HPLP100 - Computation of the rate of refund of the energy of a plate fissured in thermoelasticity

Summarized

It acts of a test in thermoelasticity for a two-dimensional problem. A fissured rectangular plate is considered and one places oneself on the assumption of the plane strains.

In **the modelization A**, the rate of refund of energy is calculated in postprocessing by two different methods:

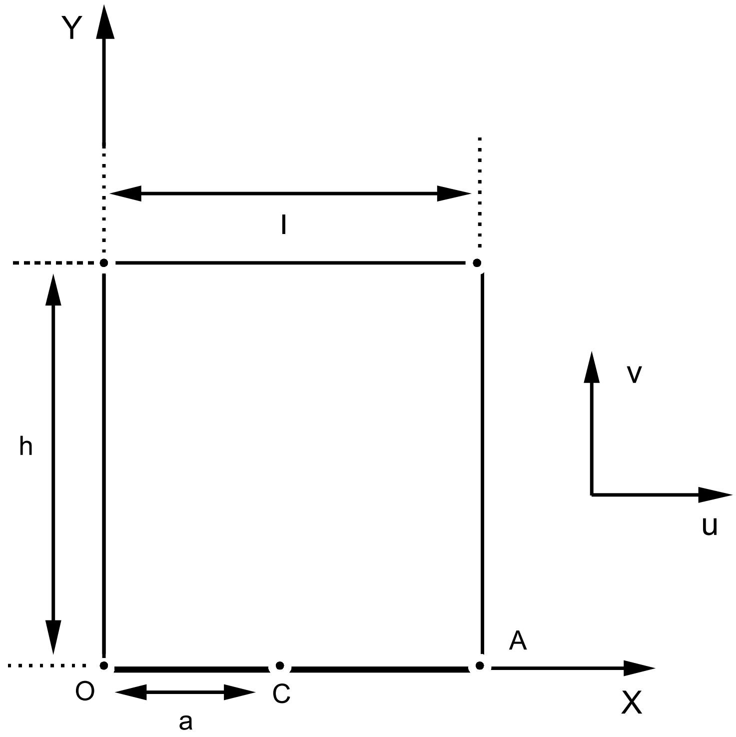
- classical computation by the method theta,
- computation by the formula of IRWIN starting from the coefficients of intensity of stresses KI and KII .

These two computations are carried out on 4 different integration contours. Their interest is to compare the values of G and from $G(IRWIN)$ ratio with the reference solution and to test the invariance of computations compared to various integration contours.

1 Problem of reference

1.1 Geometry

It acts of a fissured rectangular plate (one represents only the quarter of structure):



Appear 1.1-a: Fissured rectangular plate

dimensions of this plate are the following ones:

Half-height of the plate:	$h=200.0\,mm$
Half-width of the plate:	$I=100.0\,mm$
Half-length of crack:	$a=50.0\,mm$

1.2 Properties of the material

thermal Properties:	$Cp=0.$
	$\lambda=1.0\,W/m°C$
Mechanical properties:	$E=200000\,MPa$
	$\nu=0.3$
	$\alpha=5.10^{-6}/°C$

We are on the assumption of the plane strains

1.3 Boundary conditions and loadings

- Temperature imposed in $X=0.$: $T=-100.0°C$
- Temperature imposed in $X=100$: $T=+100.0°C$
- Displacement for $a<X<I$ $Y=0.$: $v=0.$
- Displacement for $0<X<I$ $Y=H$: $v=0.$

- Displacement for $X=0. \quad Y=H : u=0.$

2 Reference solution

2.1 Méthode de calcul used for the reference solution

the reference solution is resulting from WILSON and YU [bib1]:

$$K_I = \frac{E\,\alpha\,T_0}{1-\nu} F\sqrt{\pi a} \quad F = 0.154$$

a en mm

E en N / mm^2

$$K_I = 92.0291$$

In plane strains, the formula of IRWIN gives: $G = \frac{(1-\nu^2)}{E}\left(K_I^2 + K_{II}^2\right)$

that is to say numerically: $G = 3.8535\ 10^{-1}$

2.2 Results of reference

the results of reference are those resulting from the reference solution from WILSON and YU [bib1]:

$$G = 3.8535\ 10^{-1}$$
$$K_I = 92.0291$$
$$K_{II} = 0.$$

2.3 Bibliographical references

1) The Uses of J-Integrals in thermal stress ace problems - International Newspaper of Fracture (1979) WILSON and YU.

2) Qualification complementary to codes INCA/MAYA in linear thermoelasticity. Note technical DRE/STRE/LMA 84/598

3 Modelization A

3.1 Characteristic of the modelization

There are 4 contours defined by the command CALC_THETA :

Crown 1: $Rinf=10.$ $\mathrm{Rsup}=40.$
Crown 2: $Rinf=15.$ $\mathrm{Rsup}=45.$
Crown 3: $Rinf=5.$ $\mathrm{Rsup}=47.$
Crown 4: $Rinf=3.$ $\mathrm{Rsup}=48.$

The crack tip is defined by DEFI_FOND_FISS, and for each contour one carries out:

- a computation of G classic (option CALC_G of CALC_G),
- a computation from G the formula of IRWIN starting from the coefficients of intensity of stresses K_I and K_{II} (option CALC_K_G of CALC_G).

3.2 Characteristics of the mesh

Many nodes: 853
Number of meshes and types: 359 meshes TRIA6 and 27 meshes QUAD8

3.3 Values tested and results of the modelization A

the values tested are those of G obtained by the classical method and that of G_{IRWIN} obtained by the formula of IRWIN starting from the coefficients of intensity of stresses:

Identification		Reference	Tolerance
Crowns 1	G	$3.8535\ 10^{-1}$	8.00%
Contour 1	G_{IRWIN}	$3.8535\ 10^{-1}$	8.00%
Contour 2	G	$3.8535\ 10^{-1}$	8.00%
Contour 2	G_{IRWIN}	$3.8535\ 10^{-1}$	8.00%
Contour 3	G	$3.8535\ 10^{-1}$	8.00%
Contour 3	G_{IRWIN}	$3.8535\ 10^{-1}$	8.00%
Contour 4	G	$3.8535\ 10^{-1}$	8.00%
Contour 4	G_{IRWIN}	$3.8535\ 10^{-1}$	8.00%

3.4 Remarks

the numerical values are stable compared to various integration contours and almost identical for the two methods of calculating. Nevertheless the variation with the values of reference is about 6 with 7% , which seems high.

4 Summaries of the results

At the time of **the first modelization**, the variation with the values of reference is from 6 to 7%. The validation independent of the batch fracture mechanics should bring brief replies on the validity of G in thermoelasticity.