0604H1: Fracture

HW Exam-I: Topics Related to Fracture

Due Monday, Dec 06, 2021

1.

Explain why the mechanical energy for driving the crack forward can be equated to the *increase* in the stored elastic energy around the microcrack. Be explicit as to how an increase in energy can compensate for the work done to advance the crack.

2.

Please write less than one page on (i) why the stress intensity factor is important in engineering, and (ii) why it helps in understanding the atomistic/microstructural mechanism/criterion of fracture at the crack tip.

Please make use of equations and sketches to make your arguments.

3.

In class we derived the result that

$$K_{IC} = \sigma\sqrt{c} \qquad (1)$$

where σ is the tensile stress felt by a *penny shaped crack* in a body.

Now consider a ribbon shaped crack of width "c" in a body. This is now a two-dimensional problem (rather than the three-dimensional problem of the penny shaped crack).

Derive the equation for K_{IC} for this configuration of the crack.

4.

This problem is related to the displacement and stress fields at the crack tip as a function of the applied K_I, and the position relative to the tip of the crack expressed as (r,θ).

Carefully derive Eq. (5) in the notes, $\sigma^*_{yy}(\theta = 0, r = \Omega^{1/3}) = \dfrac{K_{IC}}{\sqrt{2\pi\Omega^{1/3}}}$,

explaining, *carefully*, the assumptions and steps in the derivation.