Fracture Mechanics

FIRST YEAR FIRST SEMESTER EXAM 2018

M.E. MECHANICAL ENGINEERING, MASTER OF NUCLEAR ENGINEERING

Time : 3 hrs full Marks : 100

Group –'A'

Answer any four questions

1. Answer any four questions (4 X5)

   a) What is the significance of fracture mechanics in Design.
   b) Compare the fracture stress from atomic model and stress concentration?
   c) Compare ductile and brittle fracture ?
   d) Explain Griffith's criteria for crack growth.
   e) Show that the energy release rate in load control & displacement control are same.

2. Answer any four questions (4 X5)

   a) Explain different modes of fracture ?
   b) Explain conditions for stable and unstable crack growth ?
   c) Explain thickness dependence of fracture toughness ?
   d) Derive size of plastic zone for plane stress and plane strain situations ?
   e) Explain Irwin's correction for K_I for SSY situation

3. Answer any four questions (4 X5)
   a) How J Integral is measured from multiple specimen method ?
   b) How CTOD can be a fracture parameter for EPFM ?
   c) Why pre-cracking is required for measurement of fracture toughness ?
   d) How J Integral can be measured for a growing crack ?
   e) Describe any method for measurement of crack growth.

4. Answer any four questions (4 X5)
   a) Discuss constraint dependence of J_{IC} ?
   b) Describe different zone for crack tip surrounding & corresponding fracture parameters ?
   c) Explain temperature dependence of fracture toughness ?
   d) How fracture toughness can be described in ductile to brittle transition zone ?
   e) 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 constraint level depends on loading type, specimen type, thickness, a/w ratio?
   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)

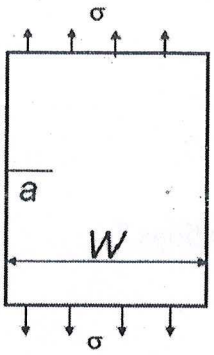
a) What aspects are significant in case of dynamic fracture ?
b) How fracture toughness is measured for high loading rate based on response time ?
c) Explain crack arrest phenomenon and its significance ?
d) Describe the effect of strain rate on ductile fracture and brittle fracture ?
e) What is dynamic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

Group –'B'

Answer any two questions (2 X 10)

1. A large plate having a central crack of 30mm long fractures at stress of 7MPa. Calculate strain energy release rate using i) Griffith theory and ii) LEFM.

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.



$K_I = \sigma \sqrt{\pi a}\, f(\alpha)$; $\alpha = a/W$; $0 < \alpha < 0.6$

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

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.

4. A plate having a central crack of 10 mm long and inclined at 20^0 is subjected to a stress of 200 MPa. Fracture toughness of the material is 30 MPa $m^{1/2}$. Check whether crack growth will be there or not ?