ZZZZ309 - Validation of the topological options ZONE_MAJ and TORUS in DEFI_GROUP

Summary:

The purpose of this data-processing test is the validation of the topological options ZONE_MAJ and TORUS available in DEFI_GROUP for a model containing one or more cracks X-FEM. These options make it possible to define groups of nodes around the bottom of the crack to facilitate postprocessing.

1 Problem of reference

1.1 Geometry

A cube of size is considered $10\times10\times10\,mm$ who presents a crack on one on his sides (figure 1.1-a).

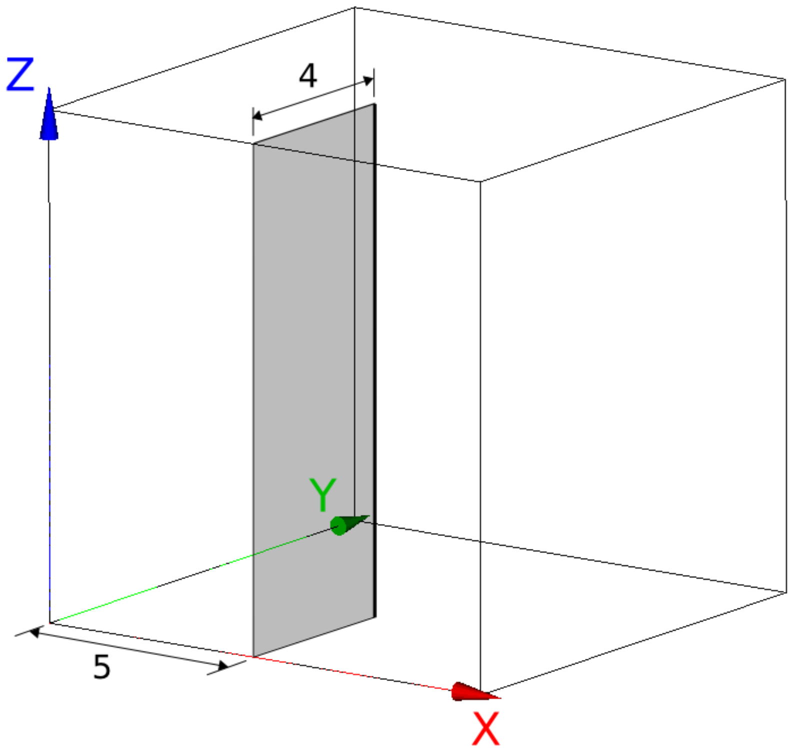

Figure 1.1-a: fissured geometry of the structure

1.2 Properties of material

One uses a material with the following elastic properties: $E=70000\ MPa$ and $\nu=0.34$.
These properties are used by `PROPA_FISS` for calculation amongst cycles of tiredness. However, the model finite elements is not solved and one does not need to calculate the number of cycles, which makes arbitrary the choice of the properties of material.

1.3 Boundary conditions and loadings

No boundary condition is defined because one does not solve the model finite elements: one will calculate a propagation in mode I existing crack with displacement imposed and constant along bottom. The crack remains plane during the propagation.

One imposes a projection equalizes with $\Delta a=1\,mm$. The bottom of the crack propagates while remaining always right.

1.4 Initial conditions

The initial crack is a half-plane. Its length is equal to $a_0=4\,mm$. The bottom of the crack is right.

2 Principle of the test

One must check that the groups of nodes defined by the options ZONE_MAJ and TORUS of DEFI_GROUP are correct (see U4.22.01 documentation for the description of these two options). To carry out this checking, one will build the group expected by the geometrical options available in DEFI_GROUP and one will compare his nodes with those contained in the group built by the option to check.

Indeed that is possible because the bottom of the crack is right and thus the locus of the nodes of the group created is always a cylinder built around the bottom which one knows a priori the ray. One can thus use CREA_GROUP_NO/OPTION=' ENV_CYLINDRE' of DEFI_GROUP to create the group of nodes contained in the cylinder.

To simplify the determination of the ray of the cylinder, the option is used RAYON_TORE in PROPA_FISS (see U4.82.11 documentation for the description of this option), which makes it possible to specify the ray of the zone of update. In the case of use of an auxiliary grid and checking of the group created by ZONE_MAJ on the grid of the structure (see modeling D), the ray of the cylinder is independent of that specified by the option RAYON_TORE while being coinciding with the ray of projection between auxiliary grid and grid of the structure. In this case its value is equal to the sum of the imposed projection ($1\,mm$) and of the ray of convergence specified by RAY in PROPA_FISS (see Doc. U4.82.11 for the description of this option).

