

## SSLV312 – Perpendicular semi-elliptic crack has the interface of a bi--material

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### Summary:

This case test treats the study of the influence of a perpendicular semi-elliptic crack has the interface of two elastic materials.

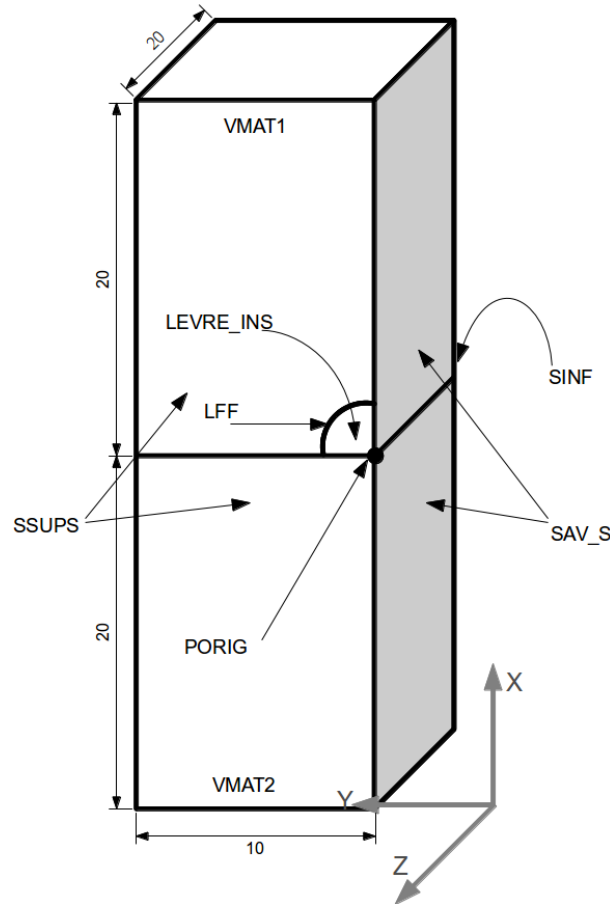
The first model represents a circular crack (modeling A). The second model is an elliptic crack of main roads report on small axis equal to 2. The models are three-dimensional solid mass with a loading by uniform pressure on the lip of the crack.

The aim of the study is the calculation of  $G$  room along the bottom of crack and the measurement of the average standard deviation, by report has the reference, on the geometrical factor of correction  $F_I$  along the bottom of crack.  $F_I$  is calculated has to leave  $G$  room by using the formula of Irwin in plane deformations.

The cracks being located in an infinite medium, the limits of the model finite element were selected according to the experience feedback acquired during the pre-validation of the fissured block.

## 1 Problem of reference

### 1.1 Geometry



**Figure 1.1 Geometry of the problem**

Solid mass is composed of two materials, VMAT1 for the upper part and VMAT2 for the lower part. The crack is modelled by its bottom (LFF) and one of its lips (LEVRE\_INS). The second lip does not need to be modelled with symmetries of the problem. SAV\_S corresponds to the side faces (there negative). SINP corresponds to the back faces (Z negative). SSUPS corresponds to the front faces (Z positive).

Only the quarter of the structure presented is modelled then conditions of symmetry are applied in order to respect the geometry of the initial problem.

### 1.2 Properties of material

For material 1 (VMAT1) :

Young modulus	$E = 1,98 \times 10^{11} Pa$
Poisson's ratio	$\nu = 0.1$

For material 2 (VMAT2) :

Young modulus	$E = 5,94 \times 10^{11} Pa$
Poisson's ratio	$\nu = 0.1$

## 1.3 Boundary conditions and loadings

Imposed displacement:

Embedding on face SSUPS	$DZ = 0$
Embedding on face SAV_S	$DY = 0$
Embedding of point PORIG	$DX = 0$

Imposed loading:

Pressure imposed on face LEVRE_INS	$P = 1 \times 10^6 Pa$
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## 1.4 Size of the cracks

$a$  : horizontal length characteristic of the elliptic crack.

$b$  : vertical length characteristic of the elliptic crack.

	$a$	$b$
Modeling A	2	2
Modeling B	1	2

## 2 Reference solution

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### 2.1 Results of reference

The value of G which is used as reference solution is extracted from a publication from Y. MURAKAMI: "Stress Intensity Factor" (puts 9.70)

### 2.2 Bibliographical references

- 1) Y. MURAKAMI: Stress Intensity Factor, box 9.70.  
The Society of Materials Science, Japan, Pergamon Close 1987.

