SSLA310 – Radial crack in a bimatériau subjected has an internal pressure

Summary:

This case test deals with an axisymmetric problem, in finished field, with a crack located at the interface between two materials. The materials are elastic linear isotropic. The model is subjected has a loading in pressure on the lips and has a specific loading in the center of the lips of the crack.

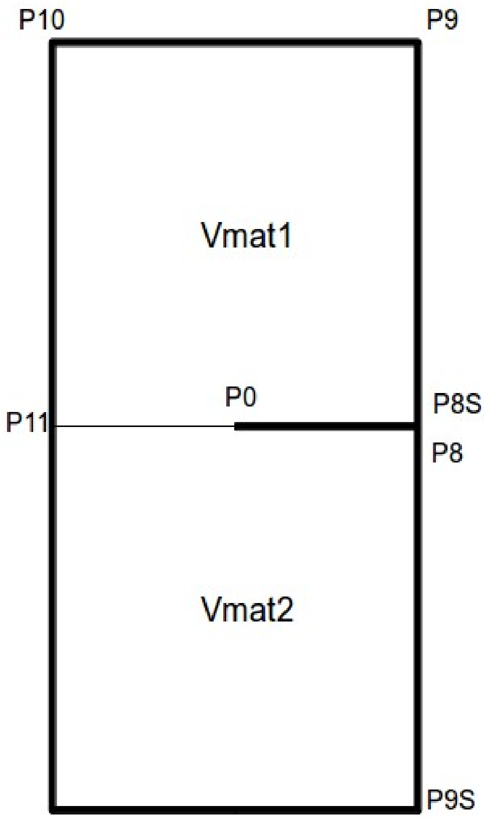
The objective of this case test is to validate the integration of G for bi--materials for different report from moduli Young, and various reports of Poisson's ratios.

The reference solution is calculated by finite element with ABAQUS.

The calculation of G is carried out known various crowns surrounding the bottom of crack.
The first crown whose lower ray is null gives poor results compared to the other crowns whose results are excellent since they lead has variations inferior has 7 %.

1 Problem of reference

1.1 Geometry



1.2 Properties of material

1.2.1 Material 1

Young modulus	$E=6\times10^{12}\,Pa$
Poisson's ratio	$\nu=0.2$

1.2.2 Materiau2

Young modulus	$E=1\times10^{11}\,Pa$
Poisson's ratio	$\nu=0.3$

1.2.3 Materiau3

Young modulus	$E=2\times10^{11}\,Pa$
Poisson's ratio	$\nu=0.2$

1.3 Boundary conditions and loadings

Points $P8$ and $P8S$ are useful the application of the force has F_Y .
The lip of the crack is the line $P8P0$. $P0$ is thus the face of crack.

For all calculations carried out, one imposes same displacements.
Imposed displacement:

Embedding of with dimensions one $P8P9S$	$DX=0$
Embedding of with dimensions one $P8SP9$	$DX=0$
Embedding of the node $P11$	$DY=0$

According to calculations one imposes 2 types of loading:

Imposed loading:

Pressure distributed on the line $P0P8$	$1.$
Pressure distributed on the line $P0P8S$	$1.$

Or:

Nodal force on the GROUP_NO $P8$	$Fy=1.591549E-3$
Nodal force on the GROUP_NO $P8S$	$Fy=-1.591549E-3$

2 Reference solution

2.1 result of reference

The result of reference resulting from an equivalent calculation by element is finished realized under ABAQUS

3 Modeling A

3.1 Characteristics of modeling A

Modeling is AXIS.
Modeling A carries out several calculations, with the 2 type of loadings (PRES_REP or FORCE_NODALE), and various assignments materials (3 different cases).
That is to say 6 different calculation cases.

Calculation n°1:
Vmat1 material is affected Matériau_1.
Vmat2 material is affected Matériau_1.
The loading is done with PRES_REP.

Calculation n°2:
Vmat1 material is affected Matériau_1.
Vmat2 material is affected Matériau_3.
The loading is done with PRES_REP.

Calculation n°3:
Vmat1 material is affected Matériau_1.
Vmat2 material is affected Matériau_2.
The loading is done with PRES_REP.

Calculation n°4:
Vmat1 material is affected Matériau_1.
Vmat2 material is affected Matériau_1.
The loading is done with FORCE_NODALE.

Calculation n°5:
Vmat1 material is affected Matériau_1.
Vmat2 material is affected Matériau_3.
The loading is done with FORCE_NODALE.

Calculation n°6:
Vmat1 material is affected Matériau_1.
Vmat2 material is affected Matériau_2.
The loading is done with FORCE_NODALE.

