Engineering Fracture Mechanics

Assignment # 5

Crack Initiation and Life Estimation

1. What are the differences between striations and beachmarks? How will you assess the crack growth rate using these?

2. Discuss the procedure involved in developing the crack growth rate curve for a material for which LEFM is applicable

3. Why conventional fatigue test is insufficient for fracture analysis? What are crack growth curves? Discuss the elegance of Paris Law.

4. After two years of service, a wide panel of an aluminium alloy was found to contain a 6 mm long centre crack oriented normal to the applied stress. The panel was designed to withstand one start-up/shut-down cycle per day for 20 years (assume 320 operating days in a year), the cyclic range being 0 to 72 MPa.

   If the fracture toughness of the alloy is 32 MPa(m)$^{1/2}$ and the cyclic growth rate of the crack is represented by the equation

   $$\frac{da}{dN} = C(\Delta K)^m = 3.3 \times 10^{-9} (\Delta K)^{3.0}$$

   where a is in meters and ΔK in MPam$^{1/2}$. Calculate whether the panel will meet its design life expectancy. Assume $K_I = \sigma\sqrt{\pi a}$.

   As the crack grows, one has to use the formulae for finite plates for calculating the pulsating SIF. Discuss how you will proceed. Mention the various steps.

5. How does a Sigmoidal Curves gets affected due to

   (i) Environmental effects

   (ii) Stress ratio