SSLP322 - the purpose of Propagation of a crack X-FEM in a flexbeam 3 points with 3 holes

Summarized

This test is validating the way of crack propagation with X-FEM in 2D, in the frame of linear elasticity.

This test brings into play a rectangular plate comprising three holes with a crack emerging, and subjected to a bending 3 points.

A modelization is considered:
- modelization A : method mesh

the values given by the method mesh constitute the values of reference (tests of non regression).

1 Problem of reference

1.1 Geometry

the geometry, dimensions and the materials are taken identical to those of Bittencourt and el. **[1]** and Ventura and al. **[2]**.
The structure $2D$ is a rectangular plate ($20\,mm\times 8\,mm$) with 3 holes, comprising an emerging crack (Figure 1.1-1). The length of initial crack is $a=1{,}5\,mm$.

The nodes noted $P1$, $P2$ and $P3$ on Figure 1.1-1 are used to impose the boundary conditions, which are clarified in the paragraph [§1.31.3].

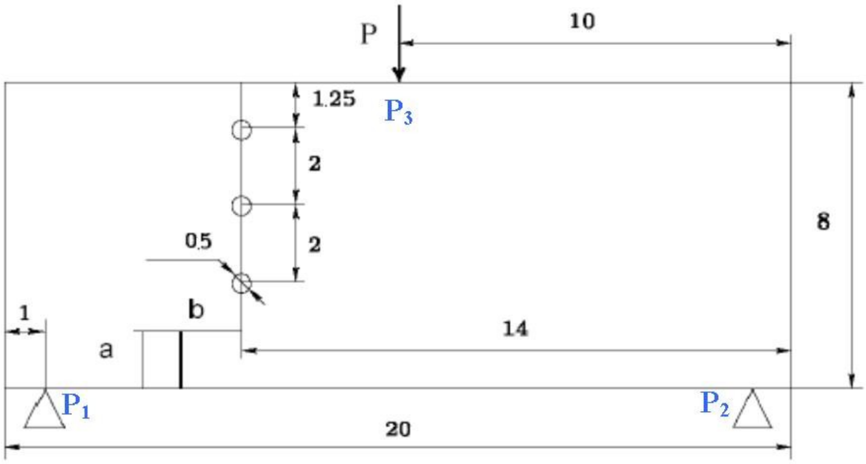

Figure 1.1-1: geometry of the fissured plate

1.2 Properties of the material

Modulus Young: $E=205\,000\,MPa$
Poisson's ratio: $\nu=0{,}3$

1.3 Boundary conditions and loadings

In order to block the rigid modes, one blocks displacements of the nodes $P1$ and $P2$ as follows:

- $DY^{P1}=DY^{P2}=0$;
- $DX^{P1}=0.$

In order to simulate the propagation in fatigue, one applies a unit nodal force in $P3$: $FY=-1$. A cycle of loading will correspond to: null loading → loading max→ null loading. 35 steps of propagation are simulated. With each step of propagation, the crack advances an imposed length being worth 0,1 Mr.

1.4 Solution

Taking into account the lack of accuracy of the diagrams of the article 3, one cannot deduce some from precise numerical values. One is satisfied to check that the ways of cracking have the same pace (see §2.34).
For the test, one A uses as reference the values of the stress intensity factors K_I K_{II} and calculated by the modelization at the end of the propagation:

$K_I^{ref}=1{,}142045\,MPa.mm^{0,5}$

$K_{II}^{ref}=-0{,}057097\,MPa.mm^{0,5}$

1.5 bibliographical References

[1] T.N. Bittencourt, P.A. Wawrzynek, A.R. Ingraffea, J.L. Sousa, Quasi-automatic simulation of ace propagation for 2D LEFM problems, Engineering Fractures Mechanics, vol. 55, pp. 321-334, 1996

[2] G. Ventura, J.X. Xu, T. Belytschko, A vector level set method and new discontinuity approximations for ace growth by EFG, *International Newspaper for Numerical Methods in Engineering* , vol. 54, pp. 923-944, 2002

2 Modelization a: Method mesh

In this modelization, the method `MAILLAGE` of operator `PROPA_FISS` is used for the crack propagation.

2.1 Characteristics of the mesh

the structure is modelled by 7551 `TRIA3`. The crack is not with a grid.

