

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 .

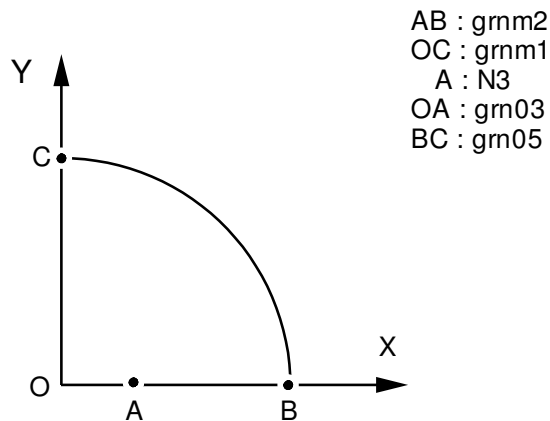
The interest of the test is the stability of G according to various crowns and the comparison with an analytical solution.

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

1.2 Material properties

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

1.3 Boundary conditions and loadings

- Mechanics: Imposed displacement

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(GROUP_NO: grnm1 DX: 0.)  
(GROUP_NO: grnm2 DY: 0.)
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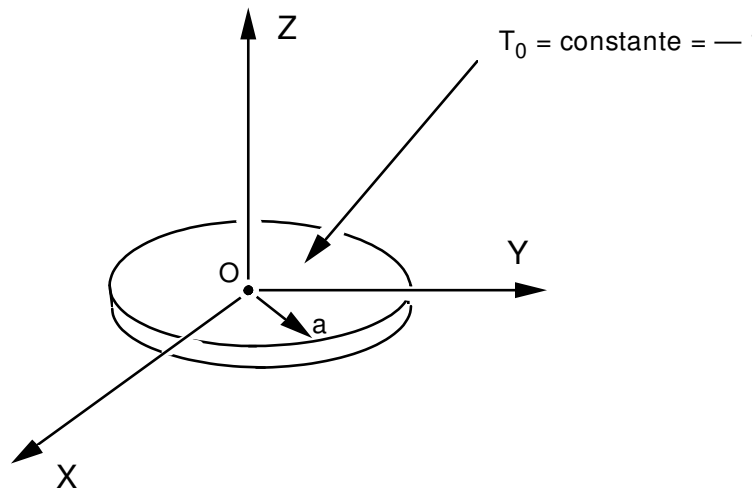
- Thermics: TEMP_IMPO

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(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:

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

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: $G = 5.9115 \cdot 10^{-7} \text{ J/m}^2$

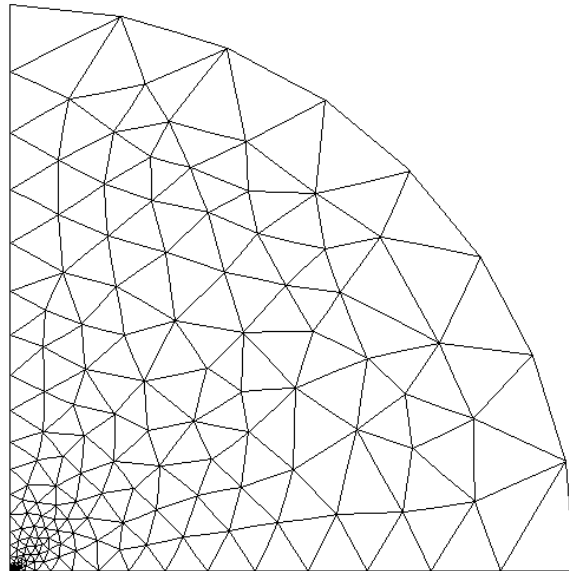
2.3 Bibliographical reference

- 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 meshes and types: 323 TRIA6, 42 QUAD8, 59 SEG3

Crown 1:	$R_{inf} = 1.$	$R_{sup} = 4.$
Crown 2:	$R_{inf} = 0.5$	$R_{sup} = 4.5$
Crown 3:	$R_{inf} = 1.5$	$R_{sup} = 3.5$
Crown 4:	$R_{inf} = 1.$	$R_{sup} = 4.5$

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	% Tolerance
Crown 1 G	$2.9556 \cdot 10^{-6}$	1.50
Crown 2 G	$2.9556 \cdot 10^{-6}$	1.50
Crown 3 G	$2.9556 \cdot 10^{-6}$	1.50
Crown 4 G	$2.9556 \cdot 10^{-6}$	1.50

3.4 Notice

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

It is given per unit of area of extension of the crack, therefore for $a=5$, it is necessary to compare the result of Aster with: $G_{Aster} = G_{ref} \times a = 2.9556 \cdot 10^{-6}$, 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.