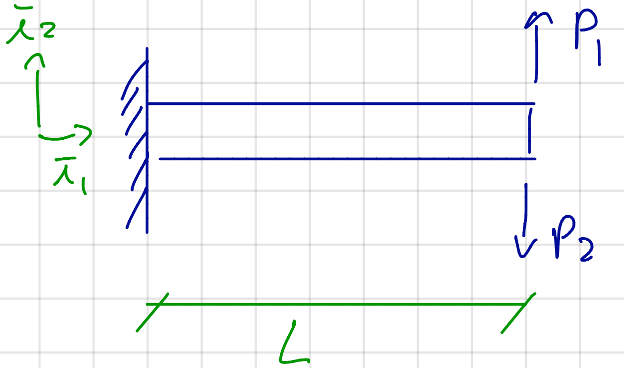
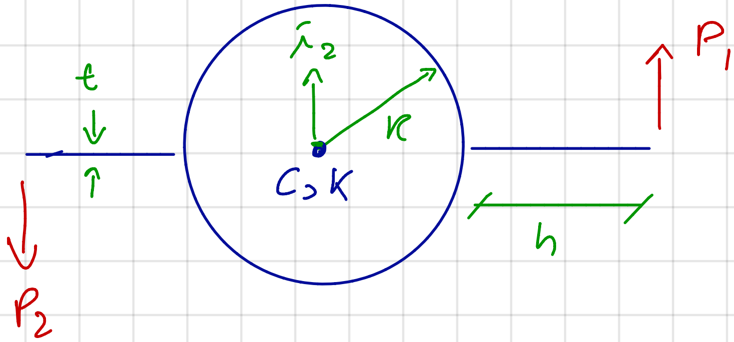
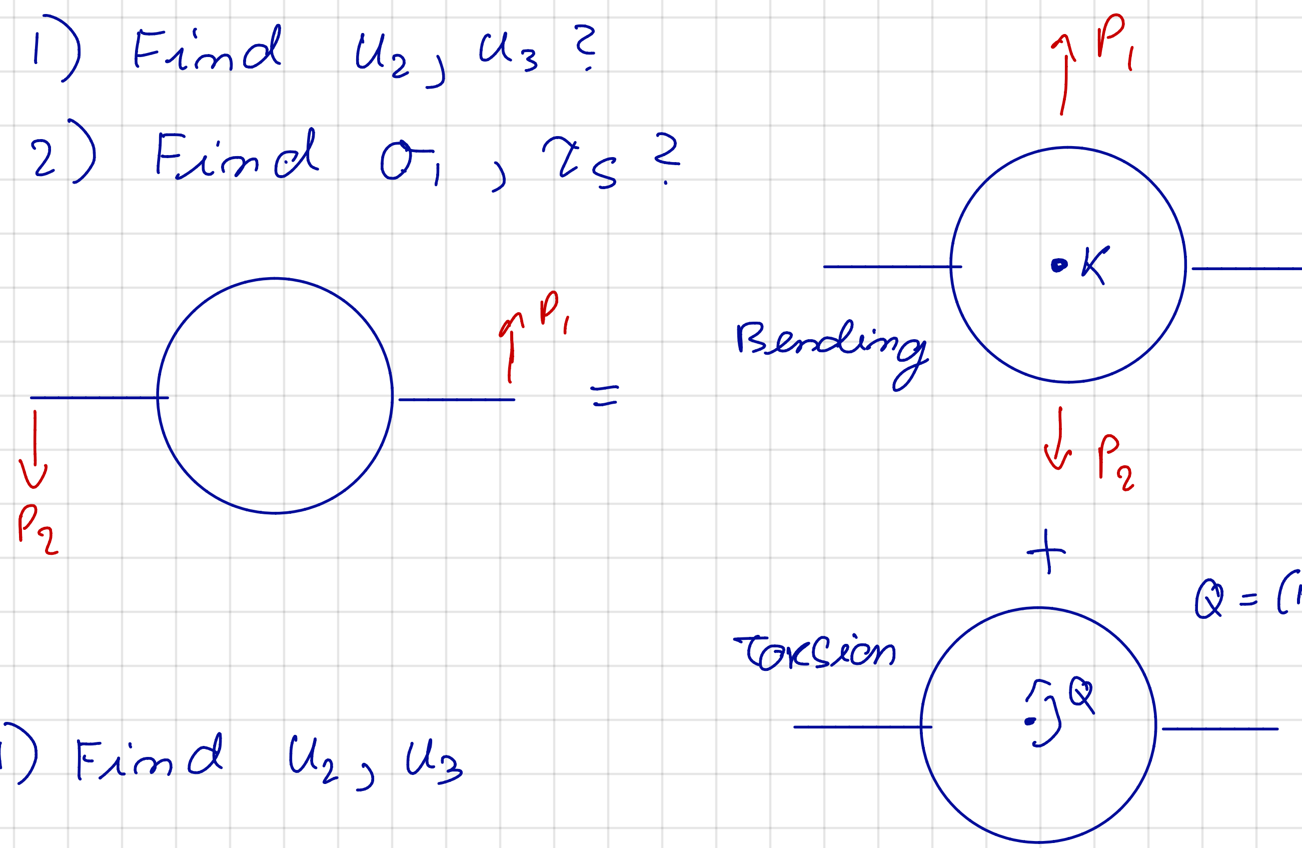




