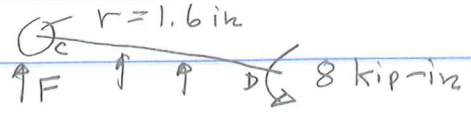
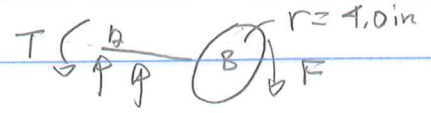
ME 35c HW #3

3.21



$\Sigma M_{CD} = 0 = 8\ \text{kip-in} - F \cdot 1.6\ \text{in}$

$F = 5\ \text{kips}$



$\Sigma M_{AB} = 0 = T - F \cdot 4\ \text{in}$

$T = 20\ \text{kip-in}$

$J = \frac{1}{2}\pi c^4$

$\tau_{max} = \frac{Tc}{J} = \frac{2}{\pi} T \frac{1}{c^3} \leq 7.5\ \text{ksi}$

(AB) $c \geq 1.193\ \text{in} \Rightarrow$ **diameter ≥ 2.386 in** using $T = 20$ k-in

(CD) $c \geq 0.879\ \text{in} \Rightarrow$ **diameter ≥ 1.758 in** using $T = 8$ k-in

3.33 $J = \frac{1}{2}\pi c^4 = 402.12\ \text{in}^4$ using $c = 4$ in

$L = 60{,}000\ \text{in}$, $G = 11.2 \times 10^6\ \text{psi}$, $\phi = 4\pi\ \text{rad}$

$T = \frac{JG}{L}\phi = 943{,}260\ \text{in-k}$

$\tau_{max} = \frac{Tc}{J} = 9.38\ \text{ksi}$

3.107 When yield reaches hole, $\rho_Y = 0.015\ \text{mm}$

$\gamma_Y = \tau_Y / G = 180\ \text{MPa} / 77.2\ \text{GPa} = 2.3316 \times 10^{-3}$

$L = 0.9\ \text{m}$

ϕ when yield reaches hole $= \frac{\gamma_Y \cdot L}{\rho_Y} = 0.1399\ \text{rad} = 8.02°$

$$T = \int_{C\text{-}S} \rho\, \tau_Y\, dA = 2\pi \tau_Y \int_{0.15\text{m}}^{0.35\text{m}} \rho^2 d\rho = 14.89\ \text{kN-m}$$

$\tau = \tau_Y = 180\ \text{MPa}$ over entire section

3.137 For W8×31, $\downarrow a$ $\downarrow b$

flange is 7.995 in × 0.435 in

web is 8.000 in × 0.285 in

} Appendix C of text

$C_1 = C_2 = \frac{1}{3}\left(1 - 0.630\,\frac{b}{a}\right) = 0.3219$ for flange

$= 0.3259$ for web

$J_{flange} = C_2\, a b^3 = 0.2118\ in^4$

$J_{web} = C_2\, a b^3 = 0.0604\ in^4$

$J_{total} = 2 \cdot J_{flange} + J_{web} = 0.4840\ in^4$

$T_{flange} = 5\ kip\text{-}in \cdot J_{flange} / J_{total} = 2.188\ kip\text{-}in$

$T_{web} = 5\ kip\text{-}in \cdot J_{web} / J_{total} = 0.624\ kip\text{-}in$

$\tau_{max,\,flange} = T_{flange} / C_1 a b^2 = \underline{4.49\ ksi}$

$\tau_{max,\,web} = T_{web} / C_1 a b^2 = \underline{2.95\ ksi}$

$\phi = T_{total} \cdot L / J_{total} G = 0.0885\ rad = \underline{5.07^\circ}$

3.139 mid-thickness dimensions are 0.115 m and 0.069 m

$A = 0.115\,m \times 0.069\,m = 0.007935\ m^2$

$T = 5k\ N \cdot m$

$t_a = 0.006\,m, \quad t_b = 0.010\,m$

$\tau = T / 2tA$ $= \boxed{52.5\ MPa \text{ at } a}$

$= \boxed{31.5\ MPa \text{ at } b}$