SSLV320 - Propagation planes of a crack 3D dividing and amalgamating with X-FEM

Summary:

The objective of this test is to check that the various methods of propagation of crack available in PROPA_FISS correctly manage a bottom of crack 3D which is divided into several funds and several funds which amalgamate in only one bottom during the propagation. Moreover, this test gives an example of use of the refinement of grid (Lobster) with the operator PROPA_FISS.

1 Problem of reference

1.1 Geometry

A parallelepiped of size is considered $30 \times 30 \times 10\,mm$ who presents three holes and a crack on one on his sides (figure 1.1-a).

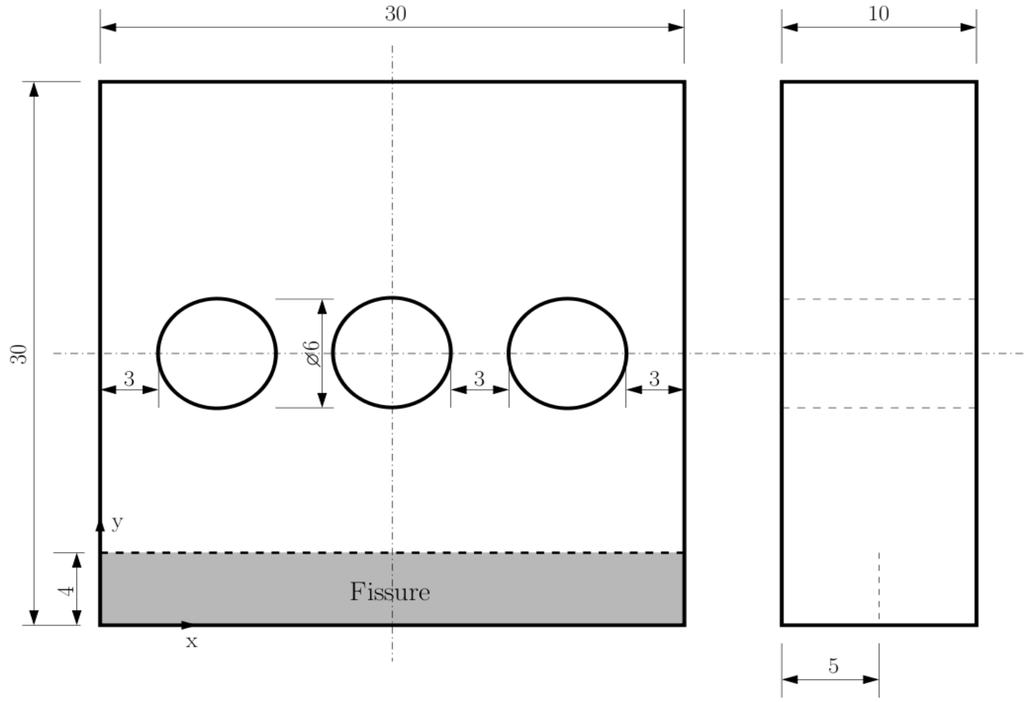

Figure 1.1-a: geometry of the structure considered

1.2 Properties of material

No material is defined because one does not solve the model finite elements.

1.3 Boundary conditions and loadings

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

On each step of propagation, one imposes a projection equalizes with $\Delta a = 12\,mm$. The bottom of the crack is propagated 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 Reference solution

2.1 Method of calculating

To each step of propagation one will calculate the two following sizes:
- the number of pieces which compose the bottom of the crack,
- the position of the crack.

Since the projection of the crack is identical for all the points of the bottom of crack, one can calculate with the hand the expected value of these sizes (figure 2.1-a).

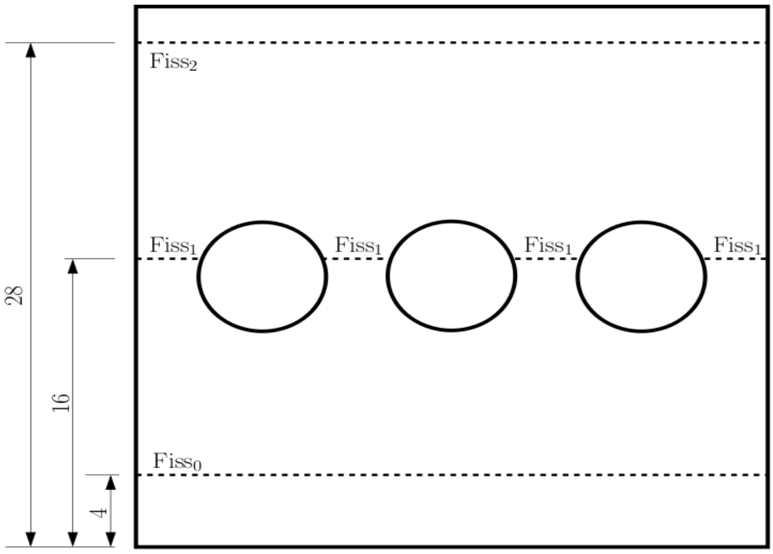

Figure 2.1-a: position of the bottom of the crack after each step of propagation. The pieces which compose each bottom are also visible.

2.2 Sizes and results of reference

The number of pieces which compose each bottom of crack is the following (figure 2.1-a):

Pas de propagation	Crack	Many pieces
0	$FISS_0$	1
1	$FISS_1$	4
2	$FISS_2$	1

The position of the crack to each step of propagation is the following one (figure 2.1-a):

Pas de propagation	Crack	Length
0	$FISS_0$	4.0
1	$FISS_1$	16.0

2	$FISS_2$	28.0

3 Modeling A

3.1 Characteristics of modeling

One uses **geometrical method** of the operator PROPA_FISS to propagate the crack. Propagation (put up to date of the level sets) is calculated directly on the grid of the structure, i.e. no auxiliary grid is used.