## 3 Modeling A

### 3.1 Characteristics of modeling A

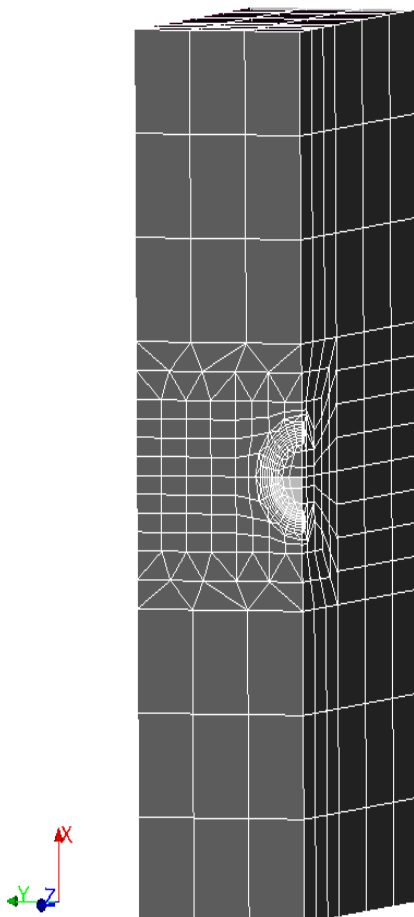


Figure 3.1. Grid of modeling A

### 3.2 Characteristics of the grid

Many nodes: 5229

Many meshes and types: 596 HEXA20 and 726 PENTA15

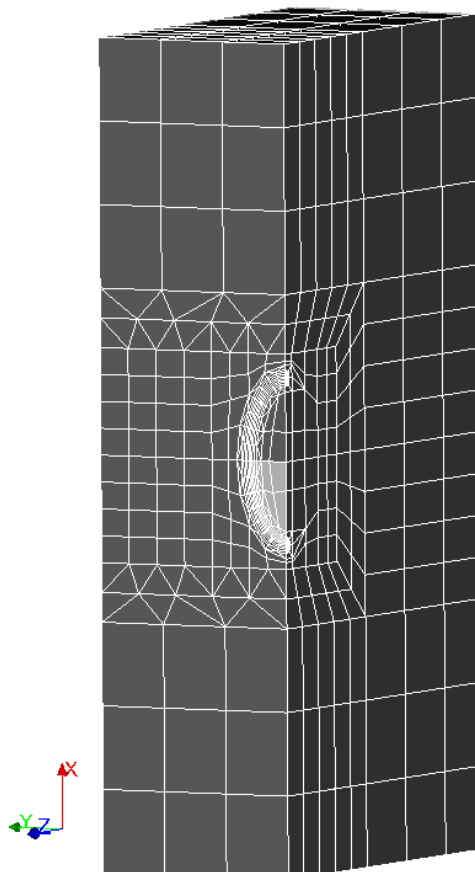
### 3.3 Sizes tested and results

Size	Localization	Value of reference	Type of reference	Tolerance (%)
G		2.187E-05	NON-DEFINI	1.E-2
G	N186	9.1496E-06	NON-DEFINI	0.04

G	N182	9.1094E-06	NON-DEFINI	0.06
G	N174	8.8822E-06	NON-DEFINI	0.05
G	N155	8.9302E-06	NON-DEFINI	0.11
G	N121	7.1453E-06	NON-DEFINI	0.07

## 4 Modeling B

### 4.1 Characteristics of modeling B



### 4.2 Characteristics of the grid

Many nodes: 6225

Many meshes and types: 760 HEXA20 and 810 PENTA15

### 4.3 Sizes tested and results

Size	Localization	Value of reference	Type of reference	Tolerance (%)
G		1.324138E-05	NON-DEFINI	1.E-2
G	N71	5.2055E-06	NON-DEFINI	0.12
G	N68	5.3992E-06	NON-DEFINI	0.13
G	N112	6.9762E-06	NON-DEFINI	0.08
G	N106	6.4492E-06	NON-DEFINI	0.08
G	N357	6.2104E-06	NON-DEFINI	0.12

## 5 Summary of the results

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The results concerning the circular crack are in conformity with those of the reference since the average standard deviation is lower than 5 %.

For the elliptic crack, the shape of the curve representing the evolution of  $G$  local is appreciably different from that of the reference solution. The average standard deviation remains however lower than 10 %.

## 6 Remarks

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The differences between the reference solutions and the solution of CODE\_ASTER can come from the grid insufficiently refined in the particular zone located on the lip of the crack.

Moreover the passage of  $F_I$  with  $G$  is given by the formula of Irwin in plane deformations is correct only in the middle of the part, and certainly not at the end of a crack which leads to a free surface (it probably goes from there in the same way for a crack emerging from the interface between two materials).