ZZZZ309 - Validation of topological options ZONE_MAJ and TORE in DEFI_GROUP

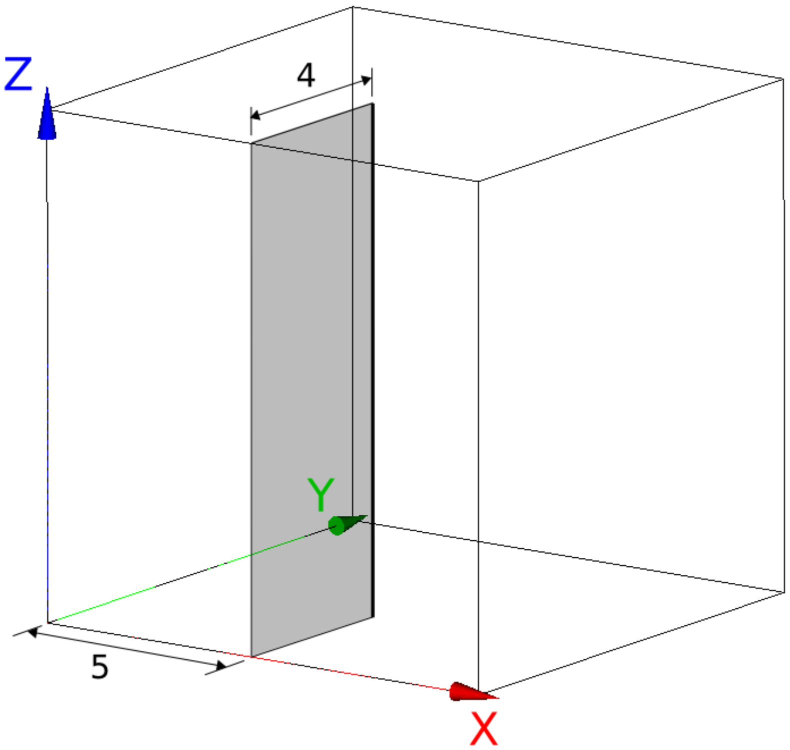
Summarized:

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

1 Problem of reference

1.1 Geometry

One considers a cube of size $10\times10\times10\,mm$ which presents a crack on one on its sides (figure 1.1-a).



Appear 1.1-a: fissured geometry of the structure

1.2 Properties of the 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 computation amongst cycles of fatigue. However, one the model does not solve finite elements and one does not need to calculate the number of cycles, which makes arbitrary the choice of the properties of the material.

1.3 Boundary conditions and loadings

No boundary condition is defined because finite elements the model are not solved: one will calculate a propagation in mode I of 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 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 crack is right.

2 Principle of the test

One must check that the nodes groups defined by options ZONE_MAJ and TORE 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 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 radius. One can thus use CREA_GROUP_NO/OPTION=' ENV_CYLINDRE' of DEFI_GROUP to create the nodes group contained in the cylinder.

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

In any case, the determination of the expected nodes group must be made same way 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 expected nodes group 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), fields at nodes are used. For each group, one builds a field at nodes by assigning the value 1.0 to 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 at 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 .

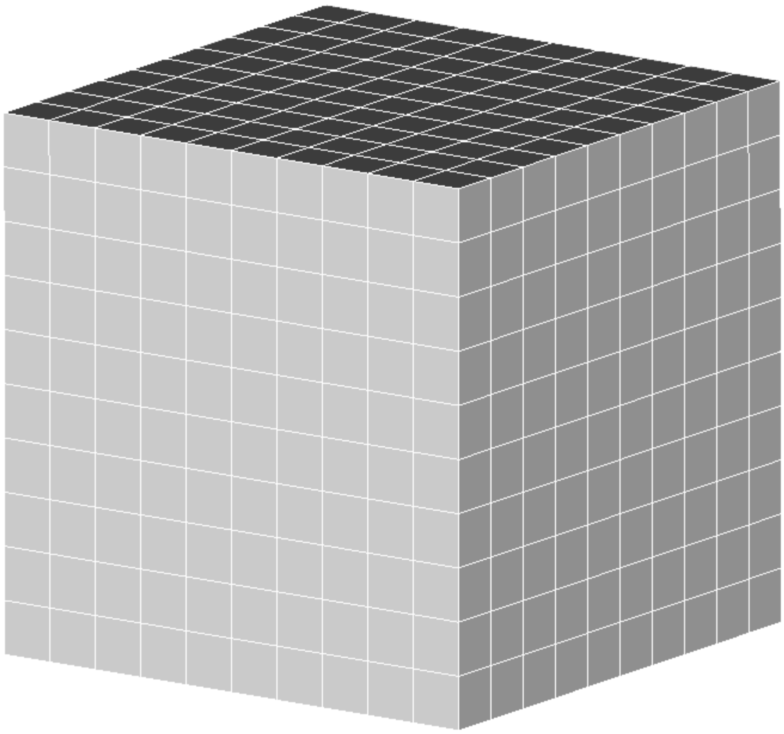
3 Modelization A

3.1 Characteristic of the modelization

One does not use one auxiliary grid. One will test option ZONE_MAJ. The radius of the cylinder ($4\,mm$) coincides with that of the torus imposed by RAYON_TORE in PROPA_FISS.

3.2 Characteristics of the mesh

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



Appear 3.2-a: mesh of solid of figure 1.1-a

3.3 Quantities tested and results

One tests that the values maximum and minimal field difference are equal to zero.
Option ZONE_MAJ thus calculates correctly the nodes group where the level-sets of crack were updated.

4 Modelization B

4.1 Characteristic of the modelization

One does not use one auxiliary grid. One will test option TORE. The radius of the cylinder ($4\,mm$) coincides with that of the torus.

4.2 Characteristics of the mesh

One uses the same mesh as that of modelization A.

4.3 Grandeurs tested and results

One tests that the values maximum and minimal field difference are equal to zero.
Option TORE thus calculates correctly the nodes group which belongs to the torus of radius given built around the bottom of crack.

5 Modelization C

5.1 Characteristic of the modelization

One uses one auxiliary grid. One will test option ZONE_MAJ on auxiliary grid. The radius of the cylinder ($4\,mm$) definite on auxiliary grid coincides with that of the torus imposed by RAYON_TORE in PROPA_FISS.

5.2 Characteristics of the mesh

the same mesh is used as that used for modelization A. This mesh is also used to define auxiliary grid.

5.3 Quantities tested and results

One tests that the values maximum and minimal field difference are equal to zero.
Option ZONE_MAJ thus calculates correctly the nodes group on auxiliary grid where the level sets of crack were updated.

6 Modelization D

6.1 Characteristic of the modelization

One uses one auxiliary grid. One will test option ZONE_MAJ on the mesh of structure. The radius of the cylinder ($2\,mm$) definite on the mesh of structure coincides with the radius of projection of the level-sets between the grid and the mesh. This radius is the sum of the imposed projection ($1\,mm$) and the radius of convergence ($1\,mm$) imposed by RADIUS in PROPA_FISS.

6.2 Characteristics of the mesh

the same mesh is used as that used for modelization A. This mesh is also used to define auxiliary grid.

6.3 Quantities tested and results

One tests that the values maximum and minimal field difference are equal to zero.
Option ZONE_MAJ thus calculates correctly the nodes group of structure where the level-sets of crack were updated by projection of the values of auxiliary grid.

7 Summary of the results

One checked that options ZONE_MAJ and TORE of DEFI_GROUP correctly determine the nodes where the level-set were updated by PROPA_FISS at the same time on the mesh of structure and auxiliary grid.