WTNV148 – Flow in an interface within a porous solid mass: use of method XFEM

Summary:

This test checks the opening of an interface Hydraulic XFEM cohesive S ous the action of the injection D 'one fluid. L E test comprises a two-dimensional modeling and a three-dimensional modeling.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

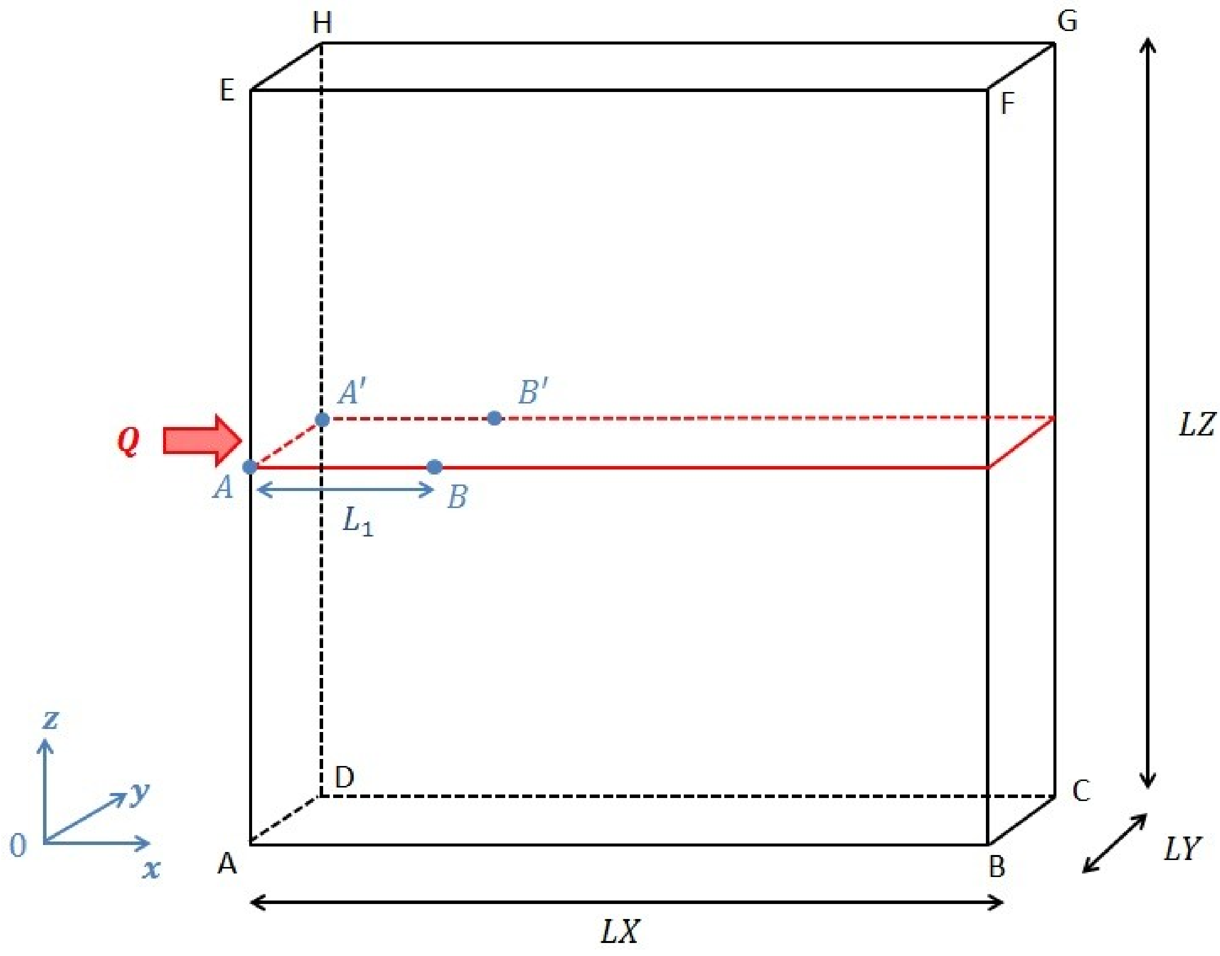
1 Problem of reference

1.1 Geometry of the problem

It is about a block height $LZ=10\,m$, length $LX=10\,m$ and of width $LY=2\,m$. CE block present one discontinuity of the type interfaces cohesive (interface nonwith a grid which is introduced into the model via the level-sets thanks to the operator DEFI_FISS_XFEM) . It is located by the level-set normal of equation $lsn=Z-5$ and entirely L crossesE block in the horizontal direction by dividing it into two identical under-blocks . Points $A(0,0,5)$, $A'(0,2,5)$, $B(3,0,5)$, and $B'(3,2,5)$ will be used for the imposition of the boundary conditions and the evaluation of the sizes tested.

