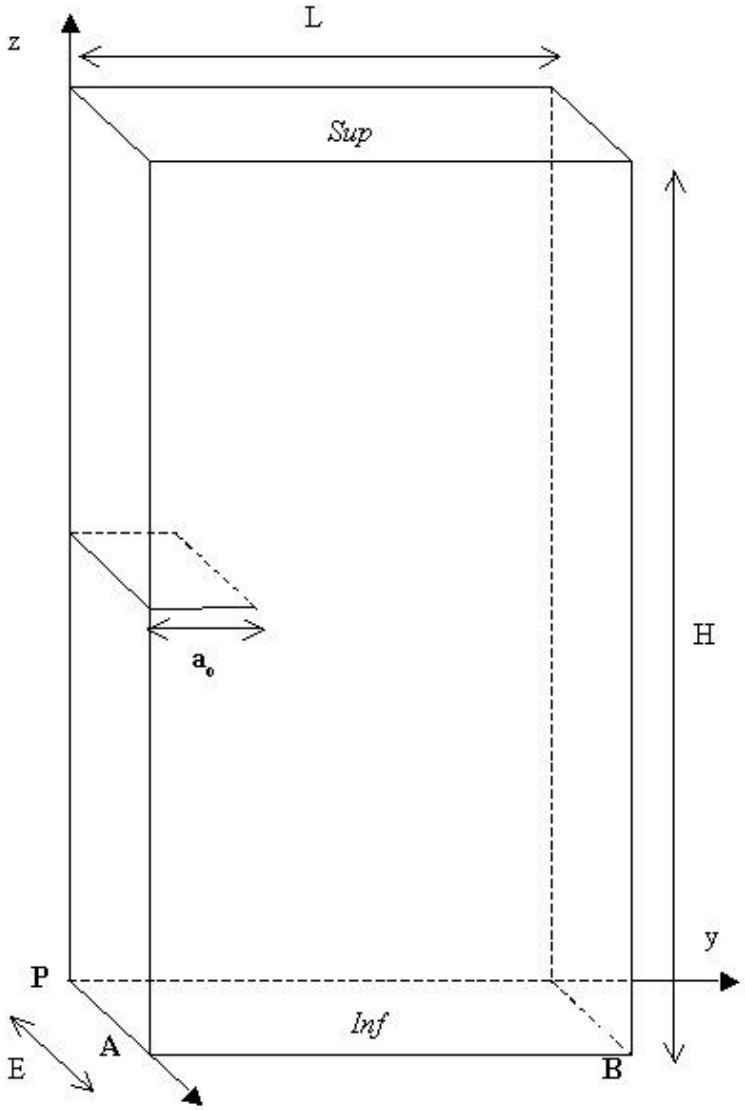
SSLV314 – Propagation planes of a crack emerging with X-FEM

Summarized:

The goal of this test is to compare the methods of propagation simplex, geometrical mesh, upwind and of operator PROPA_FISS for a crack $3D$ requested in pure I mode.

1 Problem of reference

1.1 Geometry



Appears 1.1-a: geometry of the fissured plate

geometrical Dimensions of the fissured plate:

width	$L=8\,m$
thickness	$E=1\,m$
height	$H=18\,m$

the crack is horizontal, the front being initially positioned in $(x,2,9)$.

1.2 Properties of the material

Young's modulus $E=205000\,MPa$
Poisson's ratio $\nu=0.3$

1.3 Boundary conditions and loadings

- Boundary conditions:
  Point: $P \quad \Delta X=\Delta Y=\Delta Z=0$
  Points on the segment AB : $\Delta X=\Delta Z=0$
  Points on surface INF : $\Delta Z=0$

- Loading:
  Pressure on surface SUP : $P=-1\,MPa$

2 Reference solution

the results of the modelization B (method Mesh) are taken as reference.
For the modelization B and C, one checks non regression code compared to the position of the crack tip.
For the modelizations A, D and E, one checks that the nodes closest to the trace of the crack tip on the plane $(1,y,z)$ at the last time of propagation have their level-sets very close to zero.

Time of propagation	Node	Coordinated y_i	Coordinated z_i
3	*N926*	2.33	8.80
	N1028	2.33	9.00
	N1130	2.33	9.20

These nodes are those included in a radius of capture being worth the backbone of an element, centered on the trail of crack tip on the plane $(1,y,z)$.

One B identifies these nodes in the .mess of the modelization and one estimates the value of their level-sets in the modelizations A, D and E.

