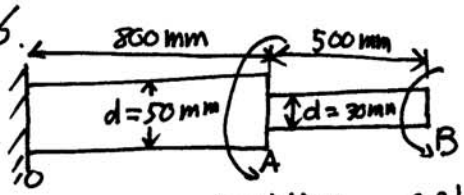
HW 6 Review

6.6.



$\tau_Y = 160$ MPa

$T_{OA} = 2$ kN·m, $T_{AB} = 0.3$ kN·m

$J_{OA} = \frac{\pi}{32}(0.05)^4 = 6.136\times10^{-7}$ m⁴

$J_{AB} = \frac{\pi}{32}(0.030)^4 = 7.952\times10^{-8}$ m⁴

(a) $\tau_{OA} = \frac{T_{OA} r_{OA}}{J_{OA}} = 81.49$ MPa

$\tau_{AB} = \frac{T_{AB} r_{AB}}{J_{AB}} = 56.59$ MPa

(b) $\tau_{max} = \tau_{OA} = 81.49$ MPa

S.F. $= \frac{\tau_Y}{\tau_{max}} = 1.96$

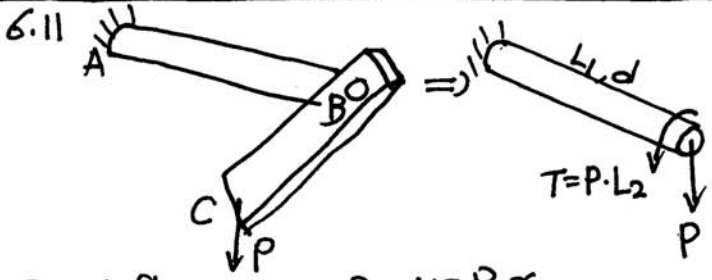
6.7. angle of twist at B, $G = 77.5$ GPa

$\psi_B = \psi_{OA} + \psi_{AB} = \theta_{OA} L_{OA} + \theta_{AB} L_{AB}$

$= \frac{T_{OA} L_{OA}}{G J_{OA}} + \frac{T_{AB} L_{AB}}{G J_{AB}}$

$= 0.0243 + 0.0336 = 0.058$ rad

6.11



δ_B : deflection by P, $M = P\cdot x$

$y_B = y_0 + \theta_0 x - \frac{P\cdot x}{2EI}x^2 - \frac{Px^3}{6EI} = -\frac{P}{3EI}x^3$

$\therefore \delta_B = \frac{PL_1^3}{3EI}$ (downward)

· Rotation at B

$\psi = \theta L_1 = \frac{TL_1}{GJ} = \frac{PL_1L_2}{GJ}$

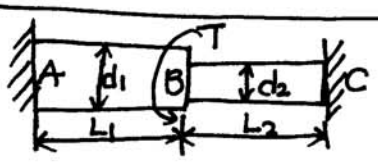
· Deflection at C

$\delta_C = \delta_B + \psi\cdot L_2 = \frac{PL_1^3}{3EI} + \frac{PL_1L_2^2}{2GI}$

$= \frac{PL_1}{6I}\left(\frac{2GL_1^2 + 3EL_2^2}{EG}\right) = \Delta$

$\therefore P = \underbrace{\frac{6IEG}{L(2GL_1^2 + 3EL_2^3)}}_{k}\Delta$

6.18



$Y = 450$ MPa

$G = 77$ GPa

(a) $J_1 = 40863.4$ mm⁴, $J_2 = 12929.4$ mm⁴

Statically indeterminate system.

$\psi_B = \frac{T_1L_1}{GJ_1} = \frac{T_2L_2}{GJ_2}$, $T_1 + T_2 = T$

$\therefore T_1 = 0.8006T$, $\tau_{AB} = \frac{T_1 d_1}{J_1} = 0.0002488T$

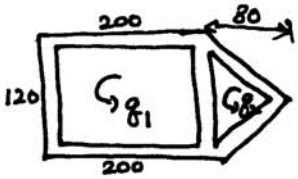
$T_2 = 0.1994T$, $\tau_{BC} = \frac{T_2 d_2}{J_2} = 0.0001469T$

$\therefore$ Section AB yields first.

$\tau_Y = 0.0002488T \Rightarrow T = 1.809$ kN·m (2)

(b) $\psi_B = \frac{T_1L_1}{GJ_1} = 4.6\times10^{-7}$ rad. (2)

6.57 $L = 3$ m, $T = 11$ kN·m



$A_1 = 24{,}000$ mm²

$A_2 = 4800$ mm²

$T = 2A_1q_1 + 2A_2q_2 = 48000q_1 + 9600q_2$

$\theta = \frac{1}{2GA_1}\left[\frac{520}{5}q_1 + \frac{120}{4}(q_1 - q_2)\right]$

$= \frac{1}{2GA_2}\left[\frac{200}{5}q_2 + \frac{120}{4}(q_2 - q_1)\right] \Rightarrow q_1 = 1.338q_2$

$11\times10^6 = 48000(1.338q_2) + 9600q_2$

$\therefore q_2 = 149$ N/mm, $q_1 = 199.4$ N/m

$\tau_{max} = \frac{q_1}{5} = 39.9$ MPa

$\psi = \theta\cdot L = 0.0513$ rad