One represents on the Figure 1.1-a geometry of the block.

Figure 1.1-a: Geometry of the problem



Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

1.2 Properties materials

Parameters given in the Table 1.2-1 , correspond to the parameters used for modeling in the hydro-mechanical coupled case. The mixing rate used is 'LIQU_SATU' . The type of cohesive model is 'STANDARD' and the cohesive law used is 'CZM_OUV_MIX'.

Liquid (water)	Viscosity $\mu_w(en\ Pa.s)$	10^{-3}
	Module of compressibility $\frac{1}{K_w}(en\ Pa^{-1})$	5.10^{-10}
	Density of the liquid $\rho_w(en\ kg/m^3)$	1
Elastic parameters	Young modulus $E(en\ MPa)$	5800
	Poisson's ratio ν	0.2
	Thermal dilation coefficient $\alpha(en\ K^{-1})$	0
Parameters of coupling	Coefficient of Biot b	1
	Initial homogenized density $r_0(en\ kg/m^3)$	2,5
	Intrinsic permeability $K^{int}(en\ m^2)$	10^{-18}
Parameters of the cohesive law	Critical stress $\sigma_c(en\ MPa)$	0.5
	Energy cohesive $G_c(en\ Pa.m)$	9000
	Coefficient of increase r	100

Table 1.2-1 : Properties of material

In addition the forces related to gravity (in the conservation equation of the momentum) are neglected. The pressure of pore of reference is taken worthless $p_1^{ref}=0\ MPa$ and the porosity of material is $\varphi=0,1$.

1.3 Boundary conditions and loadings

Conditions of Dirichlet that one applies are:

- following displacements x are blocked in on the edge left field,
- displacements according to y and z are blocked on Lbe edges inferior and superior of the field.

Also, one injects a flow of specific fluid $Q=0.025\ kg.m^{-1}.s^{-1}$ in L ' cohesive interface on the left edge of the field for one length of time $t=10\ s$.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

2 Sizes and results of reference

2.1 Sizes and results of reference

Under the action of the injection of fluid in the cohesive interface on the left edge of the field , L'cohesive interface opens and one hydraulic fracture develops. One tests the value of the pressure of fluid and the vertical opening on the level of the points A , A' , B and B' at the end of $t=10s$ of injection.

2.2 Uncertainty on the solution

One check the not-regression of the computation results.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

3 Modeling A

3.1 Characteristics of modeling

It is about a modeling D_PLAN_HM using quadratic elements HM-XFEM.

3.2 Characteristics of the grid

The block on which one carries out modeling is divided into 625 QUAD8.

3.3 Sizes tested and results

One tests the value of displacement vertical for the nodes A and B who are located on interface as well as the value of the pressure of the fluid in the interface in these 2 points. These values are summarized in the table below:

