EXAMPLE 1–2 A solid circular rod of diameter d undergoes a bending moment $M = 100$ N · m inducing a stress $\sigma = 16M/(\pi d^3)$. Using a material strength of 170 MPa and a *design factor* of 2.5, determine the minimum diameter of the rod. Using Table A–17, select a preferred fractional diameter and determine the resulting *factor of safety*.

Solution From Eq. (1–3), $\sigma = S/n_d$, then

$$\sigma = \frac{16M}{\pi d^3} = \frac{S}{n_d}$$

Solving for d yields

Answer
$$d = \left(\frac{16Mn_d}{S\pi}\right)^{1/3} = \left(\frac{16(100)2.5}{170(10)^6\pi}\right)^{1/3} = 0.021\text{ m} = 21.1\text{ mm}$$

From Table A–17, the next higher preferred size is 22 mm. Thus, when n_d is replaced with n in the equation developed above, the factor of safety n is

Answer
$$n = \frac{\pi Sd^3}{16M} = \frac{\pi(170)(10^6)0.022^3}{16(100)} = 3.55$$