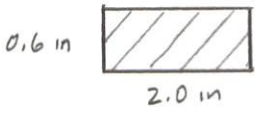
11-10

A metal bar with a 2.0 in. (50-mm) x 0.6 in. (15-mm) rectangular section is subjected to a tensile load of 18 kips (80 kN). At this load, the bar stretches 0.012 in. (0.305 mm) over an 8.0 in (200-mm) gage length. Assuming that the proportional limit of the material is 27,560 psi (190 MPa), determine the modulus of elasticity of the material and indicate a possible type of metal comprising the bar.



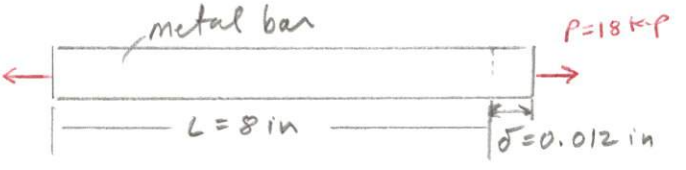
$A = 2.0\text{ in} \times 0.6\text{ in} = 1.2\text{ in.}^2$

Tensile Stress

$$\sigma = \frac{P}{A} = \frac{18\text{ kip}}{1.2\text{ in}^2} = 15\text{ ksi} = 15{,}000\text{ psi} < \sigma_p = 27{,}560\text{ psi}$$

The allowable tensile stress is well within the proportional limit, the axial deformation is elastic, and the following formula for elastic deformation applies:

$$\delta = \frac{PL}{AE}$$



$P = 18\text{ kip}$

$L = 8\text{ in.}$

$A = 1.2\text{ in.}^2$

$\delta = 0.012\text{ in.}$

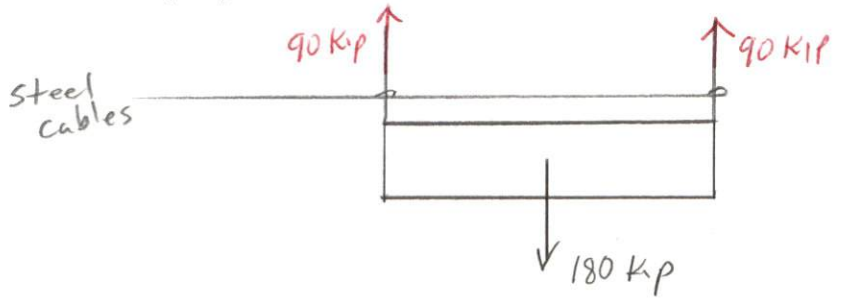
$$E = \frac{PL}{\delta A} = \frac{18\text{ kip}\,(8\text{ in})}{1.2\text{ in.}^2\,(0.012\text{ in.})}$$

$$= 10{,}000\text{ ksi}$$

Possible type of metal is Aluminum.

11-14

Two high-strength steel cables with σ_y = 102 ksi (700 MPa) support a load of 180 kip (800 kN). Assuming that the cables share the load equally and using a factor of safety of 2 to guard against yielding, select the diameter of the cable to the nearest inch (mm).



F.S. = 2

$$\sigma_{allow} = \frac{\sigma_y}{2} = \frac{102\ ksi}{2} = 51\ ksi$$

$$\sigma = \frac{P}{A} \Rightarrow A = \frac{P}{\sigma_{allow}} = \frac{90\ Kip}{51\ Kip/in^2} = 1.7647\ in.^2$$

$$A = \frac{\pi d^2}{4} = 1.7647\ in.^2$$

$$d = \sqrt{\frac{4(1.7647\ in.^2)}{\pi}} = 1.49896\ in.$$

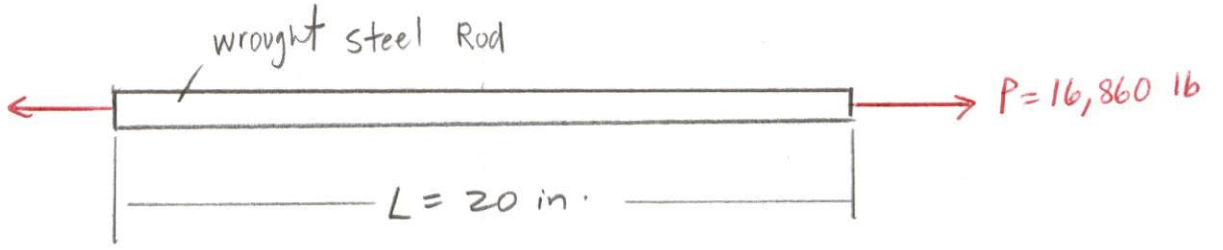
use, $d = \underline{2.0\ in}$

OR, use $d = 1.5$ in

(nearest ½-in)

11-16

A wrought steel rod 20 in. (500 mm) long is subjected to a tensile load of 16, 860 lb (75 kN). The allowable tensile stress is 21,760 psi (150 MPa), and the allowable elongation is not to exceed 0.009843 in. (0.25 mm). Select the diameter of the rod to the nearest sixteenth of an in. (mm). The modulus of elasticity is 30,460 ksi (210 GPa).



$\sigma_{allow} = 21,760$ psi

$\delta = 0.009843$ in.

$E = 30,460$ ksi

For strength

$$A = \frac{P}{\sigma_{allow}} = \frac{16,860 \text{ lb}}{21,760 \text{ lb/in.}^2} = 0.775 \text{ in.}^2$$

For Stiffness

$$A = \frac{PL}{\delta E} = \frac{16,860 \text{ lb} \left(\frac{\text{Kip}}{1000 \text{ lb}}\right)(20 \text{ in.})}{0.009843 \text{ in.} \left(30,460 \frac{\text{Kip}}{\text{in.}^2}\right)} = 1.1247 \text{ in.}$$

Stiffness Governs

$$\frac{\pi d^2}{4} = 1.1247 \text{ in.}^2$$

$$d = \sqrt{\frac{4(1.1247 \text{ in.}^2)}{\pi}} = 1.197 \text{ in.}$$

use, $d = 1\ 4/16$ in.

$= 1\text{-}1/4$ in.

$(d = 1.25$ in.)