6.22 This problem asks that we assess the four alloys relative to the two criteria presented. The first criterion is that the material not experience plastic deformation when the tensile load of 35,000 N is applied; this means that the stress corresponding to this load not exceed the yield strength of the material. Upon computing the stress

$$\sigma = \frac{F}{A_0} = \frac{F}{\pi\left(\frac{d_0}{2}\right)^2} = \frac{35{,}000 \text{ N}}{\pi\left(\frac{15 \text{ x } 10^{-3} \text{ m}}{2}\right)^2} = 200 \text{ x } 10^6 \text{ N/m}^2 = 200 \text{ MPa}$$

Of the alloys listed, the Al, Ti and steel alloys have yield strengths greater than 200 MPa.

Relative to the second criterion (i.e., that Δd be less than 1.2 x 10^{-2} mm), it is necessary to calculate the change in diameter Δd for these three alloys. From Equation 6.8

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

Now, solving for Δd from this expression,

$$\Delta d = -\frac{\nu\sigma d_0}{E}$$

For the aluminum alloy

$$\Delta d = -\frac{(0.33)(200 \text{ MPa})(15 \text{ mm})}{70 \text{ x } 10^3 \text{ MPa}} = -1.41 \text{ x } 10^{-3} \text{ mm}$$

Therefore, the Al alloy is not a candidate.

For the steel alloy

$$\Delta d = -\frac{(0.27)(200 \text{ MPa})(15 \text{ mm})}{205 \text{ x } 10^3 \text{ MPa}} = -0.40 \text{ x } 10^{-2} \text{ mm}$$

Therefore, the steel is a candidate.

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