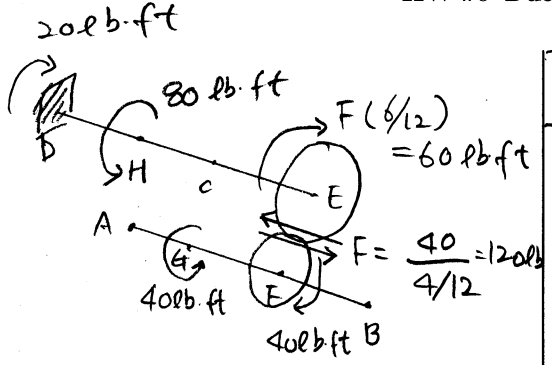
5-59



$$\phi_E = \sum \frac{TL}{JG}$$

$$= \frac{1}{\frac{\pi}{2}(0.5^4)(11)(10^6)}\left[-60(12)(30)+(20)(12)\times(10)\right]$$

$$= \left|-0.01118 \text{ rad}\right| = 0.01118 \text{ (rad)}$$

$$\phi_F = \frac{6}{4}\phi_E = \frac{6}{4}(0.01118) = 0.02667$$

$$\phi_{A/F} = \frac{T_{GF} L_{GF}}{JG}$$

$$= \frac{-40(12)(10)}{\frac{\pi}{2}(0.5^4)(11)(10^6)}$$

$$= |-0.004444| \text{ (rad)}$$

$$= 0.004445 \text{ (rad)}$$

$$\phi_A = \phi_F + \phi_{A/F}$$

$$= 0.02667 + 0.004445 \text{ (rad)}$$

$$= 0.03111 \text{ (rad)}$$

$$= \underline{1.78^\circ}$$

5-64

· Allowable shear stress

$$\tau_{max} = \tau_{allow} = \frac{T_{BC} \cdot C}{J}$$

$$12.0 = \frac{T(0.5)}{\frac{\pi}{2}(0.5^4)}$$

$$\underline{T = 2.356 \text{ (kip·in)}}$$

$$\tau_{max} = \tau_{allow} = \frac{T_{BA} \cdot C}{J}$$

$$12.0 = \frac{T(1)}{\frac{\pi}{2}(1^4 - 0.15^4)}$$

$$\underline{T = 12.89 \text{ kip·in}}$$

· Angle of Twist

$$\phi_B = \frac{T_{BA} \cdot L_{BA}}{J \cdot G} = \frac{T(12)}{\frac{\pi}{2}(1^4 - 0.15^4)(11)(10^3)}$$

$$= 0.001016 (T)$$

$$\phi_{C/B} = \frac{T_{BC} \cdot L_{BC}}{JG} = \frac{T(24)}{\frac{\pi}{2}(0.5^4)(11)(10^3)}$$

$$= 0.022224 (T)$$

$$(\phi_C)_{allow} = \phi_B + \phi_{C/B}$$

$$\frac{3\pi}{180} = (0.001016 + 0.022224)T$$

$$\underline{T = 2.25 \text{ (kip·in)}}$$

↑ answer