ZZZZ283 – Validation of the use of a grid with a crack X-FEM on a mesh refined by Summarized

Homard:

This test validates computation by DEFI_FISS_XFEM of the functions of level (level sets) of a crack X-FEM on a grid if the mesh of structure is refined by Homard.

1 Problem of reference

1.1 Geometry

One considers a parallelepiped of dimensions $4\times4\times2\,mm$ with a plane crack:

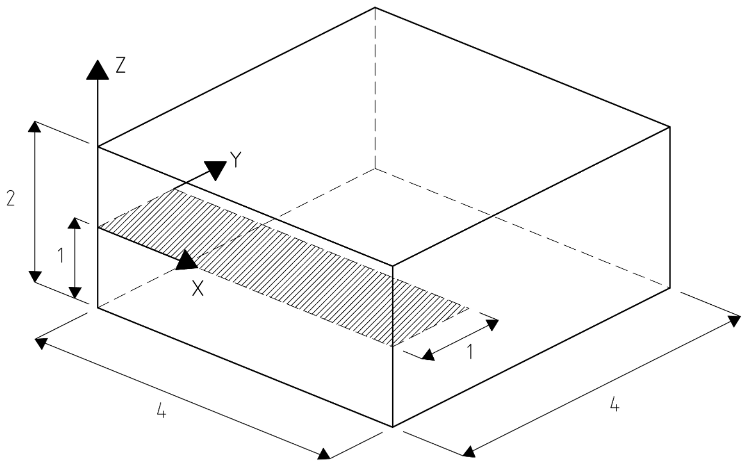

Figure 1.1-1: geometry of the crack

1.2 Boundary conditions and loadings

One will propagate crack of figure 1.1-1 by imposing the same angle of propagation β and the same projection Δa in each point of the bottom in way such as the bottom remains always right:

$\beta=5°$
$\Delta a=0.6\,mm$

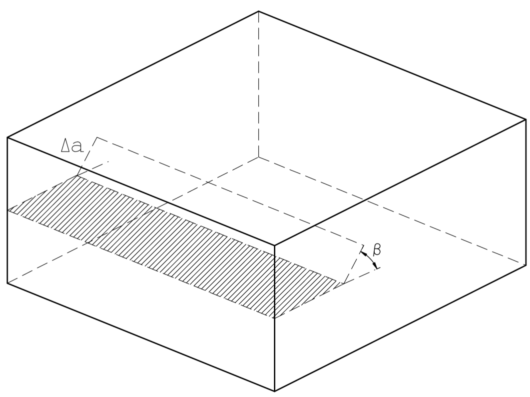

Figure 1.2-1: imposed propagation

2 Principle of the test

In DEFI_FISS_XFEM one can define crack on a grid by one of the following methods:

1.by giving the mesh of the grid to be used by MODELE_GRILLE,
2.by giving a crack with a grid already associated by FISS_GRILLE.

The second method was thought for the cases where one uses Homard to refine the mesh of structure. In this case, the grid associated with crack given by FISS_GRILLE is also associated with new crack and the level sets already there definite are kept with the identical one. Information concerning the localization of the field of computation and the use of one auxiliary grid is kept for new crack, which makes it possible to correctly propagate it by PROPA_FISS. A contrario, the level sets on the mesh are calculated by interpolation by Homard and they passed directly to DEFI_FISS_XFEM by DEFI_FISS/CHAMP_NO_LS*.

To check the good performance of the two methods, one will propagate by PROPA_FISS crack $FISS0$ of figure 1.1-1 in three stages:

1.one propagates $FISS0$, crack with auxiliary grid associated, which was defined by means of operand MODELE_GRILLE in DEFI_FISS_XFEM. One obtains $FISS1$.
2.one refines the mesh from $FISS1$ Homard. Then one auxiliary grid will define same crack on the mesh refined while keeping (operand FISS_GRILLE of DEFI_FISS_XFEM). One obtains $FISS1raff$, who coincides with $FISS1$ except at the place where mesh more refined.
3.one propagates $FISS1raff$ and one obtains $FISS2$.

Same the values of angle of propagation and advanced crack are imposed in each point of the crack tip. These values are maintained constant between the two propagations. The propagated funds are thus always right and one knows a priori their position in structure. If the two methods go correctly, the position of $FISS2$ must be coïncidente with that expected.

