SE104 Homework 12

1. Determine the critical crack length for a through crack in a thick plate of 7150-T651 aluminum alloy under uniaxial tension. The critical stress intensity factor of this alloy is 25.5 MPa·m$^{1/2}$ and the working stress is σ = 400 MPa. Assume $Y = \pi^{1/2}$.

2. A material contains precracks. Its fracture resistance (i.e. the critical energy release rate) is 3.9 kJ/m^2; its Young's modulus is 150 GPa. (a) By using the equation $K_{IC} = \sigma \sqrt{\pi c}$ (i.e. the geometric factor Y = 1), plot the fracture stress (MPa) versus crack size c (mm), for c values from 0.2 mm to 2.0 mm. (b) If a constant stress of 495 MPa is applied, what is the minimum crack size that will cause catastrophic failure?

3. The tensile strength of a brittle material was measured to be 70 MPa. However, after being hit by a hammer once, in a tensile test the same material failed at only 50 MPa. What is a possible explanation?

4. A double-cantilever beam (DCB) specimen is 10 cm wide. Each arm is 4 cm high. It is made of material with E = 200 GPa and K_{IC} = 60 MPa·m$^{1/2}$. The crack length is 30 cm. What is the critical crack opening displacement (D) for the crack to propagate?

5. (a) Describe how the critical stress intensity factor, the critical energy release rate, and the critical crack-tip plastic-zone size are related to the critical fracture condition. (b) What is the relationship among them?