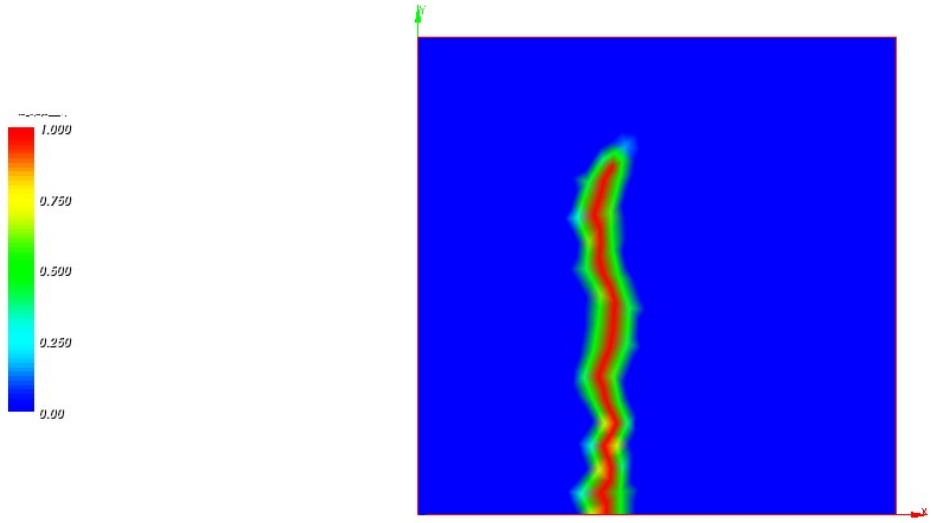

Illustration 6: Variable of damage ($V1$), $t=1\mathrm{s}$

3.2 Values tested

The value of displacement is tested at the point $testpn$ defined above.

Place	Component	moment	Value of nonregression	Tolerance (%)
$testpn$	DX	1	8.828E5	1.E-3

4 Summary of the results

This test represents modeling by means of the law ENDO_HETEROGENE starting of a crack in a plate made up of materials heterogeneous. This plate undergoes a loading in the form of a slope of imposed displacements. The place of starting is defined by chance (determined here by the choice of seed). The got results correspond well to the expected results.

Note: because of random generation of the thresholds of starting during the use of the law **ENDO_HETEROGENE**, the results of nonregression will be different according to the number of processors used for the execution.