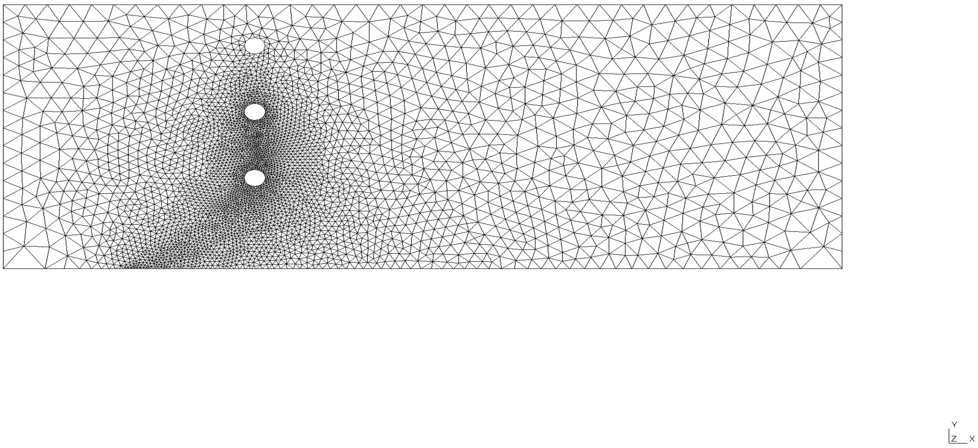

Figure 2.1-1: mesh of structure

the size of meshes in the refined zone is approximately 0,05 mm.

2.2 Quantities tested and results

One tests the value of the stress intensity factors K_I and K_{II} after the last step of propagation, given by `CALC_G`. Integration contours are `R_INF` = 0,1 mm and `R_SUP` = 0,2 mm.

Standard	identification of reference	Value of reference	Tolerance
K_I	"NON_REGRESSION"	1.142045	0.01%
K_{II}	"NON_REGRESSION"	0.000000	0.01%

2.3 complementary Results

One compares the ways of cracking between those resulting from 3 and that obtained by *Code_Aster*.

Note: the center of the reference is not the same one between 3 and that of computation. To find the reference defined in 3 , it is advisable to carry out a translation of a vector (- 10; -4) of the results of *Code_Aster* . For reasons of clearness, the crack ways are represented in the same reference on Figure 2.3-1 .

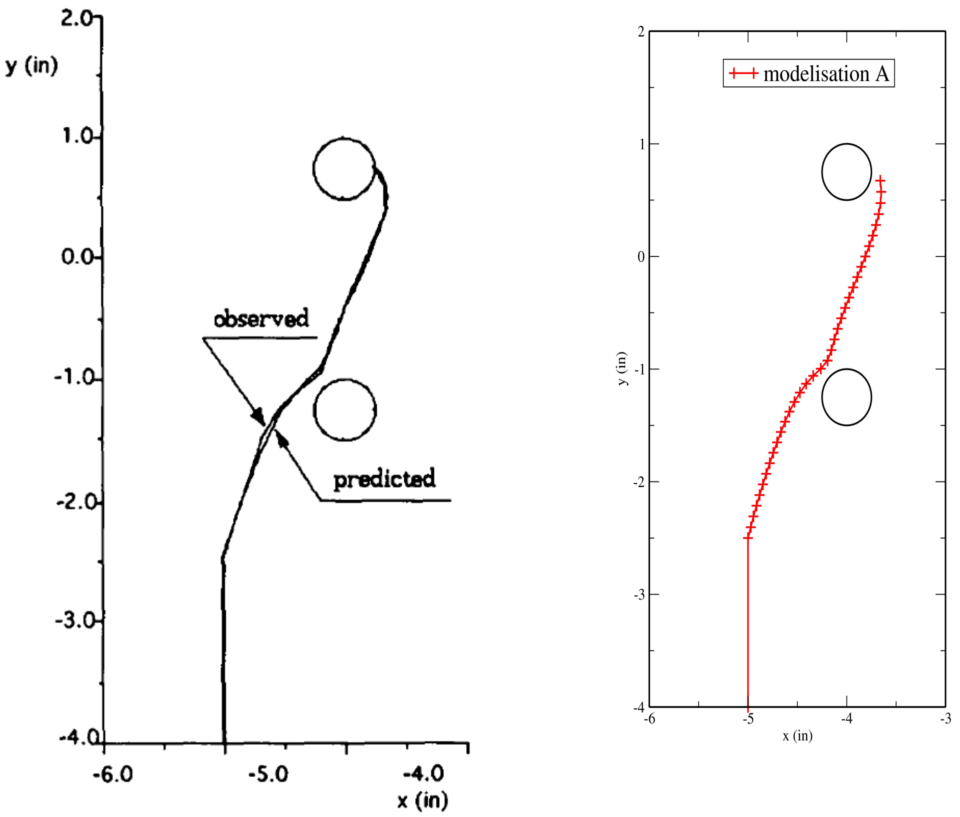

Figure 2.3-1: Comparison of the ways of cracking

3 Summary of result

the purpose of the test is reached.