

## SSNV198 – The purpose of conditions of Dirichlet with X-FEM in 3D

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### Summarized

This test is 3D validating the imposition of conditions of Dirichlet (imposed displacements) on nodes nouveaux riches by the method X-FEM [bib1] on an academic case.

This test 3D brings into play a structure comprising an emerging crack plane at right bottom. Boundary conditions are applied to a face of structure, container of the nodes nouveaux riches.

Several configurations of mesh are tested and compared with the analytical solution.

## 1 Problem of reference

### 1.1 Geometry

the structure is a unit cube ( $LX=1\text{ m}$ ,  $LY=1\text{ m}$  and  $LZ=1\text{ m}$ ), comprising an emerging plane crack length  $a=0,5\text{ m}$ , being at middle height [Figure 1.1 -1.1-a]. One calls face from behind the face located in the plane  $x=0$  and that of front the face located in the plane  $x=LX$ .

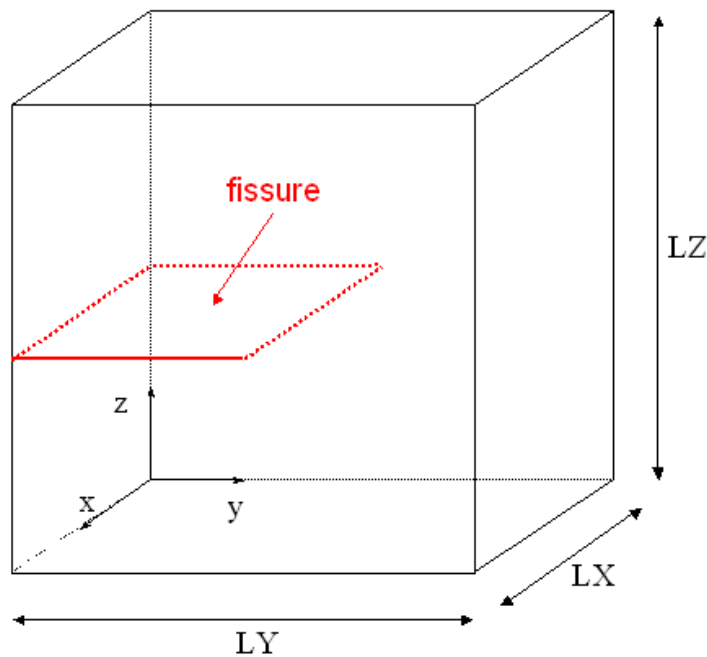


Figure 1.1 -1.1-a : geometry of the cube fissured

### 1.2 Properties of the material

Modulus Young:  $E=100\text{ MPa}$

Poisson's ratio:  $\nu=0$ .

### 1.3 Boundary conditions and loadings

the studied loading is a loading which requests crack in mode *III* (out-plane), without creating discontinuity of displacement.

For that one imposes a fixed support of the nodes of the face from behind:  $DX=DY=DZ=0$  and a displacement of the nodes of the face of front following the normal direction (i.e along the axis)  $x$ .

$DNOR=10\text{ 6m}$  Bibliography

### 1.4 GENIAUT

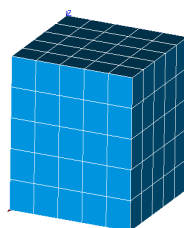
1.S., MASSIN P.: eXtended Finite Element Method, Handbook of reference of Code\_Aster ,  
[R7.02.12] Modelization

## 2 A In

this modelization, the crack is not with a grid, and the mesh is selected so that the crack tip is in center of the elements containing the bottom. Characteristics

### 2.1 of the mesh

the structure is modelled by a regular mesh composed of HEXA  $5 \times 5 \times 5$  8, respectively along the axes  $x, y, z$ . The crack tip is thus at the center of the elements containing the crack tip. Figure



#### 2.1 - 2.1-a2.1-a mesh such as the bottom is at the center of the elements Functionalities

### 2.2 tested One

tests the application of conditions of Dirichlet via command `AFPE_CHAR_MECA` on nodes nouveaux riches (here, nodes nouveaux riches by the Heaviside function and other nodes nouveaux riches by the asymptotic functions). This imposition is done as for classical nodes by the key word `DDL_IMPO` or `FACE_IMPO`. Quantities

