**Fracture Mechanics ME 6104** **National University of Singapore**

**Prof. M. Perl** **Dept. of Mechanical Engineering**

## Assignment # 2

Problem 1

Given a DCB specimen of thickness B subjected to the loading described in Fig. 1.

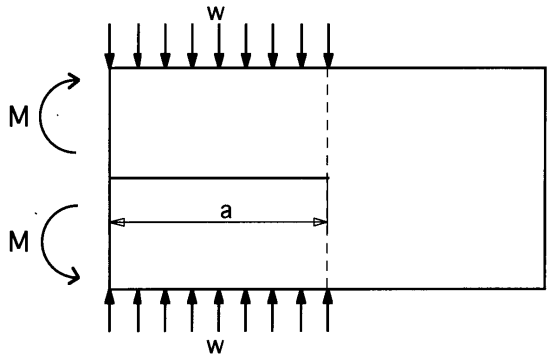



Fig. 1

(a) Develop an approximate expression for $K_I$

(b) Draw $K_I$ as a function of $\frac{M}{wa^2/2}$ what conclusions can be drawn?

Problem 2

The Green function for an edge crack loaded by a pair of forces P, as described in Fig. 2, can be approximated by:

$$K_I = \frac{2}{3}\frac{P}{\sqrt{\pi a}}\frac{4-\left(\frac{x}{a}\right)}{\sqrt{1-\left(\frac{x}{a}\right)^2}}$$

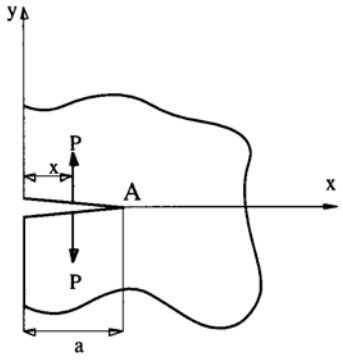



Fig. 2

A thick-walled cylinder is subjected to cyclic internal pressure $P_i$. As a result, a single radial crack develops at the bore as described in the Fig. 3.

(a) Using Schwartz alternating method develop a *first approximation* for the Stress Intensity Factor (SIF) prevailing at the tip of this crack for normalized crack lengths in the range of: $0 < \frac{a}{R_2 - R_1} \le 0.8$ (any integration method may be used).

(b) Compare you results with Fig. 5.9 of the lecture notes. Explain why the approximation yields better results when the crack length is shorter?
**Note**: Full pressure penetrates into the crack's cavity

(c) In another case, two symmetrical internal cracks developed as shown in Fig. 4. For this new configuration , using Schwartz alternating method again, develop a *first approximation* for the SIFs for normalized crack lengths in the range of:

$$0 < \frac{a}{R_2 - R_1} \le 1.8$$

The Green function for a central crack loaded by a pair of opposite colinear forces P is given by:

$$K_I = \frac{P}{\sqrt{\pi a}} \sqrt{\frac{a+x}{a-x}}$$

The stress components in a thick walled cylinder are:

$$\sigma_{rr} = \frac{P_i R_1^2}{R_2^2 - R_1^2}\left(1 - \frac{R_2^2}{r^2}\right)$$

$$\sigma_{\theta\theta} = \frac{P_i R_1^2}{R_2^2 - R_1^2}\left(1 + \frac{R_2^2}{r^2}\right)$$

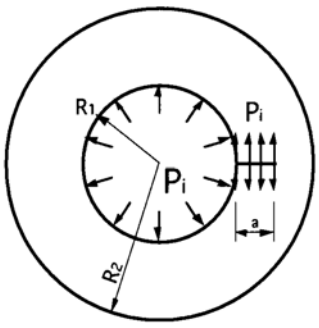



Fig. 3

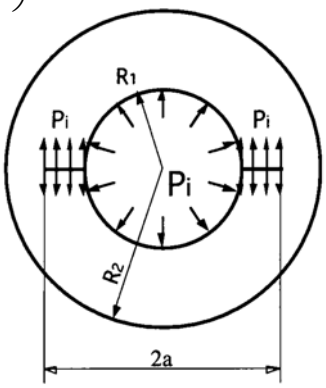



Fig. 4