Problem 11.1

Consider a thin plate 12 in. by 12 in. with a center crack being subjected under a tensile load. The plate has Young’s modulus $E=30 \times 10^6$ psi, Poisson’s ratio $\nu=0.3$, and the material ultimate strength $\sigma_f = 380$ Ksi. The ultimate applied stress for the plate is 30 Ksi if the crack size is 4 inches long.

Determine:

a) the ultimate strength of the plate with a crack size, 8 inches
b) the strain energy release rate for the plate with 4 inches crack size under 30 Ksi
c) the maximum crack opening displacement on the crack surface

Problem 11.2

A large thin steel plate is loaded as shown below in each case. The material properties of the plate is given as

$$E = 30 \times 10^6 \text{ psi}, \quad \nu = 0.3, \quad S_{\text{ult}} = 82 \text{ ksi}$$

$$S_y = 47 \text{ ksi}, \quad K_c = 110 \text{ ksi}\sqrt{\text{in}}$$

A 4” crack is located at the center of the plate.

(a) If the stress measurement at Point $A$ is given as $\sigma_x = 4,000$ psi and $\sigma_y = 16,000$ psi. Find $K_I$ and $K_{II}$, crack opening displacement at Point $B$.

(b) If the same plate shown in Figure (b) is subjected to 11,000 psi, estimate the size of the plastic zone near the crack tip.

(c) Determine the max. permissible crack length of the same plate under 55,000 psi (tensile load).
Problem 11.3

Find the total strain energy release rate for a slit beam loaded as shown in the following cases.

a) $M$ and $P$ are given the applied load and moment, respectively.

b) a couple forces with equal magnitude but opposite direction, $P$ as shown