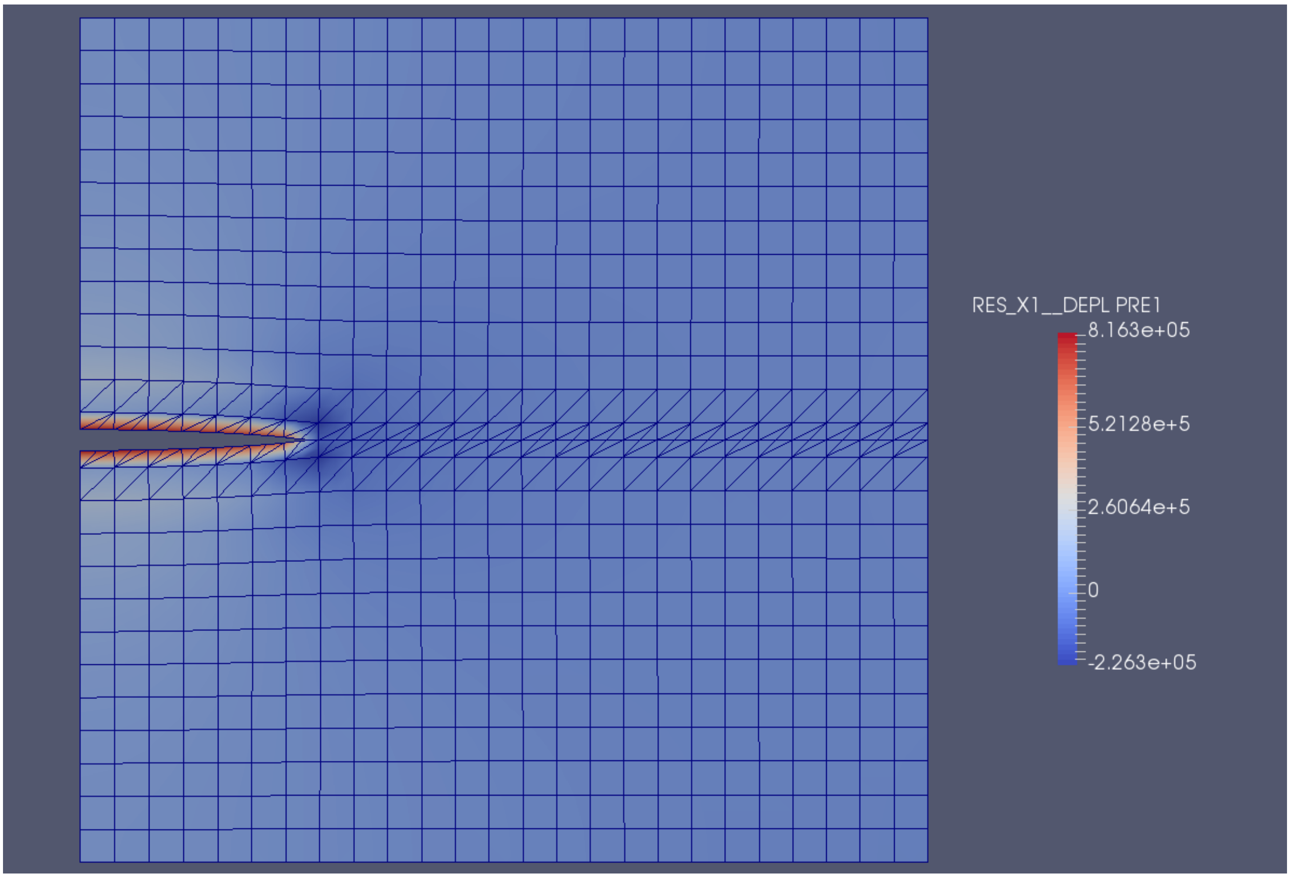
Sizes tested	Type of reference	Value of reference
DY (node With in lower part)	'NON_REGRESSION'	-8.731819099E5 m
DY (node With in top)	'NON_REGRESSION'	8.731819098.E5 m
DY (node B in lower part)	'NON_REGRESSION'	-4.62904976E5 m
DY (node B in top)	'NON_REGRESSION'	4.62904976E5 m
PRE_FL1 (node With)	'NON_REGRESSION'	816304 Pa
PRE_FL1 (node B)	'NON_REGRESSION'	712838 Pa

3.4 Remarks

There is also post-treaty the field of pressure of pore as well as the amplified deformation (X1000) (Figure 3.4-a) thanks to SALOMÉ.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

Figure 3.4-a: Field of preSSion of pore and amplified deformation (X1000)



Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

4 Modeling B

4.1 Characteristics of modeling

It is about a modeling `3D_HM` using quadratic elements HM-XFEM.

4.2 Characteristics of the grid

The block on which one carries out modeling is divided into 49 `QUAD8`.

4.3 Sizes tested and results

One tests the value of displacement vertical for the nodes A , A' , B and B' who are located on interface as well as the value of the pressure of the fluid in the interface in these 4 points. These values are summarized in the table below:

