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

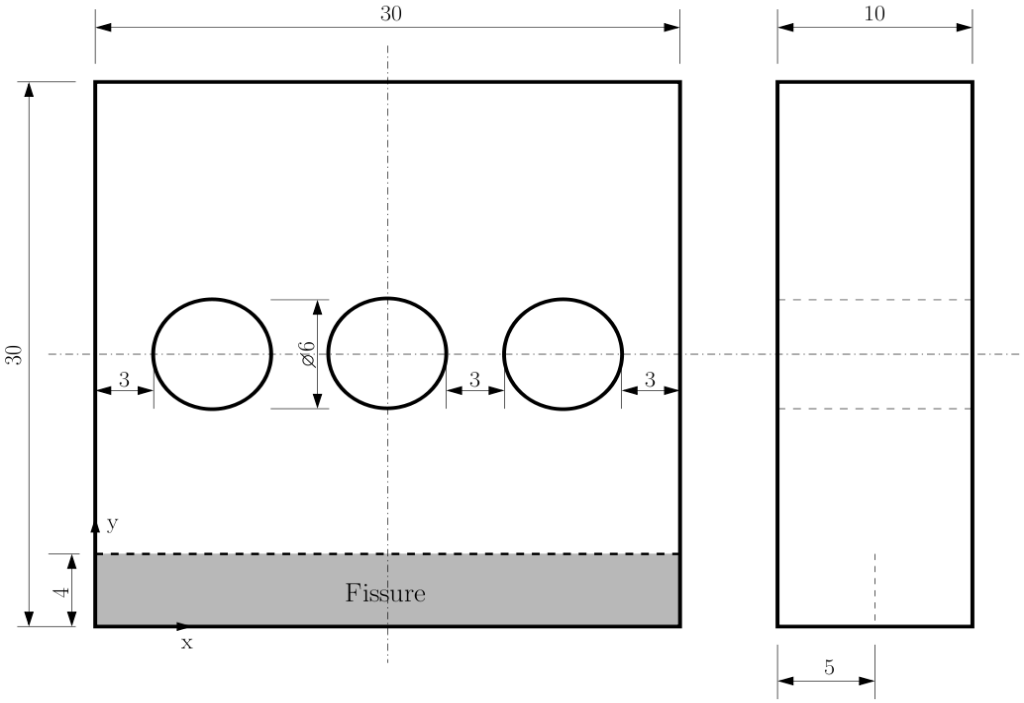
Summarized:

The purpose of this test is to check that the various methods of crack propagation available in PROPA_FISS correctly manage a crack tip 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 mesh (Homard) with operator PROPA_FISS.

1 Problem of reference

1.1 Geometry

One considers a parallelepiped of size $30\times30\times10\,mm$ which introduces three holes and a crack on one on its sides (figure 1.1-a).



Appear 1.1-a: geometry of structure considered

1.2 Properties of the material

No material is defined because finite elements the model are not solved.

1.3 Boundary conditions and loadings

No boundary condition is defined because finite elements the model are not solved: one I will calculate two propagations in mode of 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 crack is propagated while remaining always right.

1.4 Initial conditions

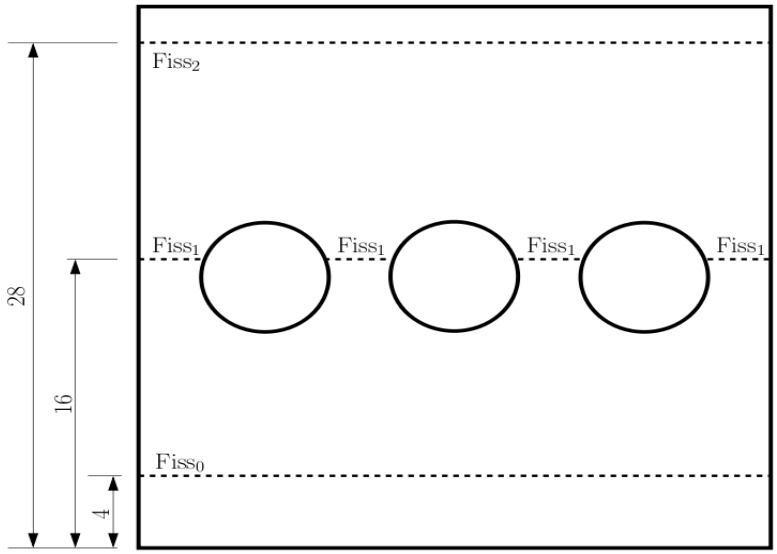
The initial crack is a half-plane. Its length is equal to $a_0=4\,mm$. The bottom of crack is right.

