

6.15 This problem asks that we calculate the force necessary to produce a reduction in diameter of 2.5×10^{-3} mm for a cylindrical bar of aluminum. For a cylindrical specimen, the cross-sectional area is equal to

$$A_0 = \frac{\pi d_0^2}{4}$$

Now, combining Equations 6.1 and 6.5 leads to

$$\sigma = \frac{F}{A_0} = \frac{F}{\frac{\pi d_0^2}{4}} = E \varepsilon_z$$

And, since from Equation 6.8

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

Substitution of this equation into the above expression gives

$$\frac{F}{\frac{\pi d_0^2}{4}} = E \left(-\frac{\Delta d}{\nu d_0} \right)$$

And, solving for F leads to

$$F = -\frac{d_0 \Delta d \pi E}{4 \nu}$$

From Table 6.1, for aluminum, $\nu = 0.33$ and $E = 69$ GPa. Thus,

$$\begin{aligned} F &= -\frac{(19 \times 10^{-3} \text{ m})(-2.5 \times 10^{-6} \text{ m})(\pi)(69 \times 10^9 \text{ N/m}^2)}{(4)(0.33)} \\ &= 7,800 \text{ N (1785 lb}_f\text{)} \end{aligned}$$