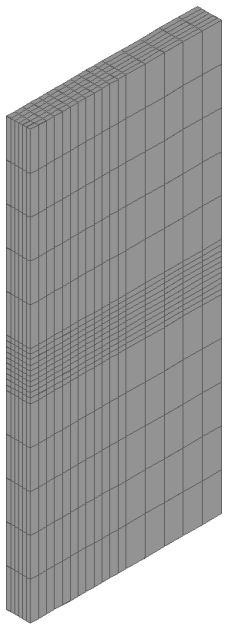
3 Modelization A

3.1 Characteristic of the modelization

the method **simplex** is used by PROPA_FISS.

3.2 Characteristics of the mesh

the structure is modelled by a mesh made up of 2040 elements HEXA8 (see Appear 3.2-a).



Appear 3.2-a: mesh of structure

The mesh is very coarse to reduce the computing time. Elements a little smaller are used in the zone of propagation of crack. The dimension of the elements is $0.17\times 0.33\times 0.2 m$ in this zone. The largest element used has a dimension equalizes with $0.17\times 0.8\times 1.6 m$.

3.3 Quantities tested and results

One extracts the level set norm (LSN) and tangent (LST) by means of operator POST_RELEVE_T and one checks that the values maximum and minimal remain understood in the radius of capture of the nodes tested around the crack front, that is to say 1/3:

$Propag. i$	$Max\ LSN_i$	$Min\ LSN_i$	$Max\ LST_i$	$Min\ LST_i$
the 3.0.2.0.2			0.267	0.267

got results show well that the level-sets remain lower than the radius in which the crack front was localised. That means that the crack tip was correctly located by the method simplex.

4 Modelization B

4.1 Characteristic of the modelization

the method MAILLAGE is used by PROPA_FISS.
Option CALC_K_G is used by CALC_G to estimate the stress intensity factors.

4.2 Characteristics of the mesh

One uses the same mesh as for modelization A.

4.3 Grandeurs tested and results

One tests, into non regression with a tolerance of 0.1%, the position of the crack tip to the last iteration of propagation by raising the extrema of the Y-coordinates of the points which compose it.

Time of propagation	$Max\ Coord\ y_i$	$Min\ Coord\ y_i$
3.2.6		2.57

5 Modelization C

5.1 Characteristic of the modelization

the method MAILLAGE is used by PROPA_FISS.
Operator POST_K1_K2_K3 is used to estimate the stress intensity factors.

5.2 Characteristics of the mesh

One uses the same mesh as for modelization A.

5.3 Grandeurs tested and results

One tests, into non regression with a tolerance of 0.1%, the position of the crack tip to the last iteration of propagation by raising the extrema of the Y-coordinates of the points which compose it.

Time of propagation	$Max\ Coord\ y_i$	$Min\ Coord\ y_i$
3.2.6		2.592

6 Modelization D

6.1 Characteristic of the modelization

method UPWIND without auxiliary grid is used by PROPA_FISS.

6.2 Characteristics of the mesh

One uses the same mesh as that of modelization A.

6.3 Grandeurs tested and results

One extracts the level-set norm (LSN) and tangent (LST) by means of operator POST_RELEVE_T and one checks that the values maximum and minimal remain understood in the radius of capture of the nodes tested around the crack front, that is to say 1/3:

$Propag.i$	$Max\ LSN_i$	$Min\ LSN_i$	$Max\ LST_i$	$Min\ LST_i$
the 3.0.2.0.2			0.267	0.267

got results show well that the level-sets remain lower than the radius in which the crack front was localised. That means that the crack tip was correctly located by the method upwind.

7 Modelization E

7.1 Characteristic of the modelization

method GEOMETRIQUE is used by PROPA_FISS.

7.2 Characteristics of the mesh

One uses the same mesh as that of modelization A.

7.3 Grandeurs tested and results

One extracts the level-set norm (LSN) and tangent (LST) by means of operator POST_RELEVE_T and one checks that the values maximum and minimal remain understood in the radius of capture of the nodes tested around the crack front, that is to say 1/3:

$Propag.\ i$	$Max\ LSN_i$	$Min\ LSN_i$	$Max\ LST_i$	$Min\ LST_i$
the 3.0.2.0.2			0.267	0.267

got results show well that the level-sets remain lower than the radius in which the crack front was localised. That means that the crack tip was correctly located by the geometrical method.

8 Summary of the results

All the methods of propagation used (simplex, geometrical mesh, upwind and) of operator PROPA_FISS made it possible to calculate the position of a crack well propagating in pure I mode in a structure $3D$.