3.2 Characteristics of the grid

The grid is composed of 19464 elements of the type TETRA4. The average length of the edges of the elements of the grid is of $1.5\,mm$.

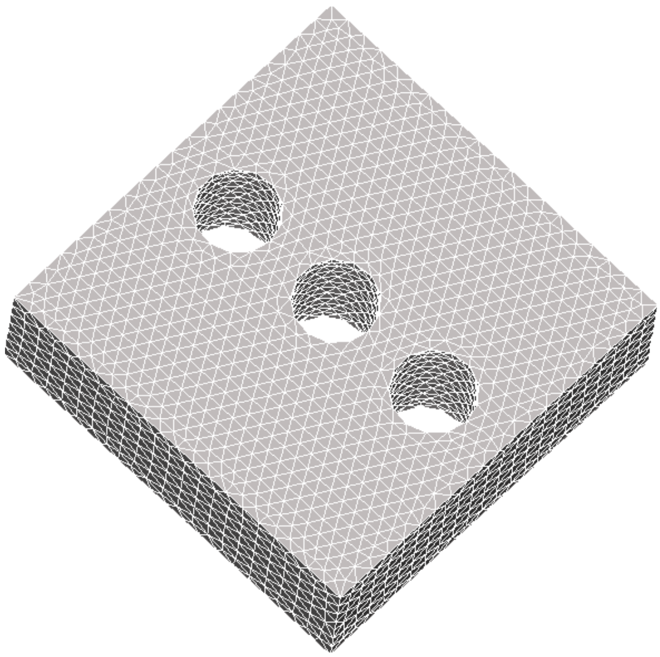

Figure 3.2-a: grid of the solid of figure 1.1-a

3.3 Sizes tested and results

One first of all tests the number of pieces which compose the bottom of the crack to each step of propagation:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	4
2	'ANALYTICAL'	1

One tests also the position of the bottom of the crack to each step of propagation, which is feasible by checking the maximum value of the coordinate there points of the bottom:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	16.0
2	'ANALYTICAL'	28.0

4 Modeling B

4.1 Characteristics of modeling

One uses **method simplex** of the operator PROPA_FISS to propagate the crack. Propagation (put up to date of the level sets) is calculated directly on the grid of the structure, i.e. no auxiliary grid is used.

4.2 Characteristics of the grid

The grid is the same one as that of modeling A.

4.3 Sizes tested and results

One first of all tests the number of pieces which compose the bottom of the crack to each step of propagation:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	4
2	'ANALYTICAL'	1

One tests also the position of the bottom of the crack to each step of propagation, which is feasible by checking the maximum value of the coordinate there points of the bottom:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	16.0
2	'ANALYTICAL'	28.0

5 Modeling C

5.1 Characteristics of modeling

One uses **method upwind** of the operator PROPA_FISS to propagate the crack. An auxiliary grid is used.

5.2 Characteristics of the grid

The grid is the same one as that of modeling A.
The auxiliary grid is made up of 2800 elements of the type HEXA8 of size $1.5\times1.5\times2\,mm$. The grid extends inside the holes.

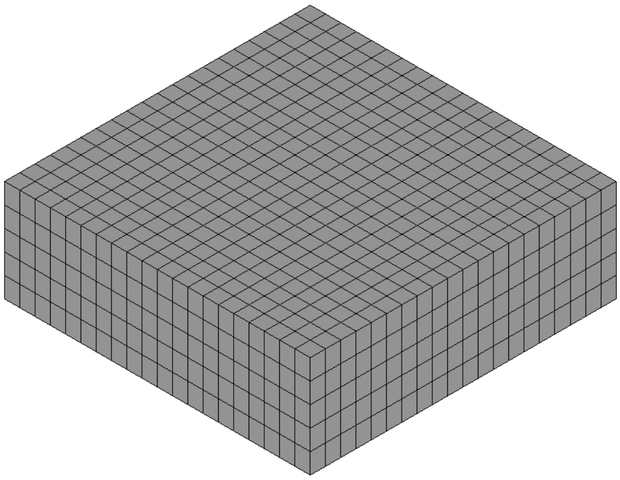

Figure 5.2-a: auxiliary grid used for the update of the level sets of the crack

5.3 Sizes tested and results

One first of all tests the number of pieces which compose the bottom of the crack to each step of propagation:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	4
2	'ANALYTICAL'	1

One tests also the position of the bottom of the crack to each step of propagation, which is feasible by checking the maximum value of the coordinate there points of the bottom:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	16.0
2	'ANALYTICAL'	28.0

6 Modeling D

6.1 Characteristics of modeling

One uses **method grid** of the operator PROPA_FISS to propagate the crack.

6.2 Characteristics of the grid

The grid is the same one as that of modeling A.

6.3 Sizes tested and results

One first of all tests the number of pieces which compose the bottom of the crack to each step of propagation:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	4
2	'ANALYTICAL'	1

One tests also the position of the bottom of the crack to each step of propagation, which is feasible by checking the maximum value of the coordinate there points of the bottom:

Pas de propagation	Type of reference	Value of reference
1	'ANALYTICAL'	16.0
2	'ANALYTICAL'	28.0

7 Summary of the results

Various methods available in PROPA_FISS manage well to calculate at the same time the number of pieces and the position of each bottom of crack. That shows that one can simulate well during the propagation the separation of a bottom in several funds and the fusion of several funds in a single bottom.