Total number of printed pages – 7 **B. Tech**

PEMT 6408

Eighth Semester Examination – 2008

FRACTURE MECHANICS AND FAILURE ANALYSIS

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10

   (a) What are the different types of fracture in metals and how is the appearance of fracture surfaces ?

   (b) Sketch the brittle fracture of single crystal and ductile fracture of a polycrystalline material.

   (c) What is the relationship between the stress intensity factor (K) and strain energy release rate (G) ?

   (d) What is the critical crack length (2a) having yield strength of 900 MPa and fracture toughness K_{IC} = 57 $Mpam^{1/2}$ for Ti-6A1-4V alloy.

   (e) What is the thickness to achieve plane-strain condition and valid K_{IC} measurement ?

   (f) What is the microscopic and macroscopic feature of fatigue fracture surfaces ?

(g) Explain the term fatigue limit of a material with the help of S-N curve.

(h) What are the methods for improving the fatigue life ?

(i) What is the use of Ultrasonic testing in failure analysis ?

(j) Explain briefly why ceramics are brittle and metals are ductile.

2. (a) How you differentiate theoretical cohesive strength and theoretical shear strength of metal ? Determine the cohesive strength of a silica fiber, if E = 95 GPa, $\gamma_s = 1 Jm^{-2}$ and a_o = 0.16 nm. 5

(b) Explain the Griffith theory of brittle fracture. 5

3. (a) Describe the J-integral fracture toughness testing for a single specimen. 5

(b) A material possessing a plane-strain fracture toughness value of 50 $Mpam^{1/2}$ and a yield strength of 1000 MPa is to be made into a large panel.

(i) If the panel is stressed to a level of 250 MPa, what is the maximum size flaw that can be tolerated before catastrophic failure occurs ? 3

(ii) At a point of fracture, what is the size of the plastic zone at the middle of the plane along the crack front ? 2

4. (a) What is fatigue ? Derive the relationship for calculation of fatigue life using Paris law. 5

(b) Compare the difference in fatigue life-times for three components that experienced crack extension from 2 to 10 mm, versus where the initial crack length was four times smaller (a_o = 0.5 mm), or where the final crack length was four times larger (a_f = 0 mm). Assume that crack growth rates follow a Paris relation where P = 4. 5

5. (a) Derive the relationship between strain energy release rate and stress intensity factor. 5

(b) Describe the Woods mechanism of crack initiation in fatigue and its propagation. 5

6. (a) Classify the different types of failure. 5

(b) Describe the typical origins of failure due to casting defects, metal working defects and welding defects. 5

7. (a) What are the different stages of failure analysis ? Describe the selection, preservation and cleaning of fracture surfaces. 6

(b) Explain the features of microscopic examination of fracture surfaces. 4

8. (a) What is stress corrosion cracking ? 3

(b) What are the different models of crack movement during hydrogen embrittlement ? 3

(c) How K_{IEAC} is measured experimentally ? 4

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