

Meta

COLLEGE OF ENGINEERING, PUNE

END SEMESTER EXAMINATION 2013: B. Tech (Metallurgy)

Fracture and Failures (MT 410)

Date : 25 April 2013

Duration : 3 hours

Time: 2- 5 pm

Max Marks: 50

Instructions:

- 1 Draw neat figures to support your answers.
 - 2 Use of non programmable calculator is permitted.
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Q.1)

- a) Write a complete account of the microscopical aspects of fatigue crack initiation, growth and subsequent failure . 6
- b) How the fatigue life of the component can be improved? 4

Q. 2)

- a) Explain how metal can be made more fracture resistant with reference to high strength low alloy steel. State various applications of HSLA steels. 6
- b) What are the objectives of failure investigations and how will you select the sample for these investigations? 4

Q.3)

a) A pressure vessel is to be fabricated from steel plate which may be either-

1) **Steel A** with Yield strength 1900 MN/ m^2 and Plain stain fracture toughness

$(K_{IC}) = 182 \text{ MN m}^{-3/2}$; or

2) **Steel B** with Yield strength 1000 MN/ m^2 and Plain stain fracture toughness (K_{IC})

$= 50 \text{ MN m}^{-3/2}$.

Which of these two steels has the better tolerance to defects? Compare their fracture toughness if they are to have the same defect tolerance. A factor of safety 2 should be used for the design stress. 6

b) Define wear and explain typical wear mechanisms map.

4

Q.4

a) The fatigue behavior of a specimen under alternating stress condition with zero mean stress is given by the expression-

$$\sigma^a \cdot N_f = K$$

where σ is the range of cyclic stress, N_f is the number of cycles to failure and K and a are material constants. It is known that $N_f = 10^6$ when $\sigma = 300 \text{ MN/m}^2$ and $N_f = 10^8$ when $\sigma = 200 \text{ MN/m}^2$.

Estimate life of the specimen when subjected to a stress range of 100 MN/m^2

6

b) A thick plate of a high strength steel contains a crack of total length $2c = 10 \text{ mm}$ which runs perpendicular to the applied stress. For this steel, $K_{IC} = 105 \text{ MNm}^{-3/2}$ and the yield stress = 700 Mpa . If the applied stress is increased steadily, will the plate fail by yielding or by brittle mode of fracture?

4

Q.5)

a) Design a nickel based super alloy microstructure and its processing for fabricating turbine blades of a gas turbine aircraft engine that will have a particularly long creep-rupture time at temperatures approaching 1100°C .

6

b) A steel bolt 0.003 m^2 in cross section is subjected to a static mean load of 178 KN . What value of completely reversed direct fatigue load will produce failure in 10^7 cycles. Use Soderberg equation and assume that the yield strength of the steel is 344 MN/m^2 and the stress required to produce failure at 10^7 cycles under zero mean stress condition is 276 MN/m^2

4
