SSLV318 – Validation of the catalogue of tridimentionnelles cracks X-FEM

Summary:

The purpose of this document is to validate the definition of a three-dimensional crack X-FEM *via* catalogues of predefined forms.

1 Problems of reference

1.1 Geometry of the "right-angled" crack of form

One considers a cube of with dimensions of $1\,m$. This cube comprises a crack in the shape of rectangle with angles rounded. The crack is located in the plan of normal y halfway between the front and back face of the cube (see Figure 1.1-1). The crack is in fact a half-rectangle. The complete rectangle has as a length $2a$ and for width $2b$. Moreover, the corners of the rectangle are rounded, with a ray r. The center of the complete rectangle is thus the point of coordinates $(0,5\,;0,5\,;1)$. The center of the reference mark is the point $P4$. In the continuation, one will take $a=0,3$, $b=0,15$ and $r=0,05$.

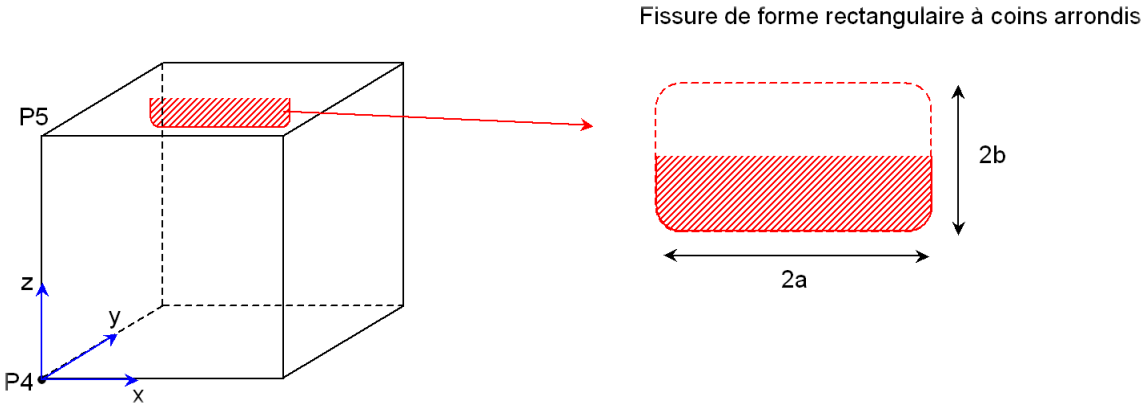

Figure 1.1-1: diagram of the cube fissured by the "right-angled" crack of form

1.2 Geometry of the crack of form "rolls"

One considers the same cube as previously, but comprising a crack in the shape of cylinder. The axis of the cylinder is parallel to the axis y and passes by the point C coordinates $(1\,;0,5\,;1)$. The ray of the cylinder is $r=0,5$. The face of crack is thus a quadrant. The lips of the crack are located in the half space $y\leq 0,5$ (see Figure 1.2-1).

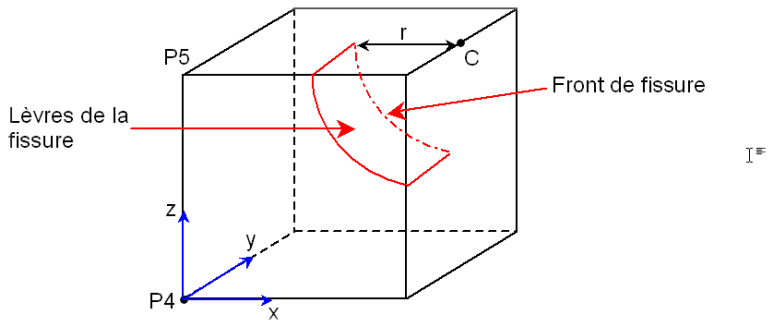

Figure 1.2-1: diagram of the cube fissured by the crack of form "rolls"

2 Reference solution

2.1 “Right-angled” crack of form

The goal of this test is to validate the definition of this crack by the calculation of the level sets associated. The test relates in fact only to the value of lst at the points $P4$ and $P5$. A fast calculation gives $lst(P4)=\sqrt{((\frac{1}{2}-(a-r))^{2}+(1-(b-r))^{2})}-r$ and $lst(P5)=0,2$.

2.2 Crack of form “rolls”

The goal of this test is to validate the definition of this crack by the calculation of the level sets associated. The test relates to the values of lsn and lst at the points $P4$ and $P5$. A fast calculation gives:
$lsn(P4)=\sqrt{2}-r$ and $lst(P5)=1-r$,
$lst(P4)=-0,5$ and $lst(P5)=-0,5$.

3 Modeling a: fissures of “right-angled” form

This modeling tests the “right-angled” crack of form.

3.1 Characteristics of the grid

The initial grid is healthy: it is discretized in $40\times5\times40$ HEXA8.

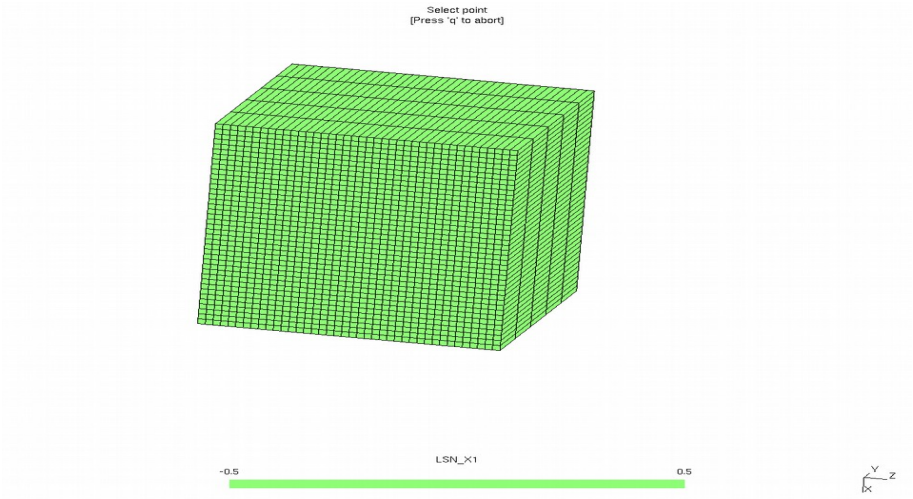

Figure 3.1-1: initial healthy grid

3.2 Sizes tested and results

The test relates to the value of lst at the points $P4$ and $P5$.

Identification	Type of reference	Value of reference	Tolerance
$lst(P4)$	'ANALYTICAL'	0,884077	10^{-12}
$lst(P5)$	'ANALYTICAL'	0,2	10^{-12}

4 Modeling b: fissures of form “rolls”

This modeling tests the crack of form “rolls”.

4.1 Characteristics of the grid

The grid is identical to that of modeling A

4.2 Sizes tested and results

The test relates to the value of lsn and lst at the points $P4$ and $P5$.

Identification	Type of reference	Value of reference	Tolerance
$lsn(P4)$	'ANALYTICAL'	0,914214	10^{-12}
$lsn(P5)$	'ANALYTICAL'	0,5	10^{-12}
$lst(P4)$	'ANALYTICAL'	-0,5	10^{-12}
$lst(P5)$	'ANALYTICAL'	-0,5	10^{-12}

5 Summary of the results

This test makes it possible to validate the definition of a three-dimensional crack X-FEM of following form:

– rectangular with corners rounded,
– cylinder.