THE UNIVERSITY OF IOWA
Department of Mechanical Engineering

Fracture Mechanics	**Computer Project #2**	**Assigned: February 21, 2020**
ME:5159	**Total Points: 20**	**Due: March 06, 2020**

Problem 1:

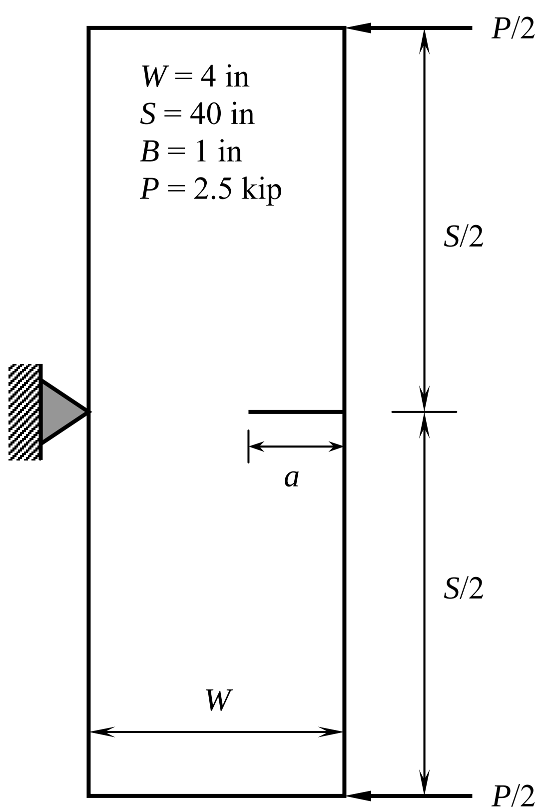
Consider a plate with an edge crack under three-point bending as shown below. The load and geometric dimensions are given. For the material properties, use E = 30,000 ksi and ν = 0.3. Assume *unit* thickness of the plate and *plane stress* condition. Using CASCA and FRANC2D/L at CSS (ICAEN):

- Calculate the mode-I stress-intensity factor, K_I by both (1) the displacement correlation method and (2) the J-integral method in FRANC2D/L for the following three crack geometries: (a) a/W = 0.25, (b) a/W = 0.5, and (c) a/W = 0.75.

- For each of the three cracks, conduct a local mesh refinement study by using the SUBDIVIDE command of FRANC2D/L. For example, try 1-rosette mesh, 2-rosette mesh, 3-rosette mesh, etc., for the singular finite elements around the crack tip. Determine sensitivity of the results of K_I to this refinement. Discuss the convergence rate of K_I predicted by the two methods.

- Compare your finite element results of K_I with the empirical results given by Table on p. 81 of Lecture No. 10. Quantify the difference between these results.

Show all work and attach relevant snapshots. Provide enough comments to justify your answers.



Problem 2:

Cracks have been discovered emanating from both sides of a circular hole in a plate, as shown below. As an engineer, you are asked to conduct a flaw evaluation of this problem. Using CASCA and FRANC2D/L at CSS (ICAEN):

- Calculate the mode-I stress-intensity factor K_I by a suitable numerical technique for several crack sizes ranging from a = 0.1 inch to a = 2 inches. Then, develop a plot of K_I vs. normalized crack size a/r. Invoke the PROPAGATE command of FRANC2D/L to perform an automatic crack propagation study. What happens to K_I when $a/r \to \infty$? Why?

- Compare your finite element results from above (i.e., K_I vs. a/r plot) with the only available results for such cracks in an infinite plate (compiled by Paris and Sih) which state that:

$$K_I = \sigma^\infty \sqrt{\pi a}\, f\left(a/r\right),$$

where $f(a/r)$ is an empirical geometry function and is tabulated below.

a/r	0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.5	2.0
f(a/r)	3.39	2.73	2.41	2.15	1.96	1.83	1.71	1.58	1.45	1.29	1.21

For your calculations, assume the load and geometric dimensions given in the figure below. For the material properties, use E = 30,000 ksi and ν = 0.3. Assume *unit* thickness of the plate and *plane stress* condition. Show all work and attach relevant snapshots. Provide comments to justify your answers.