Fracture Mechanics ME 6104 **National University of Singapore**

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Assignment # 3

Problen 1

(a) Develop an analytical expression for the curve circumscribing the plastic zone ahead of a mode-I crack tip for the cases of *plane strain* and *plane stress*. Assume that yielding is controlled by:

1. vom-Mises yield criterion
2. Tresca's yield criterion

Hint: An analytical expressions for the principal stresses in the vicinity of the crack tip, should be developed first using Westergaard's solution.

(b) Plot the contour lines obtained in (a) for *plane strain* and *plane stress* using the two yield criteria.

(c) Compare the results to Irwin's and Dugdale's plastic radii.

Problem 2

In order to determine the *fracture toughness*- K_{Ic} of 4Al-4Mo-2Sn-0.5Si Titanium alloy a static test was performed on a Compact Tension Specimen (CTS), that fractured when the load reached the value of P=5165 lb. The geometry of the specimen was :

width	W=4"
thickness	B=0.25"
crack length	a/W=0.5

(a) Assuming the specimen met all size requirements, evaluate the material's fracture toughness.

(b) Is the value obtained in (a) the material's plane strain fracture toughness K_{Ic} ?

(c) What is the next step in determining K_{Ic} for this material? Is there any practical problem in performing the next step ?.

(d) Would the process described in (c) always converge? Explain in detail.

(e) Estimate the size of the plastic zone and the Crack Tip Opening Displacement (CTOD) at the tip of the crack in the above experiment. What are your conclusions?