For each one of the preceding calculation case, have calculation G on various crowns:

Crown 0:
Lower ray = 0.0
Higher ray = 0.025
Crown 1:
Lower ray = 0.025
Higher ray = 0.05
Crown 2:
Lower ray = 0.05
Higher ray = 0.075
Crown 3:
Lower ray = 0.075

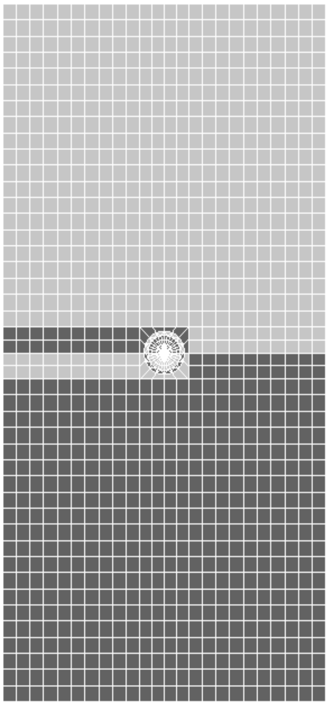
Higher ray = 0.1

Crown 4:

Lower ray = 0.025

Higher ray = 0.5

3.2 Characteristics of the grid



Many nodes: 3785

Many meshs and types: 138 SEG3
80 TRI6
1152 QUAD8

The ray of the radiant grid make some of crack is of 0.125.

3.3 Sizes tested and results

One calculation G for several crowns for each calculation case:

Result for calculation n°1:

Size	Crown	Value of reference	Type of reference	Precision (%)
G	0	0.00146438	SOURCE_EXTERNE	7 %
G	1	0.00146438	SOURCE_EXTERNE	3 %
G	2	0.00146438	SOURCE_EXTERNE	3 %
G	3	0.00146438	SOURCE_EXTERNE	3 %
G	4	0.00146438	SOURCE_EXTERNE	3 %

Result for calculation n°2:

Size	Crown	Value of reference	Type of reference	Precision (%)
G	0	0.000673168	SOURCE_EXTERNE	5 %
G	1	0.000673168	SOURCE_EXTERNE	0.5 %
G	2	0.000673168	SOURCE_EXTERNE	0.5 %
G	3	0.000673168	SOURCE_EXTERNE	0.5 %
G	4	0.000673168	SOURCE_EXTERNE	0.5 %

Result for calculation n°3:

Size	Crown	Value of reference	Type of reference	Precision (%)
G	0	0.000706637	SOURCE_EXTERNE	11 %
G	1	0.000706637	SOURCE_EXTERNE	7 %
G	2	0.000706637	SOURCE_EXTERNE	7 %
G	3	0.000706637	SOURCE_EXTERNE	7 %
G	4	0.000706637	SOURCE_EXTERNE	7 %

Result for calculation n°4:

Size	Crown	Value of reference	Type of reference	Precision (%)
G	0	5.52152E-09	SOURCE_EXTERNE	7 %
G	1	5.52152E-09	SOURCE_EXTERNE	3 %
G	2	5.52152E-09	SOURCE_EXTERNE	3 %
G	3	5.52152E-09	SOURCE_EXTERNE	3 %
G	4	5.52152E-09	SOURCE_EXTERNE	3 %

Result for calculation n°5:

Size	Crown	Value of reference	Type of reference	Precision (%)
G	0	2.5974E-09	SOURCE_EXTERNE	3 %
G	1	2.5974E-09	SOURCE_EXTERNE	7 %
G	2	2.5974E-09	SOURCE_EXTERNE	7 %
G	3	2.5974E-09	SOURCE_EXTERNE	7 %
G	4	2.5974E-09	SOURCE_EXTERNE	7 %

Result for calculation n°6:

Size	Crown	Value of reference	Type of reference	Precision (%)
G	0	2.53699E-09	SOURCE_EXTERNE	5 %
G	1	2.53699E-09	SOURCE_EXTERNE	1 %
G	2	2.53699E-09	SOURCE_EXTERNE	1 %
G	3	2.53699E-09	SOURCE_EXTERNE	1 %
G	4	2.53699E-09	SOURCE_EXTERNE	1 %

4 Summary of the results

Results for the rate of refund of energy G are correct because the variation is lower has 7 % (out calculation on the first crown whose ray is null).

The stability of calculation of G on the other crowns is excellent since it leads has lower variations has $0{,}05$ %.

The use of crowns having a ray lower no one has to proscribe.