In any case, the determination of the group of nodes expected must be made same manner as the algorithm used by PROPA_FISS (see R7.02.13 documentation). One must thus first of all determine the nodes contained in the cylinder. Then to select all the elements which contain at least one of these nodes in their definition. The group of nodes expected is that formed by the nodes of the elements thus selected.

In order to compare between them the lists of the nodes contained in each group (expected group and groups built by the option to check), one uses fields with the nodes. For each group, one builds a field with the nodes by affecting the value 1.0 with the nodes which are in the group and the value 0.0 with the other nodes. Then one calculates the difference node by node between the two fields and one obtains the field with the nodes difference. If the two groups are identical, the field difference contains only of the zeros, which can be tested by checking that the values maximum and minimal field are 0.0 .

3 Geometrical modeling a: method

3.1 Characteristics of modeling

An auxiliary grid is not used. One will test the option ZONE_MAJ. The ray of the cylinder ($4\,mm$) coincide with that of the torus imposed by RAYON_TORE in PROPA_FISS.

3.2 Characteristics of the grid

The grid is composed by 1000 elements of the type HEXA8. The length of the edges of the elements of the grid is $1\,mm$.

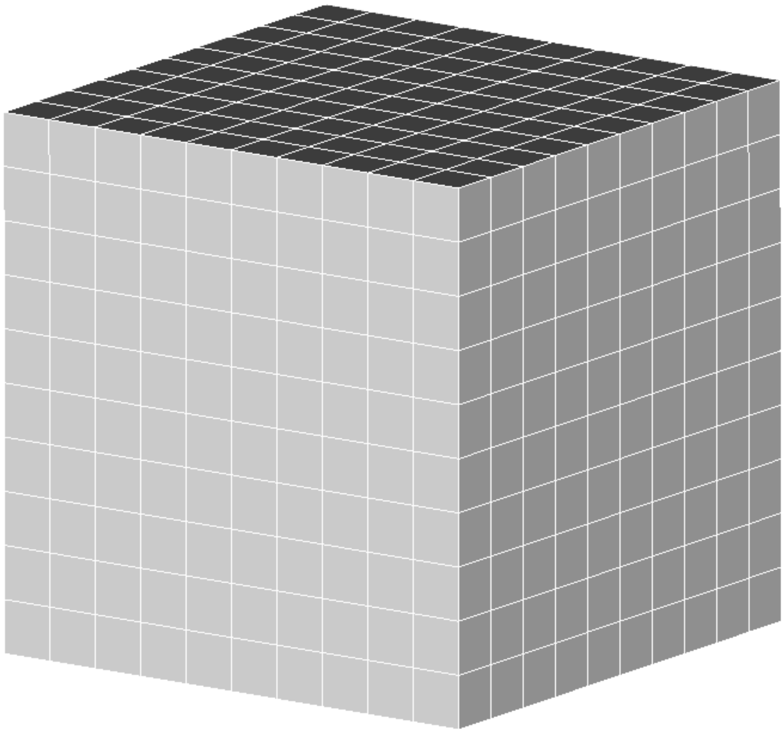

Figure 3.2-a: grid of the solid of figure 1.1-a

3.3 Sizes tested and results

One tests that the values maximum and minimal field difference are equal to zero.
The option ZONE_MAJ thus calculate correctly the group of nodes where the level-sets of the crack were put up to date.

4 Geometrical modeling b: method

4.1 Characteristics of modeling

An auxiliary grid is not used. One will test the option TORUS. The ray of the cylinder ($4\ mm$) coincide with that of the torus.

4.2 Characteristics of the grid

One uses the same grid as that of modeling A.

4.3 Sizes tested and results

One tests that the values maximum and minimal field difference are equal to zero.
The option TORUS thus calculate correctly the group of nodes which belongs to the torus of ray given built around the bottom of the crack.

5 Modeling C: geometrical method

5.1 Characteristics of modeling

An auxiliary grid is used. One will test the option ZONE_MAJ on the auxiliary grid. The ray of the cylinder ($4\,mm$) defined on the auxiliary grid coincides with that of the torus imposed by RAYON_TORE in PROPA_FISS.

