

Elastic Properties of Materials

6.14 (a) We are asked, in this portion of the problem, to determine the elongation of a cylindrical specimen of steel. Combining Equations 6.1, 6.2, and 6.5, leads to

$$\sigma = E\varepsilon$$

$$\frac{F}{\pi \left(\frac{d_0^2}{4} \right)} = E \frac{\Delta l}{l_0}$$

Or, solving for Δl (and realizing that $E = 207$ GPa, Table 6.1), yields

$$\Delta l = \frac{4F l_0}{\pi d_0^2 E}$$

$$= \frac{(4)(48,900 \text{ N})(250 \times 10^{-3} \text{ m})}{(\pi)(15.2 \times 10^{-3} \text{ m})^2 (207 \times 10^9 \text{ N/m}^2)} = 3.25 \times 10^{-4} \text{ m} = 0.325 \text{ mm} \quad (0.013 \text{ in.})$$

(b) We are now called upon to determine the change in diameter, Δd . Using Equation 6.8

$$\nu = -\frac{\varepsilon_x}{\varepsilon_z} = -\frac{\Delta d / d_0}{\Delta l / l_0}$$

From Table 6.1, for steel, $\nu = 0.30$. Now, solving the above expression for Δd yields

$$\Delta d = -\frac{\nu \Delta l d_0}{l_0} = -\frac{(0.30)(0.325 \text{ mm})(15.2 \text{ mm})}{250 \text{ mm}}$$

$$= -5.9 \times 10^{-3} \text{ mm} \quad (-2.3 \times 10^{-4} \text{ in.})$$

The diameter will decrease.