Q1a

$d = 1.128a$

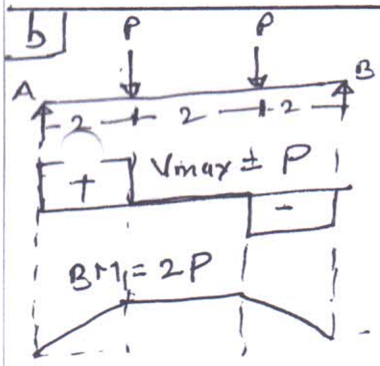
$$\sigma_{b\,cir} = \frac{M}{Z} = \frac{M}{\frac{\pi}{32}d^3} = \frac{32M}{\pi(1.128a)^3}$$

$$= 7.097\frac{M}{a^3} \quad \text{--- (2)}$$

$$\sigma_{b\text{-}rect} = \frac{M}{Z} = \frac{M}{\frac{a^3}{6}} = \frac{6M}{a^3} \quad \text{--- (2)}$$

Ratio $\dfrac{\sigma_{b\,cir}}{\sigma_{b\text{-}rect}} = \dfrac{7.097}{6} = 1.18$ --- (2)

b



$V_{max} = P$ kN --- ½

$BM_{max} = 2P$ kNm --- ½

For max. bending stress

$M = \sigma \cdot Z$

$$2P\times10^6 = 60\left(\frac{150\times300^2}{6}\right)$$

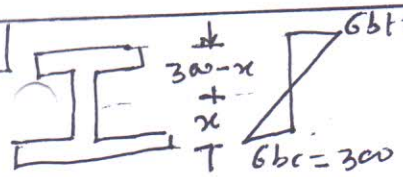
$\boxed{P = 67.5\text{N}}$ --- (2)

For maxi shear stress

$$\tau_{max} = 1.5\,\tau_{av} = 1.5\left(\frac{P\times10^3}{150\times300}\right) = 1.5$$

$\boxed{P = 45\text{N}}$ --- (2)

c



--- (2)

$$\frac{300}{x} = \frac{150}{300-x}$$

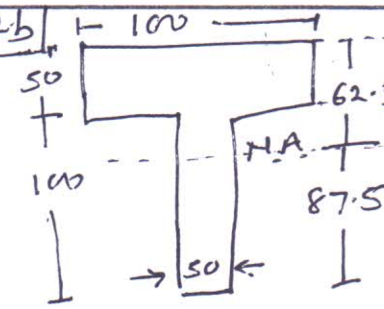
$\boxed{x = 200\text{mm}}$ --- (2)

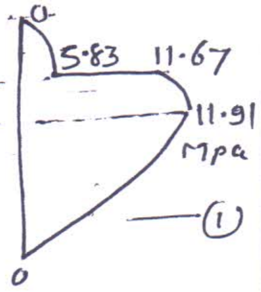
Q2a $MR_{sq.section} = \sigma\cdot Z = \sigma\left(D^3/6\right)$ --- (2)

$M.R._{circular} = \sigma\left(\frac{\pi}{32}D^3\right)$ --- (2)

Ratio $\dfrac{MR_{sq}}{MR_{cir}} = \dfrac{\sigma D^3/6}{\sigma\left(\frac{\pi}{32}D^3\right)} = 1.7$ --- (2)

Q2b





--- (1)

$\bar{y} = 87.5$ from bottom --- (1)

$I_{NA} = 19.27\times10^6\ \text{mm}^4$ --- (1)

$\tau = \dfrac{VA\bar{y}}{bI}$, At Junction

$$\tau = \frac{60\times10^3(100\times50\times37.5)}{100\times19.27\times10^6} = 5.838\text{ mpa}$$

$$= 11.676\text{ mpa}$$

$$\tau_{NA} = \frac{60\times10^3(87.5\times50\times43.75)}{50\times19.27\times10^6} = 11.91\text{ Mpa}$$

(3)

c $\tau_{max} = 1.5\,\tau_{av} = 1.5\dfrac{(50\times10^3)}{100\times d} = 5$ --- (2)

$d = \cancel{300\ \text{mm}}\ 150\text{ mm}$ --- (2)

