MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF OCEAN ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

13.10J/1.573J Structural Mechanics

Fall 2001

Problem Set 11

Assigned: Nov 14, 2001

Due: Nov 21, 2:30pm , 2001

1. A rigid-perfectly plastic beam of the length l and cross section b×a is subjected to a uniform load q_0. The beam is fully clamped at one end and simply supported at the other.

   (a) Determine the load-carrying capacity of the beam, q_c (the maximum external load that the beam can resist), as a function of a, b, l and the yield stress of the material σ_y .

   (b) How does this critical load compare to the "first" yield load, q_y? The first yield is reached where the mostly stressed point in the beam reaches the yield stress.

   (Hint: Solve the elastic problem for the beam with bending rigidity EI.)

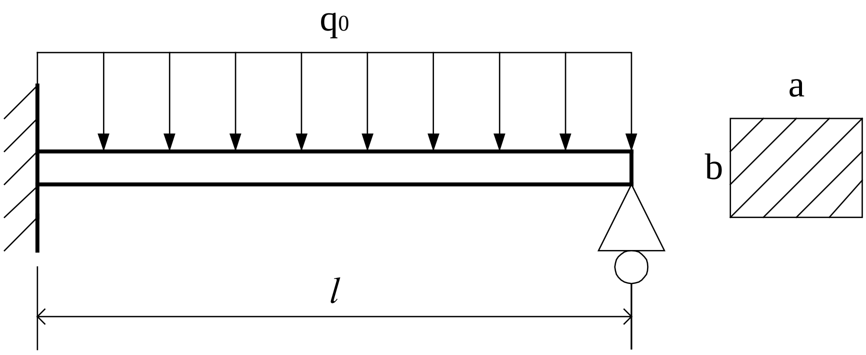

Figure 1: A diagram for problem 1

2. A thick-walled steel cylinder with open ends is subjected to an outside pressure p_0. The inner pressure is assumed to be zero. The radial and circumferential stress are given by

$$\sigma_{rr}(r) = \frac{p_0 a^2}{a^2 - b^2}\left(\frac{b^2}{r^2} - 1\right)$$

$$\sigma_{\theta\theta}(r) = \frac{p_0 a^2}{a^2 - b^2}\left(\frac{b^2}{r^2} + 1\right)$$

(a) Find the locations and magnitudes of the maximum normal and shear stresses.

(b) Find the pressure corresponding to first yield. (Use von Mises and Tresca yield condition.)

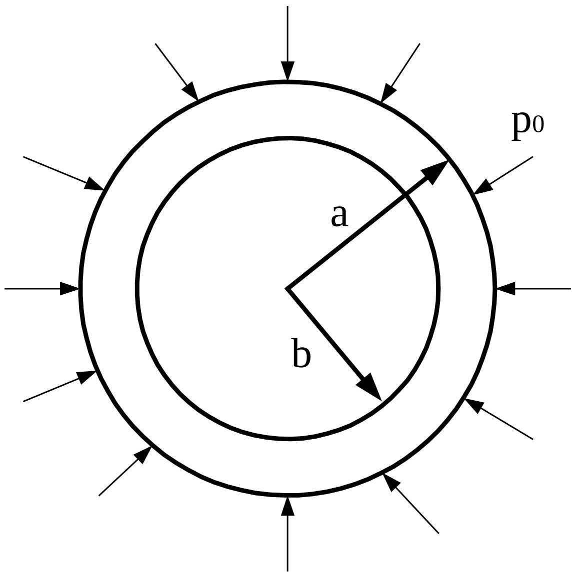

Figure 2: A diagram for problem 2

3. A flat dog-bone specimen is subjected to a tensile load P. The true(Cauchy) stress-strain relation of that material is approximated by the power law

$$\sigma = A\varepsilon^{u}$$

Find the UTS(Ultimate Tensile Strength) of the material in the engineering measures.