HPLV102 - Computation of G thermoelastic in infinite medium for a circular crack

Abstract

It acts of a test of fracture mechanics into thermomechanical for an axisymmetric problem. One considers a circular crack plunged in a presumedly infinite medium. One imposes a uniform temperature on the lips of crack. This test makes it possible to calculate rate of energy restitution G.

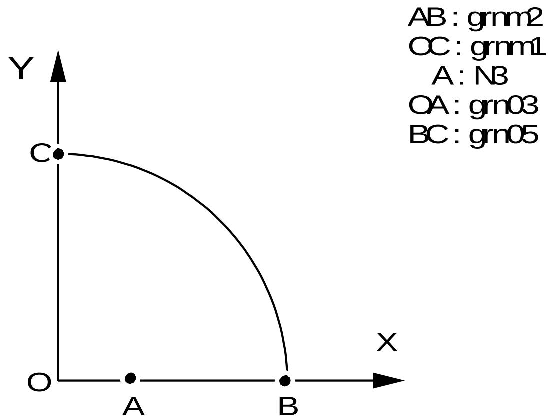
The interest of the test is the stability of G according to various contours and the comparison with an analytical solution.

This test contains a modelization into axisymmetric.

The variations of the computation of G on various contours compared to the reference solution do not exceed $1{,}5\%$.

1 Problem of reference

1.1 Geometry



It acts of a circular crack of radius $OA=5$.

The presumedly infinite medium is modelled by a sphere of radius $OB=600$.

1.2 Material properties

thermal Conductivity:	$\lambda=1.$
Thermal coefficient of thermal expansion:	$\alpha=10^{-6}/°C$
Young modulus:	$E=2.10^{5}\,MPa$
Poisson's ratio:	$\nu=0.3$

1.3 Boundary conditions and loadings

- Mechanics: Displacement imposed

```
(GROUP_NO: grnm1  DX: 0.)
(GROUP_NO: grnm2  DY: 0.)
```

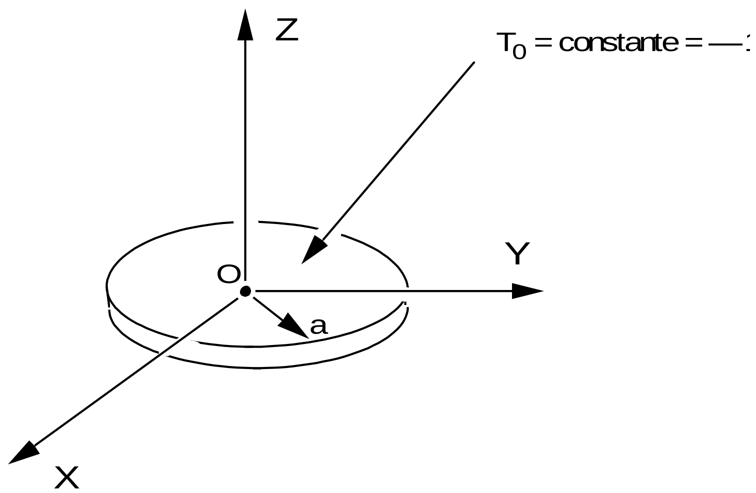
- Thermal: `TEMP_IMPO`

```
(GROUP_NO: grno3  TEMP: 0. )
(GROUP_NO: grno5  TEMP: -1.)
(THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A
RIGHT PROFILE OF THE EXCLU TYPE NODE:       N3
TEMP: -1.)
```

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is resulting from OLESIAK and SNEDDON [bib1]:



The statement of the rate of refund of energy is the following one:

$$G=\frac{(1-\nu^2)}{E}K_1^2 \text{ with } K_1=\frac{\alpha E}{\Pi(1-\nu)}T_0\sqrt{\Pi a}$$

is: $G=\dfrac{\left(1-\nu^2\right)}{\Pi\,(1-\nu)^2}\,\alpha^2 E\;T_0^2\;a$

2.2 Result of reference

result of reference is thus: $G=5.9115\,10^{-7}\,J/m^2$

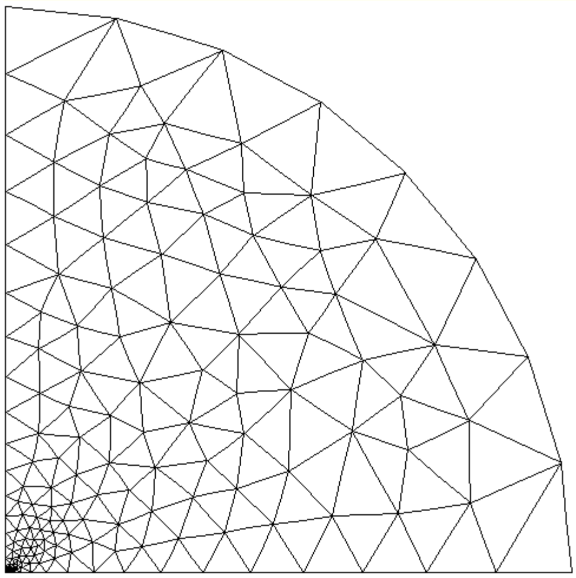
2.3 Bibliographical reference

1) Uniform Temperature one has Penny-Shaped Ace (OLESIAK and SNEDDON (1959)), included in Handbook of stress-intensity, factors of G.C. SIH.

3 Modelization A

3.1 Characteristic of the modelization

It acts of a modelization into axisymmetric:



3.2 Characteristics of the mesh

Many nodes: 832

Number of meshes and types: 323 `TRIA6`, 42 `QUAD8`, 59 `SEG3`

Crown 1:	$Rinf=1.$	$\mathrm{Rsup}=4.$
Crown 2:	$Rinf=0.5$	$\mathrm{Rsup}=4.5$
Crown 3:	$Rinf=1.5$	$\mathrm{Rsup}=3.5$
Crown 4:	$Rinf=1.$	$\mathrm{Rsup}=4.5$

3.3 Quantities tested and results of the modelization A

the values tested are those of the rate of refund of energy G on various integration contours:

Identification	Reference	*Aster*	% Tolerance
Crowns 1 G	$1.4778\ 10^{-6}$	$1.4586\ 10^{-6}$	1.50
Contour 2 G	$1.4778\ 10^{-6}$	$1.4574\ 10^{-6}$	1.50
Contour 3 G	$1.4778\ 10^{-6}$	$1.4583\ 10^{-6}$	1.50
Contour 4 G	$1.4778\ 10^{-6}$	$1.4573\ 10^{-6}$	1.50

3.4 Notices

the value of reference is $G=5.945\,10^{-7}\,J/m^2$

It is given per unit of area of extension of crack, therefore for $a=5$ and taking into account the symmetry of the mesh, it is necessary to compare result *Aster* with: $G_{Aster}=G_{réf}\times\frac{a}{2}=1.4778\,10^{-6}$, because it G in *Aster* to a surface of extension of 1 radian corresponds.

4 Summary of the Invariance

results of result compared to contours. Correct thermal term.