Fracture Mechanics

PG. M.E 1st semester Examination -2017

Time : 3 hrs

full Marks : 100

Group –'A'

Answer any four questions

1. Answer any four questions   (4 X5)

   a) Explain the relevance of fracture mechanics in Design.
   b) Derive the fracture stress from atomic model and stress concentration?
   c) Why fracture stress from energy release rate is more reliable ?
   d) Explain different fracture mechanism.
   e) Show that the energy release rate in load control & displacement control are same.

2. Answer any four questions   (4 X5)

   a) Explain LEFM ?
   b) Explain how stress intensity factor K_I can be considered as a fracture parameter ?
   c) Explain conditions for stable and unstable crack growth ?
   d) Define Plain strain fracture toughness ?
   e) Derive size of plastic zone from strip yield model?

3. Answer any four questions   (4 X5)
   a) Explain Irwin's correction for K_{IC} for SSY situation?
   b) How J Integral is measured from multiple specimen method ?
   c) How CTOD can be a fracture parameter for EPFM ?
   d) Define J Integral as non-linear energy release rate?
   e) Show that J Integral is independent of contour ?

4. Answer any four questions   (4 X5)
   a) How J Integral can be compared with stress intensity factor ?
   b) Discuss the constraint dependence of J Integral?
   c) Describe different zone for crack tip surrounding & corresponding fracture parameters ?
   d) Explain the J-R curve compared to crack tip behaviour?
   e) Explain J controlled fracture?
   f) Discuss the metallographic parameters influencing fracture.

5. Answer any four questions   (4 X5)
   a) Explain the scope of the transferability of J_{IC} from specimen to component?
   b) How Mclinlock connected J_{IC} to constraint?
   c) What is meant by T stress & Bi-axiality ratio?
   d) How the contribution of T stress is considered to nullify the effect of constraint?
   e) How J-R curve is applied considering 'Q'?

6. Answer any four questions   (4 X5)
   a) What aspects are significant in case of dynamic fracture ?
   b) How fracture toughness is measured for high loading rate based on response time ?
   c) Explain crack arrest phenomenon and its significance ?
   d) Describe the effect of strain rate on ductile fracture and brittle fracture ?
   e) What is dynamic fracture toughness and how it depends on crack speed ?
   f) How Stress Intensity factor is modified to include the effect of crack speed?

<center>Group –'B'</center>

<center>Answer any two questions (2 X 10)</center>

1. Determine the energy release rate for a double cantilever beam (DCB) specimen.
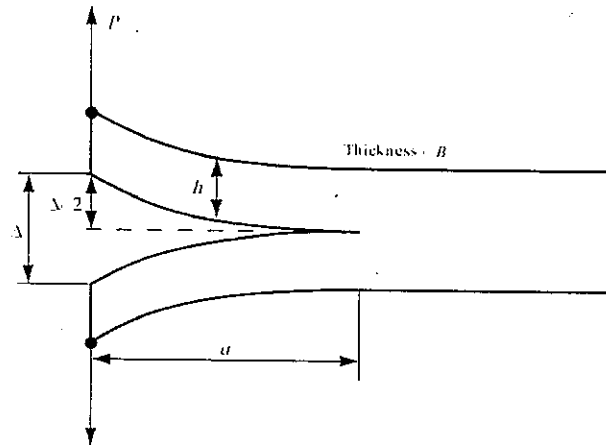
2. containing an edge crack of 20 mm and determine the plastic zone size and effective crack length and effective stress intensity factor. The plate is loaded in Mode I with a far field stress of 150MPa and the yield strength of the material is 350MPa. The stress intensity factor (SIF) is indicated in the sketch.
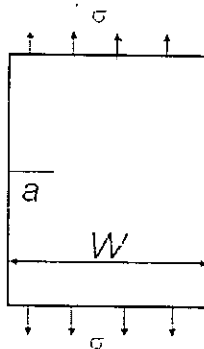
$$K_I = \sigma \sqrt{\pi a} \, f(\alpha) : \alpha = a/W \quad : 0 < \alpha < 0.6$$

$$f(\alpha) = 1.12 - 0.23 \, \alpha + 10.55 \, \alpha^2 - 21.72 \, \alpha^3 + 30.39 \, \alpha^4$$

3. A 3 mm thick tension panel 10 cm wide containing an edge crack of 1 mm yielded at a load of 150 kN. However, at a load of 120kN, another panel of same material cracked into two pieces when the crack was 5 mm long. With this information, calculate the yield stress and fracture toughness of the material.