1) Find u_2, u_3 ?

2) Find σ_1, τ_s ?

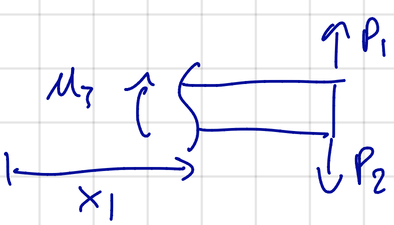


$Q = (P_1 + P_2)(R/2 + h)$

1) Find u_2, u_3

$$u_2 = u_2^{BEND} + u_2^{TOR}$$

$$u_3 = u_3^{BEND} + u_3^{TOR}$$

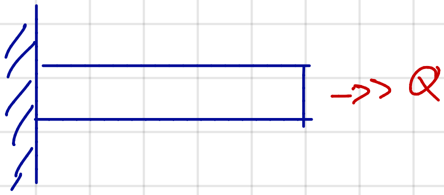


$$M_3 = (P_1 - P_2)(L - x_1)$$

$$H_{33}^c \frac{d^2 u_2^{BEND}}{dx_1^2} = M_3 = (P_1 - P_2)(L - x_1)$$

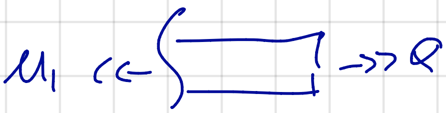
$$* \; u_2^{BEND} = \frac{(P_1 - P_2)}{\pi E R^3 t}\left(\frac{L x_1^2}{2} - \frac{x_1^3}{6}\right)$$

$* \; u_3^{BEND} = 0$ Since $M_2 = 0$, $H_{23}^c = 0$



$$Q = (P_1 + P_2)(R/2 + h)$$

$$M_1 = Q$$



$$H_{11} \frac{d\Phi_1}{dx_1} = Q$$

$$\phi_1 = \frac{(P_1 + P_2)(R/2 + h)}{2\pi G R^3 t} x_1 + \cancel{C_1}^{\,0}$$

$$* \quad u_2^{TOR} = -x_3 \, \phi_1$$

$$* \quad u_3^{TOR} = x_2 \, \phi_1$$

$$* \begin{cases} u_2 = \dfrac{(P_1 - P_2)}{\pi E R^3 t}\left(L \dfrac{x_1^2}{2} - \dfrac{x_1^3}{6}\right) - \dfrac{(P_1 + P_2)(R/2 + h)}{2\pi G R^3 t} x_1 x_3 \\[2ex] u_3 = 0 + \dfrac{(P_1 + P_2)(R/2 + h)}{2\pi G R^3 t} x_1 x_2 \end{cases}$$