### 2.3 tested and results One

tests the values of displacements of the nodes to which the conditions were applied. The postprocessing of displacement with X-FEM requires a specific stage of reconstruction, which does not preserve the nodes groups. It is thus necessary to recreate nodes groups on the mesh "fissured" post-treaty. Attention should be paid to keep only the old nodes, and to eliminate from the group the new nodes, i.e. those which coincide with the intersection of crack and the edges of the same mesh. This sort is carried out thanks to the name of the nodes: for

- $N$  ... the classical nodes, for
- $NX$  ... nodes X-FEM which are not on crack, and
- $NM$  ... For  $NP$ ... the new nodes X-FEM which are on the lip "less" and the lip "more". One

thus eliminates the nodes whose name starts with and  $NM$  .  $NP$

To test all the nodes of the group in only once, one tests the values minimum and maximum. Identification

**Aster**

**Reference**

**%**

**difference Face**

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

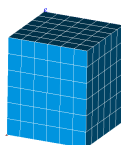
|                                      |           |           |  |      |
|--------------------------------------|-----------|-----------|--|------|
| from behind: MAX (DX)<br>0,0.0,0.0,0 |           |           |  | Face |
| from behind: MIN (DX) 0,0.0,0.0,0    |           |           |  | Face |
| from behind: MAX (DY)<br>0,0.0,0.0,0 |           |           |  | Face |
| from behind: MIN (DY) 0,0.0,0.0,0    |           |           |  | Face |
| from behind: MAX (DZ)<br>0,0.0,0.0,0 |           |           |  | Face |
| from behind: MIN (DZ) 0,0.0,0.0,0    |           |           |  | Face |
| of front: MAX (DX) formulates        | $10^{-6}$ | $10^{-6}$ |  | Face |
| of front: MIN (DX) formulates        | $10^{-6}$ | $10^{-6}$ |  | B    |

## 3 Modelization In

this modelization, the crack is not with a grid, and the mesh is selected so that the crack tip coincides with a node of the mesh. Characteristics

### 3.1 of the mesh

the structure is modelled by a regular mesh composed of HEXA  $6 \times 6 \times 6$  8, respectively along the axes [Figure  $x, y, z$  3.1 - 3.1-a3.1-a]. The crack tip is thus at the center of the elements containing the crack tip. Moreover, the crack coincides with edges of the elements. Figure



3.1 - 3.1-a3.1-a mesh such as the bottom coincides with a node Functionalities

### 3.2 tested One

tests the application of conditions of Dirichlet via command `AFFE_CHAR_MECA` on nodes nouveau riches (here, nodes nouveau riches doubly: by the Heaviside function and the asymptotic functions). This imposition is done as for the classical nodes by key words `DDL_IMPO` or `FACE_IMPO`.  
Quantities

### 3.3 tested and results One

tests the values of displacements of the nodes to which the conditions were applied. As the crack passes by the nodes of the mesh, the conditions were applied to the two lips of crack. It

is thus not necessary to filter the nodes here. All the new nodes are tested.

To test all the nodes of the group in only once, one tests the values min and max. Identification

| Aster        |                         | Reference | %         | difference Face |
|--------------|-------------------------|-----------|-----------|-----------------|
| from behind: | MAX (DX)<br>0,0.0,0.0,0 |           |           | Face            |
| from behind: | MIN (DX) 0,0.0,0.0,0    |           |           | Face            |
| from behind: | MAX (DY)<br>0,0.0,0.0,0 |           |           | Face            |
| from behind: | MIN (DY) 0,0.0,0.0,0    |           |           | Face            |
| from behind: | MAX (DZ)<br>0,0.0,0.0,0 |           |           | Face            |
| from behind: | MIN (DZ) 0,0.0,0.0,0    |           |           | Face            |
| of front:    | MAX (DX) formulates     | $10^{-6}$ | $10^{-6}$ | Face            |
| of front:    | MIN (DX) formulates     | $10^{-6}$ | $10^{-6}$ | Synthesis       |

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## 4 This

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case test validates the imposition of conditions of Dirichlet on nodes X-FEM. The imposition is done by key words DDL\_IMPO or FACE\_IMPO of the command AFFE\_CHAR\_MECA .