HPLV102 - Thermoelastic calculation of G in medium infinite for a circular crack

Summary

It is about a test of breaking process 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 the crack. This test makes it possible to calculate the rate of refund of energy G.

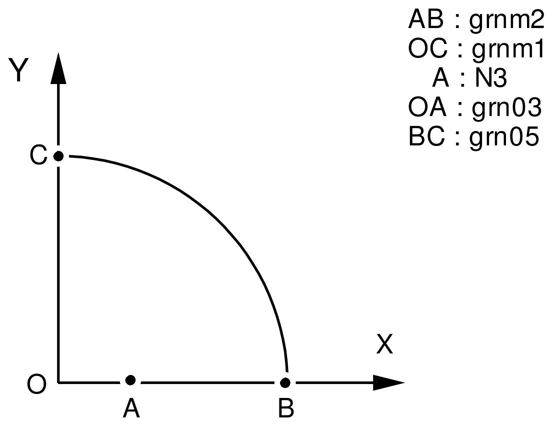
The interest of the test is the stability of G according to various crowns and the comparison with an analytical solution.

This test contains a modeling into axisymmetric.

Variations of the calculation of G on various crowns compared to the reference solution do not exceed $1,5\%$.

1 Problem of reference

1.1 Geometry



It is about a circular crack of ray $OA=5$.

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

1.2 Material properties

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

1.3 Boundary conditions and loadings

- Mechanics: Imposed displacement

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

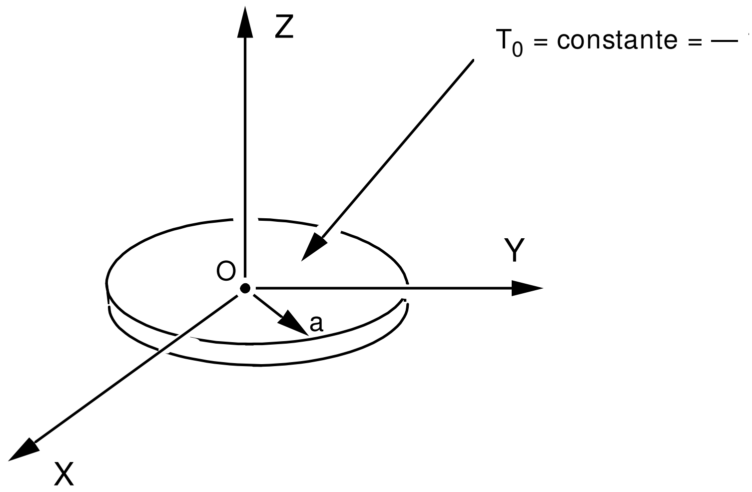
- Thermics: `TEMP_IMPO`

```
(GROUP_NO: grno3  TEMP: 0. )
(GROUP_NO: grno5  TEMP: -1.)
(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 expression of the rate of refund of energy is the following one:

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

that is to say: $G=\frac{(1-\nu^2)}{\Pi(1-\nu)^2}\alpha^2 E\, T_0^2\, a$

2.2 Result of reference

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

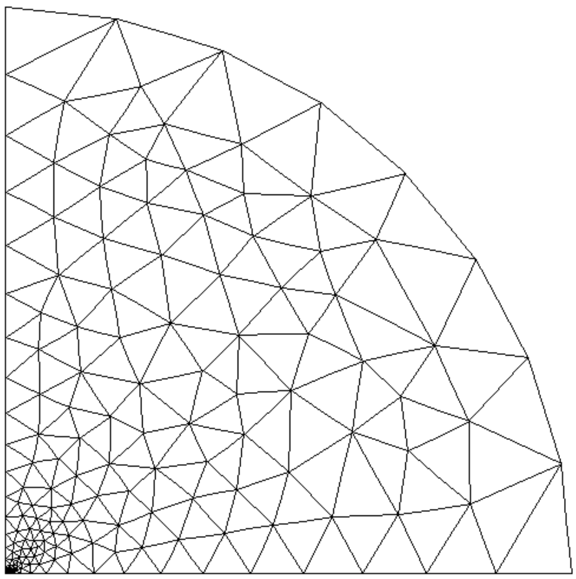
2.3 Bibliographical reference

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

3 Modeling A

3.1 Characteristics of modeling

It is about a modeling into axisymmetric:



3.2 Characteristics of the grid

Many nodes: 832

Many meshs 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 Sizes tested and results of modeling A

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

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

3.4 Notice

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

It is given per unit of area of extension of the crack, therefore for $a=5$ and taking into account the symmetry of the grid, it is necessary to compare the result of *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 results

Invariance of the result compared to the crowns. Correct thermal term.