2.1 Method of calculating

For each point of the bottom, on each step of propagation, one imposes the same angle of propagation β and the same projection Δa of crack. One can thus calculate the coordinates of each point of the bottom after each step of propagation (figures 1.1-1 and 3.2-2):

$$Y_i=Y_{i-1}+\Delta a\cdot\cos(i\cdot\beta)$$
$$Z_i=Z_{i-1}+\Delta a\cdot sen(i\cdot\beta)$$

where $(0,Y_i,Z_i)$ and $(4,Y_i,Z_i)$ are the points end of the segment which coincides with the bottom of crack $FISSi$. At the beginning, for crack $FISS0$ (figure 1.1-1):

$Y_0=1$
$Z_0=0$

2.2 Quantities and results of reference

the coordinates of the points of end expected for the bottom $FISS2$ are thus the following ones:

$X_2=[0,4]$
$Y_2=2.189\,mm$
$Z_2=0.156\,mm$

The model to check the effective position of $FISS2$ the bottom in finite elements, one of the level sets uses the values at the points of intersection between the segment defined by the two points of end above and the sides of the elements of the mesh. If the position of the bottom after the propagation is calculated correctly, the value of both level sets must be equal to zero for all the found points of intersection because, by definition, the crack tip is formed by all the points where the level set tangent and norm are equal to zero.

The points of intersection and the value of the level sets in these points can be calculated by means of the commands of postprocessing `INTE_MAIL_3D` and `POST_RELEVE_T`.

3 Modelization A

3.1 Characteristic of the modelization

One uses a modelization 3D.

3.2 Characteristics of the mesh

The mesh 3D contains 100 elements of the type HEXA8 of dimension $0.4 \times 0.4 \times 0.2\, mm$:

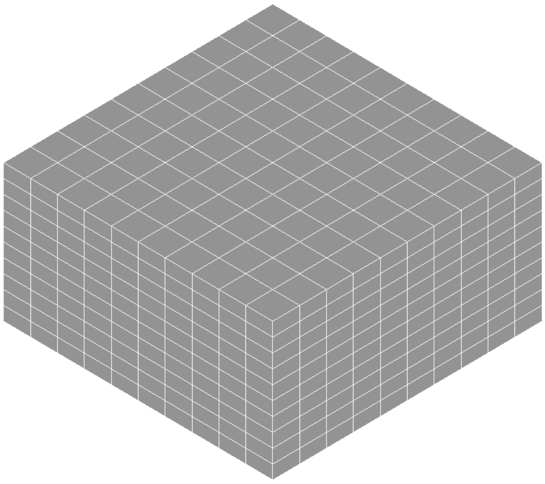

Figure 3.2-1: mesh used

For auxiliary grid, one uses a mesh 3D containing 400 elements of the type HEXA8 of dimension $0.2 \times 0.2 \times 0.1\, mm$:

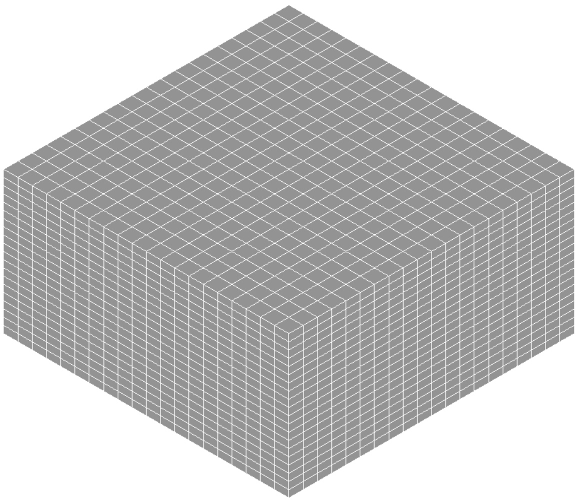

Figure 3.2-2: auxiliary grid

3.3 Quantities tested and results

After the two imposed propagations, one of the level sets calculates the values at the points of intersection between the segment connecting the points of end of the bottom $(0, 2.189, 0.156)$ and $(4, 2.189, 0.156)$ (see §2.23) and the sides of the elements of the mesh and one will check that the values maximum and minimal obtained are equal to zero. By considering that the mesh is coarse, one uses a tolerance equal to 15% length of the smallest edge of the mesh, that is to say

$0.15 \cdot 0.2 mm = 0.03 mm$. Thus one accepts the value of the level set at the point of the bottom considered if and only if it is in the interval $[-0.03, 0.03]$.

4 Summary of the results

the position of crack $FISS2$ after the two steps of propagation coincides with that expected. That means that DEFI_FISS_XFEM makes it possible well to define a crack at the same time on the mesh and auxiliary grid. Moreover, information on the localization of the field and the use of auxiliary grid is well transferred by the operand FISS_GRILLE which was installation to allow the use of the grid for a crack defined on a mesh refined by Homard.