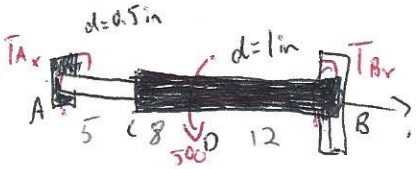


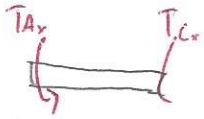
since both ends are fixed, we know $\phi_{B/A} = 0$

① Combatibility

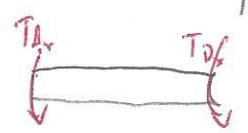
$$\phi_{B/A} = 0 = \phi_{C/A} + \phi_{D/C} + \phi_{B/D}$$

②
$$\phi_{B/A} = \frac{T_{AC} L_{AC}}{G \cdot J_{AC}} + \frac{T_{CD} L_{CD}}{G \cdot J_{CD}} + \frac{T_{DB} L_{DB}}{G \cdot J_{DB}}$$

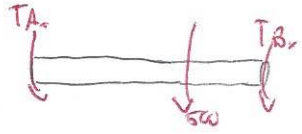
③ Cuts to find Torque (about x axis)



$$T_{Ax} + T_{Cx} = 0$$
$$T_{Cx} = -T_{Ax}$$



$$T_{Ax} + T_{Dx} = 0$$
$$T_{Dx} = -T_{Ax}$$



$$T_{Bx} + 500 + T_{Ax} = 0$$
$$T_{Bx} = -T_{Ax} - 500$$

④ Solve for Polar MoI

$$J_{AC} = \pi/2 (0.25)^4 = 6.136E\text{-}3 \text{ in}^4$$
$$J_{BC} = \pi/2 (0.5)^4 = 98.2E\text{-}3 \text{ in}^4$$

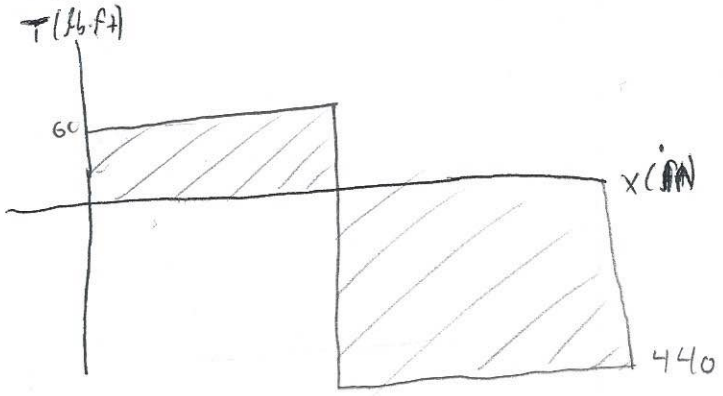
⑤ Solve for unknown

$$0 = -\frac{T_{Ax}}{G}\left[\frac{L_{AC}}{J_{AC}} + \frac{L_{CD}}{J_{BC}} + \frac{L_{DB}}{J_{DB}}\right] - \frac{500 L_{DB}}{J_{DB} \cdot G}$$

$$T_{Ax} = -720 \text{ lb·in}$$
$$= -60 \text{ lb·ft}$$

$$T_{Ax} + T_{Bx} = -500$$
$$T_{Bx} = -440$$

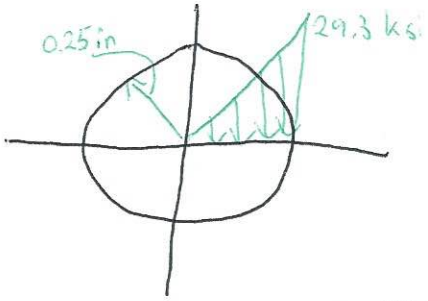
⑥



⑦
$$\tau_{AC} = \frac{720 \text{ lb·in} \cdot 0.25 \text{ in}}{6.136E\text{-}3 \text{ in}^4}$$
$$= 29300 \text{ psi}$$
$$= 29.3 \text{ ksi}$$

$$\tau_{DB} = \frac{440 \text{ lb·ft} \cdot 12 \text{ in/ft} \cdot 0.5 \text{ in}}{98.2E\text{-}3 \text{ in}^4}$$
$$= 26900 \text{ psi}$$
$$= 26.9 \text{ ksi}$$

⑧



∴ Maximum shear stress is 29.3 ksi