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2) Find σ_1 & τ_s

a) Find σ_1

$$\sigma_1 = E\left(-x_2 \frac{M_3}{H_{33}^c}\right) = -x_2 \cancel{E} \frac{(P_1 - P_2)(L - x_1)}{\pi \cancel{E} R^3 t}$$

$$\sigma_{1,max} = \frac{(P_1 - P_2) L}{\pi R^2 t}$$

b) Find τ_S

$$\tau_S = \tau_S^{BEND} + \underline{\tau_S^{TOR}}$$

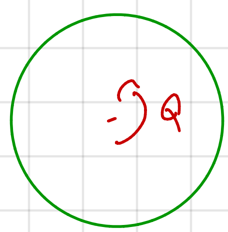
Torsion

$$M_1 = M_1^{CLOSED} + M_1^{FLANGES}$$

$$M_1^{FLANGE} = H_{11}^{FLANGE} \cdot K_1 = \frac{H_{11}^{Flange}}{H_{11}} Q$$

$$\frac{H_{11}^{FLANGE}}{H_{11}} = \frac{\frac{1}{3} \cancel{G} t^3 h}{2\pi \cancel{G} R^3 t} = \frac{1}{6\pi} \underbrace{\left(\frac{t}{R}\right)^2}_{\text{Very Small}} \underbrace{\frac{h}{R}}_{\text{order 1}}$$

$$M_1^{Flange} \approx 0$$

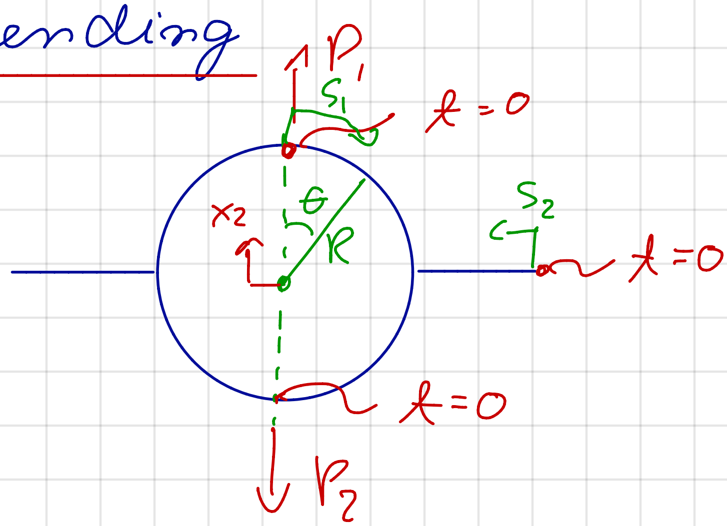


This is the problem assuming $M_1^{Flange} \approx 0$

$$\tau_S^{TOR} = \frac{M_1^{CLOSED}}{2 \cdot A_c \cdot t} \approx \frac{Q}{2 A_c t}$$

$$* \; \tau_S^{TOR} = \frac{(P_1 + P_2)(R/2 + h)}{2 \pi R^2 t}$$

Bending



$$f(s) = C + \frac{Q_3(s)\, V_2}{H_{33}^C}$$

$$f(s_2) = 0 + \frac{Q_3(s_2)\, V_2}{H_{33}^C} \qquad Q_3(s_2) = \int_0^{s_2} E\, x_2\, t\, ds_2 = 0$$

$$* \; f(s_2) = 0$$

$$f(s_1) = 0 + \frac{Q_3(s_1)\, V_2}{H_{33}^C}$$

$$Q_3(s_1) = \int_0^{s_1} E t\, x_2\, ds_1 = \int_0^{\theta} E t\, R \cos(\theta)\, R\, d\theta$$

$$Q_3(s_1) = E\, t R^2 \operatorname{Sen}(\theta)$$

$$f(s_1) = \frac{(P_1 - P_2)}{H_{33}^C} E t\, R^2 \operatorname{Sen}(\theta) \qquad s_1 = R\theta$$

$$\tau_s^{BEND}(\theta) = \frac{(P_1 - P_2)}{\pi \cancel{E} R^3 \cancel{t}} \cancel{Et} R^2 \operatorname{Sen}(\theta) = \frac{(P_1 - P_2)\operatorname{Sen}(\theta)}{\pi R t}$$

$$\tau_S(\theta) = \frac{(P_1 + P_2)(R/2 + h)}{2\pi R^2 t} + \frac{(P_1 - P_2)\,\mathrm{Sen}(\theta)}{\pi R t}$$