5.2 Characteristics of the grid

The same grid is used as that used for modeling A. This grid is also used to define the auxiliary grid.

5.3 Sizes tested and results

One tests that the values maximum and minimal field difference are equal to zero.
The option ZONE_MAJ thus calculate correctly the group of nodes on the auxiliary grid where the level sets of the crack were put up to date.

6 Modeling D: geometrical method

6.1 Characteristics of modeling

An auxiliary grid is used. One will test the option ZONE_MAJ on the grid of the structure. The ray of the cylinder ($2\,mm$) defined on the grid of the structure coincides with the ray of projection of the level-sets between the grid and the grid. This ray is the sum of the imposed projection ($1\,mm$) and of the ray of convergence ($1\,mm$) imposed by RAY in PROPA_FISS.

6.2 Characteristics of the grid

The same grid is used as that used for modeling A. This grid is also used to define the auxiliary grid.

6.3 Sizes tested and results

One tests that the values maximum and minimal field difference are equal to zero.
The option ZONE_MAJ thus calculate correctly the group of nodes of the structure where the level-sets of the crack were put up to date by projection of the values of the auxiliary grid.

7 Modeling E: method SIMPLEX

7.1 Characteristics of modeling

An auxiliary grid is not used. One will test the option ZONE_MAJ. The ray of the cylinder ($4\,mm$) coincide with that of the torus imposed by RAYON_TORE in PROPA_FISS.

7.2 Characteristics of the grid

The grid is composed by 1000 elements of the type HEXA8. The length of the edges of the elements of the grid is $1\,mm$.

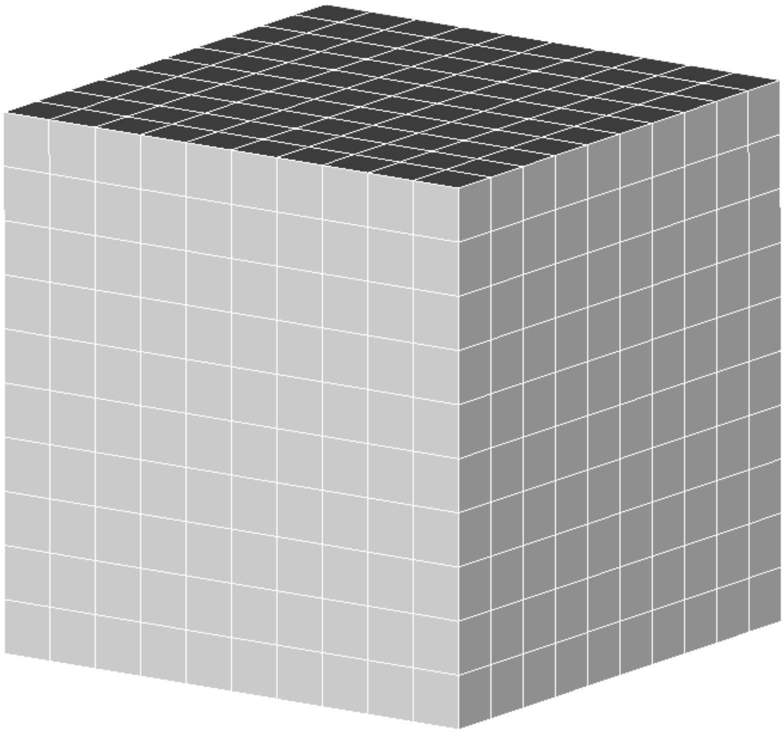

Figure 7.2-a: grid of the solid of figure 1.1-a

7.3 Sizes tested and results

One tests that the values maximum and minimal field difference are equal to zero.
The option ZONE_MAJ thus calculate correctly the group of nodes where the level-sets of the crack were put up to date.

8 Modeling F: method SIMPLEX

8.1 Characteristics of modeling

An auxiliary grid is not used. One will test the option TORUS. The ray of the cylinder ($4\,mm$) coincide with that of the torus.

8.2 Characteristics of the grid

One uses the same grid as that of modeling A.

8.3 Sizes tested and results

One tests that the values maximum and minimal field difference are equal to zero.
The option TORUS thus calculate correctly the group of nodes which belongs to the torus of ray given built around the bottom of the crack.

9 Summary of the results

It was checked that the options ZONE_MAJ and TORUS of DEFI_GROUP determine correctly the nodes where the level-set were put up to date by PROPA_FISS at the same time on the grid of the structure and the auxiliary grid.