MASSACHUSETTS INSTITUTE OF TECHNOLOGY
13.10J/1.573J/13.014/1.052
Problem Set 11

Assign : Nov. 14, 2000 (for 13.014/1.052)
Nov. 14, 2000 (for 13.10J/1.573J)
Due : Nov. 21, 2000 (for 13.014/1.052)
Nov. 22, 2000 (for 13.10J/1.573J)

For undergraduates : 9.2 and the problem 1.

For graduates : the problems 1 and 2.

1. A rigid-perfectly plastic beam of the length l and cross-section $a \times b$ is subjected to a uniform load q. 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.)

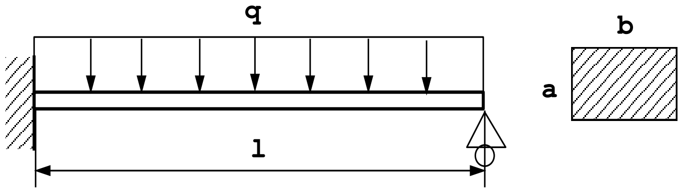

Figure 1: A diagram for problem 1

2. A thick-walled steel cylinder with open ends is subjected to an outside pressure p. The inner pressure is assumed to be zero. The radial and

circumferential stresses are given by

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

(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.)

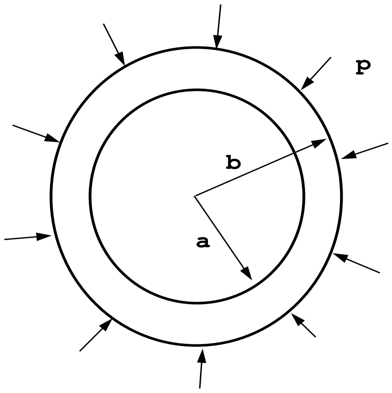

Figure 2: A diagram for problem 2