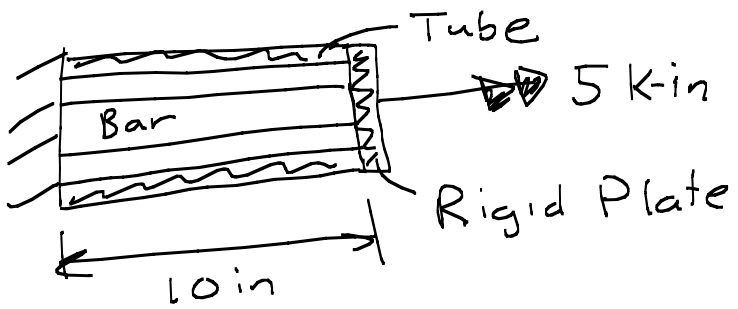
Problem 3



Bar: $I_p = 1\ in^4$, $G = 10{,}000\ ksi$

Tube: $I_p = 2\ in^4$, $G = 6{,}000\ ksi$

Determine

- The torque in the bar and the tube
- The total angle of twist

Equilibrium

$$T_{bar} + T_{tube} = 5\ K\cdot in$$

Compatibility

$$\phi_{bar} = \phi_{tube}$$

$$\phi = \frac{TL}{GI_p}$$

$$\frac{T_{bar}\cancel{L}}{G_{bar}(I_p)_{bar}} = \frac{T_{tube}\cancel{L}}{G_{tube}(I_p)_{tube}}$$

$$\frac{T_{bar}}{(10{,}000\,ksi)(1\,in^4)} = \frac{T_{tube}}{(6{,}000\,ksi)(2\,in^4)}$$

$$1.2\,T_{bar} = T_{tube}$$

$$T_{bar} = 2.27\ k\cdot in$$
$$T_{tube} = 2.73\ k\cdot in$$

$$\phi = \phi_{bar} = \phi_{tube}$$

$$= \frac{(2.27\ k\cdot in)(10\,in)}{(10{,}000\,ksi)(1\,in^4)} = 2.27\times10^{-3}\ radians$$

$$\phi = 0.13^{\circ}$$