University of Portland
ME 421 – Failure Analysis
Fall 2013

All of the following questions are for Mode 1 fracture. And if relevant, assume factor of safety of 1.

1) Given a flat plat with a width of unity (1 unit – 1 mm, 1m, 1 micron, 1 mile…). It contains a through-thickness center crack. Plot K_I as the crack grows from being "very small" to nearly the width of the plate using both the general equations and the "short crack length" equations. At what ratio of a/W does the difference between these two equations become within 5% of each other?

2) Repeat problem 1, but for a through-thickness edge crack.

3) Calculate the maximum permissible edge-crack length in a panel subjected to uniform stress (Mode I) of 20 ksi; W=6 inches, K_{IC} (fracture toughness) of 50 ksi-root inch, yield strength of 60 ksi.

4) What is the residual strength of a center cracked panel with a crack length (2a) of 6 inches? Width=18 inches, K_{IC} (fracture toughness) 30 ksi-root inch, yield strength of 70ksi.

5) You receive a fractured plate from a customer. There is a dispute between the customer and the designer/manufacturer of the plate. The plate was supposed to be designed to withstand tensile loads of 80,000 pounds. Your customer claims he did not exceed the design limit but the designer/manufacturer claims he did. The plate is 5 inches wide (W) and 1 inch thick (B). It has a fracture toughness of 20 ksi-root inches, and yield strength of 80 ksi. You determine there was a pre-existing through-thickness edge crack 0.25 inches deep. Did your customer exceed the 80,000 load limit, or did the plate fail at a lower load?