Name.....Student I.D.....

Department of Mining and Materials Engineering

Faculty of Engineering

Prince of Songkla University

Mid-term Examination for Semester: 1 Academic Year: 2010

Date: August 4, 2010 Time: 09.00-12.00

Subject: 237-407 Failure Mechanics and Analysis Room: S104

Instructions

1. There are 3 problem sets. Please do all of them. Write your answers in the space provided.
2. Dictionary and calculator are allowed.
3. Text books and course notes are not allowed.
4. This mid-term exam is accounted for 25 % of total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem no.	Full score	Student's score
1	30	
2	20	
3	40	
Total	90	

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Problem 1 (30 points)

1.1 What are the factors K, K_I, and K_{IC}? (15 points)

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1.2 What is plastic zone in Fracture Mechanics? (5 points)

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1.3 The size and shape of plastic zone are influenced by what factors? (10 points)

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Problem 2 (20 points)

A large thick plate of steel is examined by X-ray method, and found to contain no detectable cracks. The equipment can detect a single edge-crack of depth a = 0.5 mm or greater. The steel has fracture toughness K_{IC} of 50 MPa m$^{1/2}$ and yield strength of 1495 MPa. Assuming that the plate contains cracks on the limit of detection. Determine whether the plate will undergo general yield or will fail by fast fracture before general yielding occurs.

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Problem 3 (40 points)

A semicircular surface crack in a pressure vessel is in 10 mm deep. The crack is on the inner wall of the pressure vessel and is oriented such that the hoop stress is perpendicular to the crack plane. Calculate K_I if the local hoop stress = 200 MPa. Assume that the wall thickness >> 10 mm and consider at $\phi = 90°$.

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Given Formula

Tresca yield criterion:

$$\tau_{\max} = \frac{\sigma_{\max} - \sigma_{\min}}{2} \geq \frac{\sigma_{ys}}{2}$$

Strain energy release rate at failure:

$$G_C = \frac{\sigma_f^2 \pi a}{E} \qquad \text{(Plane stress)}$$

For edge crack:

$$K_I = 1.12\sigma\sqrt{\pi a}$$

For thin-walled pressure vessel:

Spherical tank:

$$\sigma_1 = \sigma_2 = \frac{pR}{2t}$$

$$\sigma_3 = 0$$

Cylindrical tank:

$$\sigma_{hoop} = \frac{pR}{t}$$

$$\sigma_{longitudinal} = \frac{pR}{2t}$$

$$\sigma_{radial} = 0$$

where p is the internal pressure

R is the radius

t is the thickness

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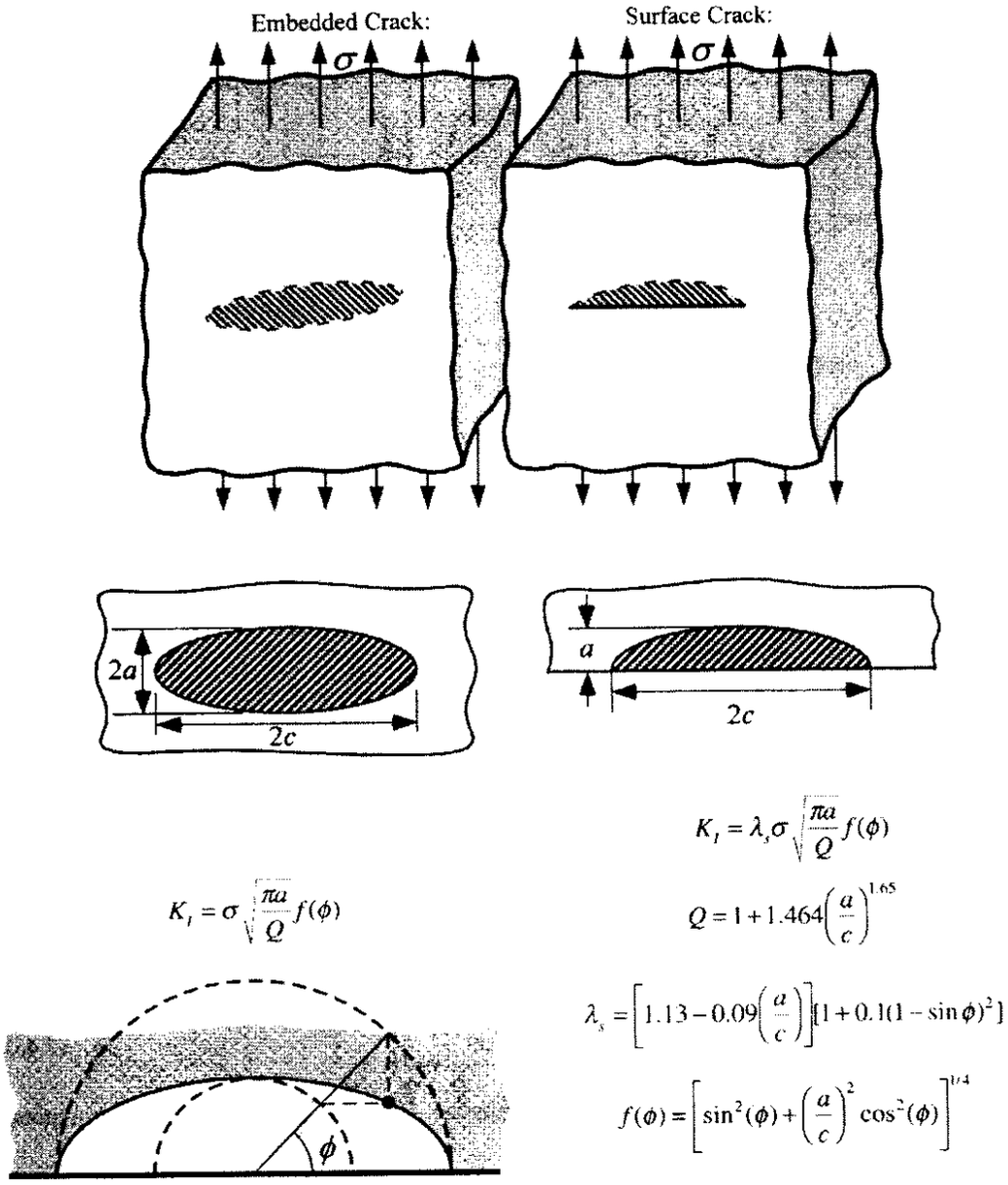

FIGURE 2.19 Mode I stress intensity factors for elliptical and semielliptical cracks. These solutions are valid only as long as the crack is small compared to the plate dimensions and $a \le c$.