MSE C212/ME C225
Deformation and Fracture of Engineering Materials
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Due: February 12, 2007

Homework No. 1

1. Consider a 1-inch thick plate of D6aC steel (composition 0.43% C, 0.85% Mn, 0.90% Cr, 0.75% Ni and 0.50% Mo: a typical high-strength, low-alloy or HSLA steel), which has been heat treated to have the following properties: yield strength, 207 ksi; ultimate strength, 233 ksi; measured K_{Ic}, 95.3 ksi√in. For a piece of plate which is 20 inches wide normal to the loading direction, containing a central crack of length 1 inch, what would be the breaking *load* (not stress) of the plate? Is it in plane strain? How does this compare to the load which would cause yielding of an uncracked plate? Comment on your answer in terms of testing machine capacities with which you are familiar. At the point of fracture of the cracked plate, what would be the size of the plastic zone?

2. You have testing equipment for compact tension specimens which is limited by the size of your clevis (see Anderson, Fig. 7.3, or STP 410, p. 133, or STP 463, p. 253) to specimens which have B = 0.75 inch. Estimates exist, as tabulated below, of approximate toughness values for these materials. On which of the following materials could you perform a valid K_{Ic} test? (You may assume $K_I = \sigma \sqrt{\pi a}$)

Material	Yield Strength, MPa	Estimated K_{Ic}, MPa√m
7075-T6	485	27.5
HSLA steel	690	98
Ti-6 Al-4 V	860	100
Inconel 718	1175	220
4130 steel, Q & T	1450	82
17-4 PH stainless steel	1120	110

For any materials which you conclude cannot be tested to determine a valid toughness, estimate the specimen size you would need for a valid test. How accurate do you expect these size calculations to be? Why?