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

Summary:
This case test study the influence of oneE perpendicular semi-elliptic crack with the interface of two elastic materials.
The first model represents a circular crack (modeling A) and it second an elliptic crack of main roads report on small axis equal to 2. The models are three-dimensionalS solid massS 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 L'evaluation average standard deviation between geometrical factor of correction F_I along the bottom of crack and a value of reference resulting from an article. 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

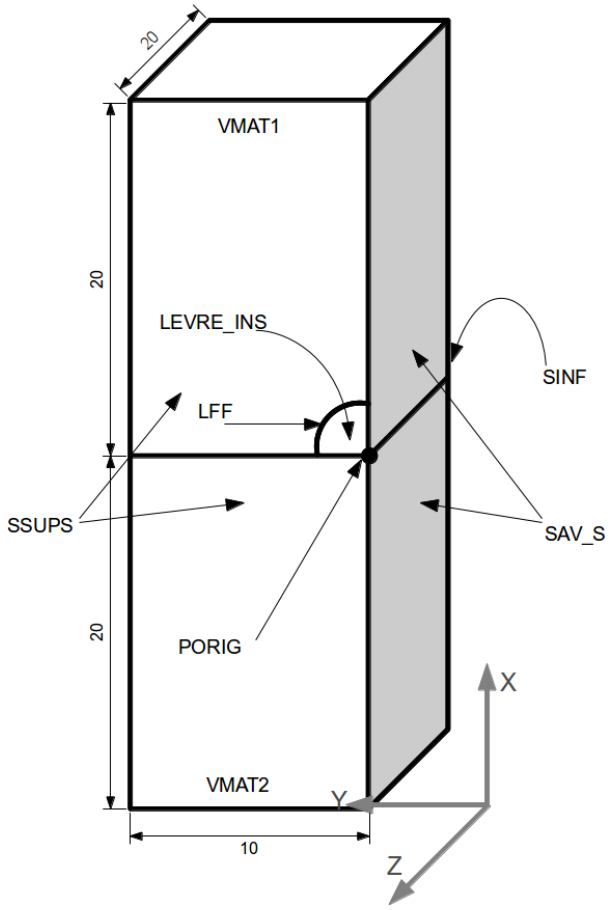


Figure 1.1 Geometry of the problem

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).
SINF 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	$E=1,98\times10^{11}\,Pa$
Poisson's ratio	$\nu=0.1$

For material 2 (VMAT2) :

Young modulus	$E=5,94\times10^{11}\ Pa$
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	$P=1\times10^{6}\ Pa$

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

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

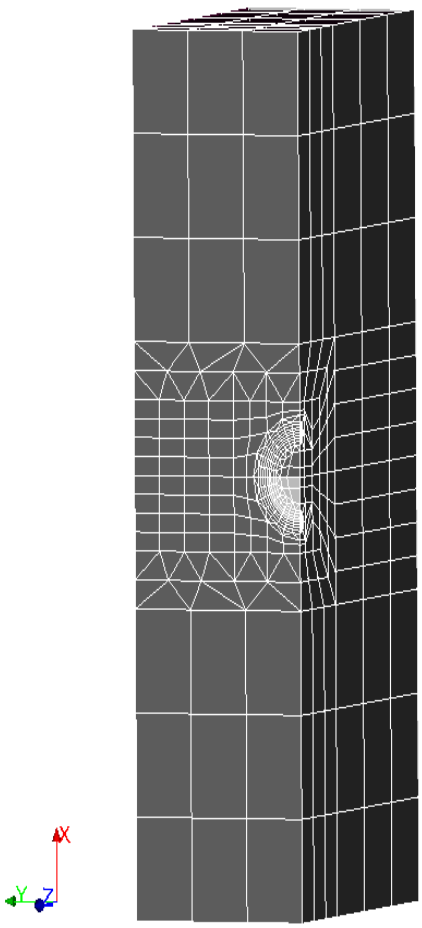


Figure 3.1. Grid of modeling A

3.2 Characteristics of the grid

Many nodes: 5229
Many meshs and types: 596 HEXA20 and 726 PENTA15

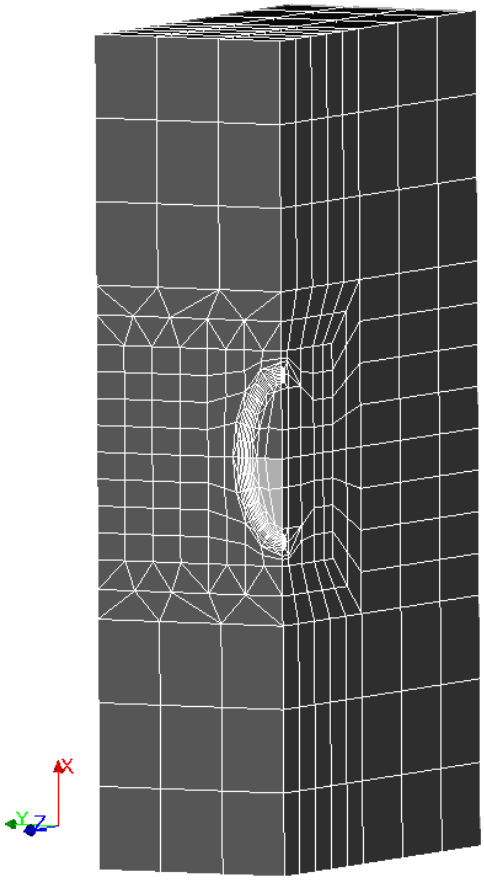
3.3 Sizes tested and results

Size	Localization	Value of reference	Type of reference	Tolerance (%)
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 meshs and types: 760 HEXA20 and 810 PENTA15

4.3 Sizes tested and results

Size	Localization	Value of reference	Type of reference	Tolerance (%)
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

The results concerning the circular crack are in conformity has those of the reference since the average standard deviation is lower has 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 has 10 %.

6 Remarks

Differences between the reference solutions and the solutionS 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 room by the formula of Irwin in plane deformations is correct only in the middle of the part, and certainly not has the end of a crack which leads to a free surface (it probably goes from there in the same way for a crack emerging with the interface between two materials).