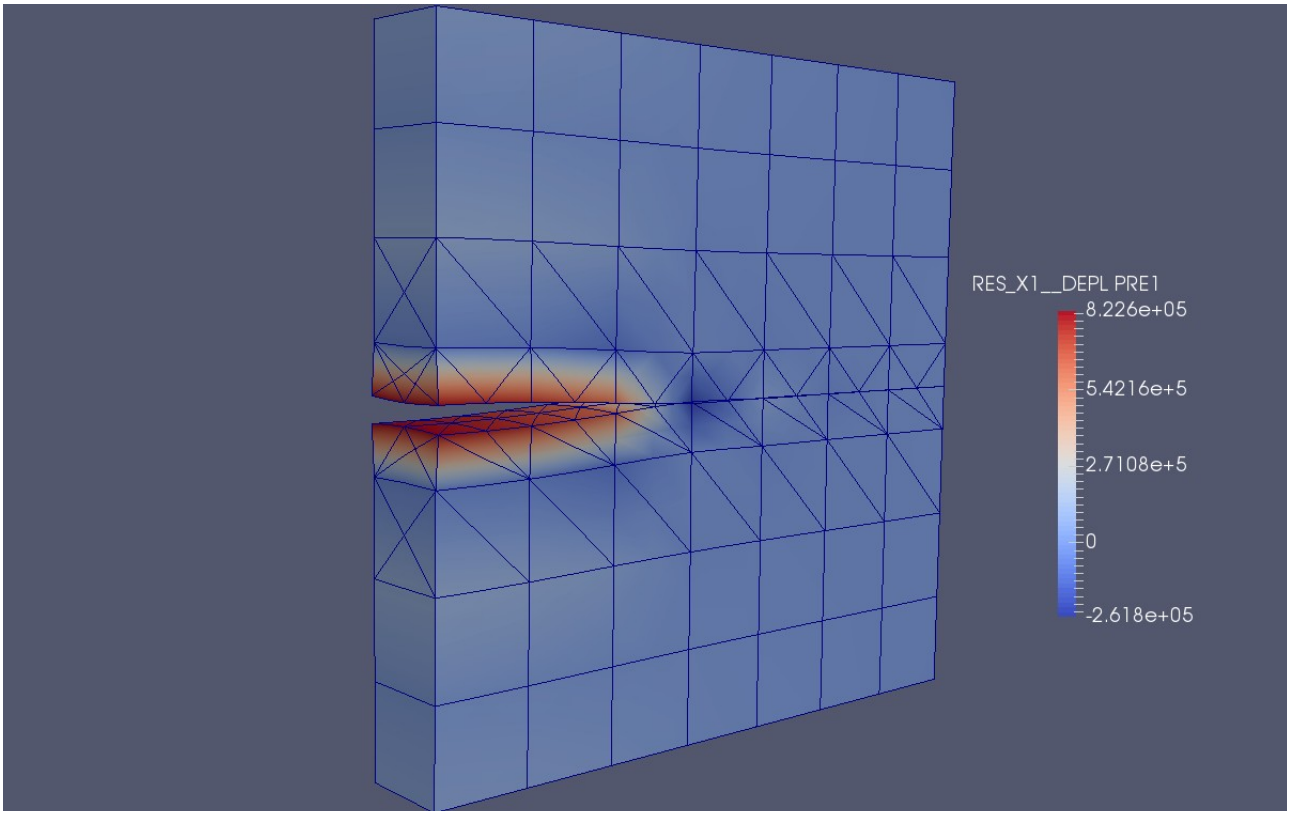
Sizes tested	Type of reference	Value of reference
DY (node With in lower part)	'NON_REGRESSION'	-1.291354325E4 m
DY (node With in top)	'NON_REGRESSION'	1.29078868E4 m
DY (node A' in lower part)	'NON_REGRESSION'	-1.290767537E4 m
DY (node A' in top)	'NON_REGRESSION'	1.291366642E4 m
DY (node B in lower part)	'NON_REGRESSION'	-1.08739681E4 m
DY (node B in top)	'NON_REGRESSION'	1.08687768E4 m
DY (node B' in lower part)	'NON_REGRESSION'	-1.08735144E4 m
DY (node B' in top)	'NON_REGRESSION'	1,E4 m
PRE_FL1 (node With)	'NON_REGRESSION'	822498 Pa
PRE_FL1 (node A')	'NON_REGRESSION'	822565 Pa
PRE_FL1 (node B)	'NON_REGRESSION'	762613 Pa
PRE_FL1 (node B')	'NON_REGRESSION'	762664 Pa

4.4 Remarks

There is also post-treaty the field of pressure of pore as well as the amplified deformation (X1000) (Figure 4.4-a) thanks to SALOMÉ.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

Figure 4.4-a: Field of preSSion of pore and amplified deformation (X1000)



Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

5 Conclusion

This test makes it possible to validate the operation of Interfaces cohesive hydraulicsS with elements HM-XFEM.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
Copyright 2019 EDF R&D - Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)