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

Summary

The purpose of this test is to validate the way of propagation of crack with X-FEM in $2D$, within the framework of linear elasticity.

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

A modeling is considered:
- •modeling A : method grid

The values given by the method grid constitute the values of reference (tests of nonregression).

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 et 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 the initial crack is $a=1,5\,mm$.

Noted nodes $P1$, $P2$ and $P3$ on Figure 1.1-1 are used to impose the boundary conditions, which is clarified in the paragraph [§1.3].

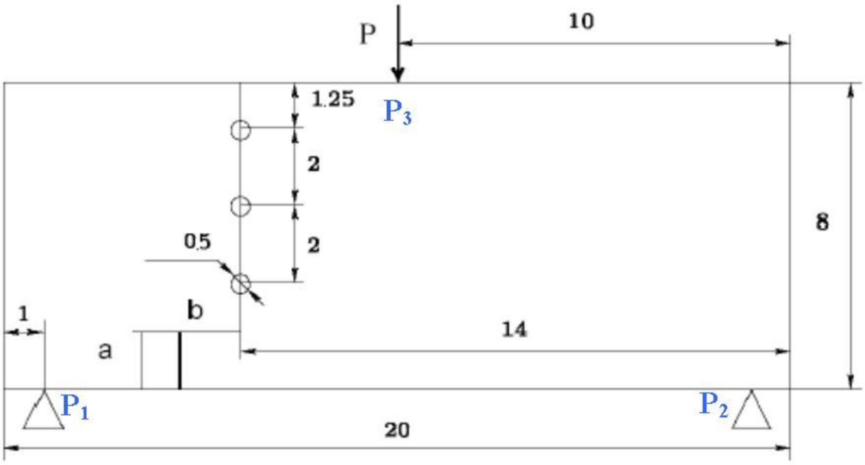

Figure 1.1-1: geometry of the fissured plate

1.2 Properties of material

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

1.3 Boundary conditions and loadings

In order to block the rigid modes, displacements of the nodes are blocked $P1$ 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 pas de propagation is simulated. With each step of propagation, the crack advances an imposed length being worth 0.1 Mr.

1.4 Reference solution

Taking into account the lack of precision of the diagrams of the article [1], one cannot deduce some from precise digital values. One is satisfied to check that the ways of cracking have the same pace (see §2.3).

For the test, one uses as reference the values stress intensity factors K_I and K_{II} calculated by modeling A 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 Modeling a: Method grid

In this modeling, method GRID of the operator PROPA_FISS is used for the propagation of crack.

2.1 Characteristics of the grid

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

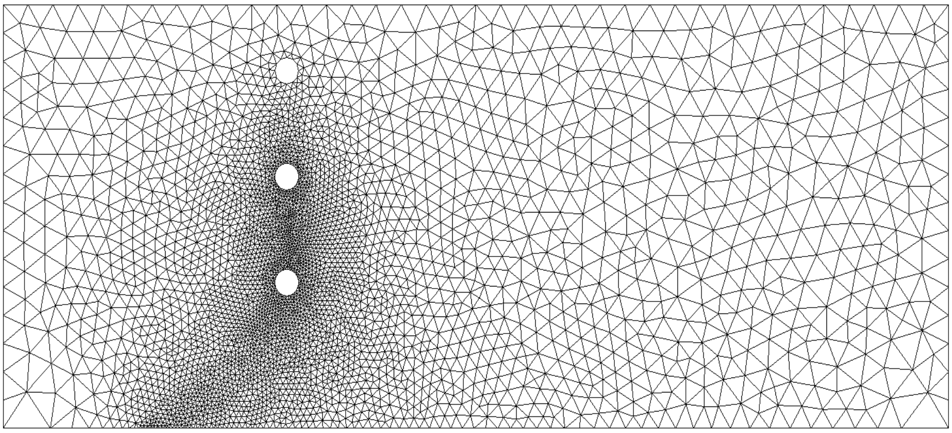

Figure 2.1-1: grid of the structure

The size of the meshs in the refined zone is approximately 0.05 mm.

2.2 Sizes 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. The crowns of integration are R_INF = 0.1 mm and R_SUP = 0.2 mm.

Identification	Type 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 [1] and that obtained by *Code_Aster*.

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

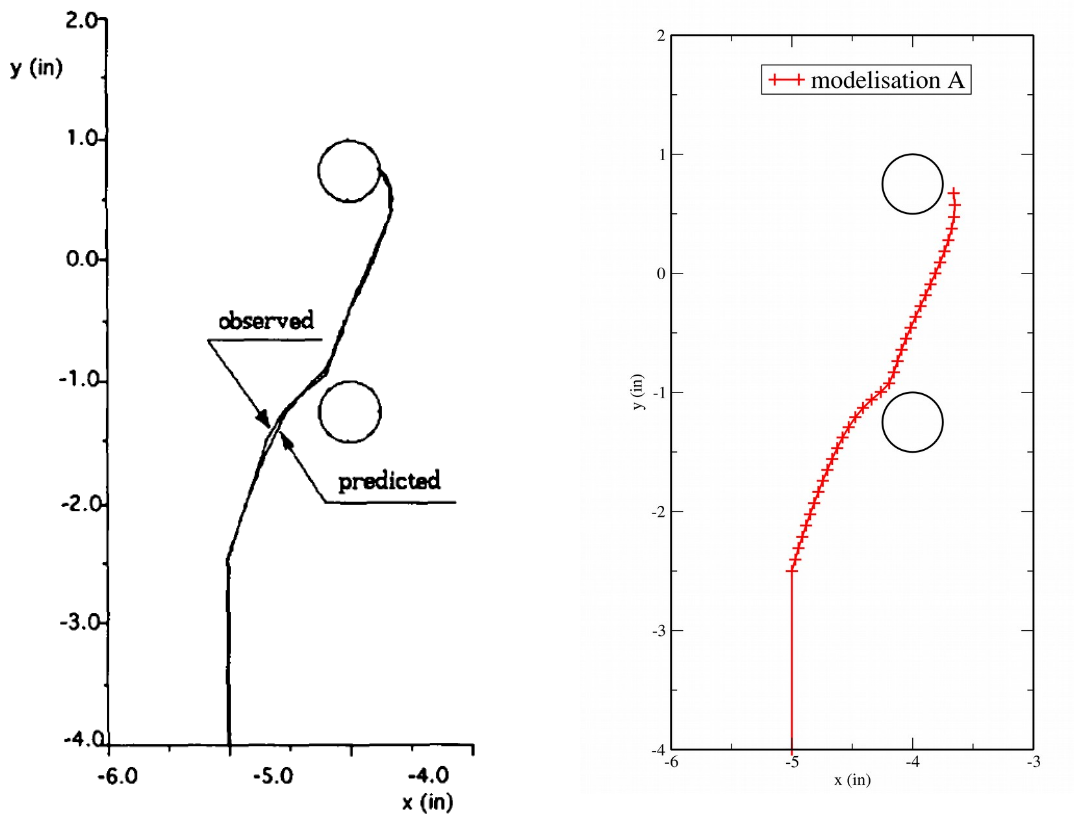

Figure 2.3-1: Comparison of the ways of cracking

3 Summary of the result

The goal of the test is achieved.