2 Reference solution

2.1 Method of calculating

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

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



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

2.2 Quantities and results of reference

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

No the propagation	Fissures	Many pieces
0	$FISS_0$	1
1	$FISS_1$	4
2	$FISS_2$	1

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

No the propagation	Fissures	Length
0	$FISS_0$	4.0
1	$FISS_1$	formula

2	$FISS_2$	formula

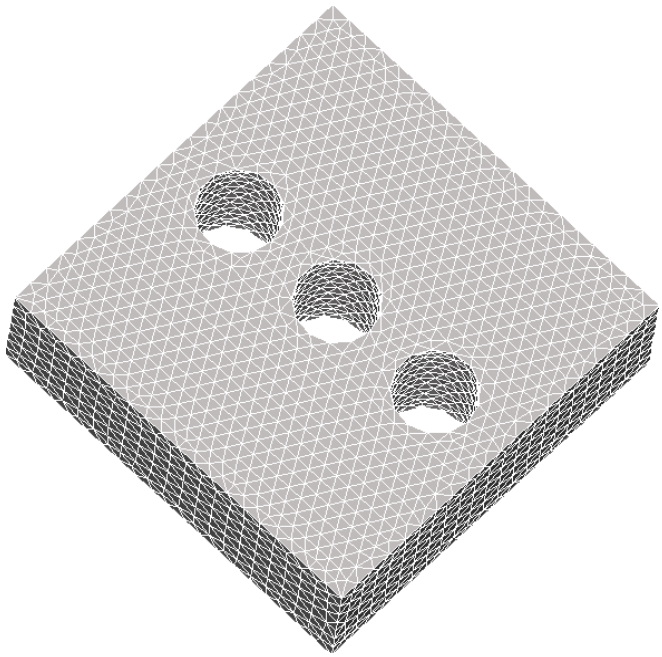
3 28.0 Modelization

3.1 Characteristic of the modelization

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

3.2 Characteristics of the mesh

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



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

3.3 Quantities tested and results

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	4
2	"ANALYTIQUE"	1

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

No the Standard	propagation of reference	Value of reference

1	"ANALYTIQUE"	16.0
2	"ANALYTIQUE"	28.0

4 Modelization B

4.1 Characteristic of the modelization

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

4.2 Characteristics of the mesh

The mesh is the same one as that of modelization A.

4.3 Grandeurs tested and results

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	4
2	"ANALYTIQUE"	1

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	16.0
2	"ANALYTIQUE"	28.0

5 Modelization C

5.1 Characteristic of the modelization

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

5.2 Characteristics of the mesh

The mesh is the same one as that of modelization A.
auxiliary grid is made up of 2800 elements of the type HEXA8 of size $1.5 \times 1.5 \times 2\, mm$. The grid extends inside holes.

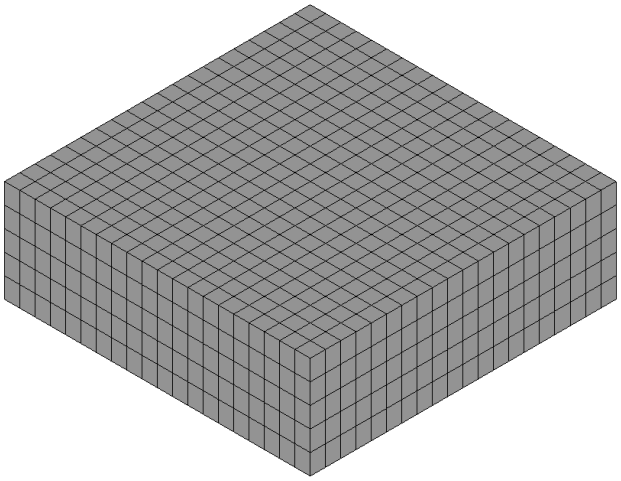


Figure 5.2-a : 5.2-a auxiliary grid used for the update of the level sets of the crack

5.3 Quantities tested and results

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	4
2	"ANALYTIQUE"	1

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	16.0
2	"ANALYTIQUE"	28.0

6 Modelization D

6.1 Characteristic of the modelization

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

6.2 Characteristics of the mesh

The mesh is the same one as that of modelization A.

6.3 Grandeurs tested and results

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	4
2	"ANALYTIQUE"	1

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

No the Standard	propagation of reference	Value of reference
1	"ANALYTIQUE"	16.0
2	"ANALYTIQUE"	28.0

7 Summary of the results

the four methods available in PROPA_FISS arrives well at calculating at the same time the number of pieces and the position of each crack tip. 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.