Q3a $L_{eff} = 3m$, $I_{mini} = I_{yy} = 2.1936\times10^7$

$r_{mini} = \sqrt{\dfrac{I_{yy}}{A}} = 54.13\text{ mm}$ --- (1)

$$\alpha = \frac{\sigma_y}{\pi^2E} = \frac{320}{\pi^2\times200\times10^3} = 0.162\times10^{-3}$$ --- (1)

$$P_E = \frac{\pi^2EI}{L_{eff}^2} = \frac{\pi^2\times200\times10^3\times2.1936\times10^7}{(3000)^2}$$

$\boxed{P_E = 4811.10\text{ kN}}$ --- (2)

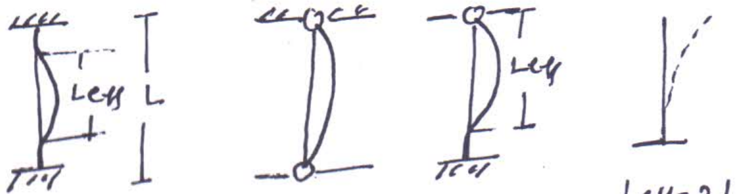
$$P_R = \frac{\sigma_y A}{1+\alpha\left(\frac{L_{eff}}{r_{mini}}\right)^2}$$

$$= \frac{320\times7485}{1+0.162\times10^{-3}\left(\frac{3000}{54.13}\right)^2}$$

$\boxed{P_R = 1600\text{ kN}}$ --- (2)

paper code: U218-114 (T2)

Q3 b



$L_{eff} = 0.5L$, $L_{eff} = L$, $L_{eff} = 0.7L$, $L_{eff} = 2L$

Each correct pattern, & Leff (1) × 4 = (4)

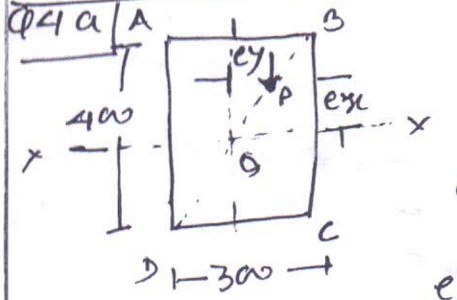
c

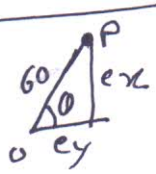
$P_{E_1} = \dfrac{\pi^2 EI}{L_{eff}^2}$, .. for both ends hinged $L_{eff} = L$ ——— (1)

$P_{E_2} = \dfrac{\pi^2 EI}{(0.5L)^2} = \dfrac{4\pi^2 EI}{L^2}$ .. both ends fixed ——— (1)

Ratio $\dfrac{P_{E_2}}{P_{E_1}} = 4$ ——— (2)

Q4 a





$e_x = 60 \sin\theta = 48\,mm$
$e_y = 60 \cos\theta = 36\,mm$ } (1)

$Z_{xx} = \dfrac{300 \times 400^2}{6} = 8 \times 10^6$
$Z_{yy} = \dfrac{400 \times 300^2}{6} = 6 \times 10^6$ } (1)

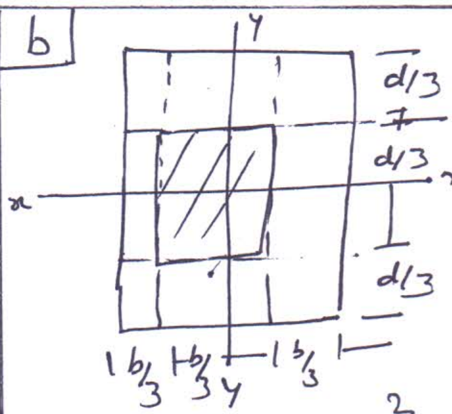
$\sigma_0 = \dfrac{P}{A} = \dfrac{300 \times 10^3}{400 \times 300} = +2.5\,Mpa\ (comp)$ ~ (1)

$\sigma b_{xx} = \dfrac{M}{Z_{xx}} = \dfrac{300 \times 10^3 \times 48}{8 \times 10^6} = \pm 1.8\,Mpa$
$\sigma b_{yy} = \dfrac{M}{Z_{yy}} = \dfrac{300 \times 10^3 \times 36}{6 \times 10^6} = \pm 1.8\,Mpa$ } (1)

At corner

$A = \sigma_0 + \sigma b_{xx} - \sigma b_{yy} = 2.5\,Mpa\ (C)$
$B = \sigma_0 + \sigma b_{xx} + \sigma b_{yy} = 6.1\,Mpa\ (C)$
$C = \sigma_0 - \sigma b_{xx} + \sigma b_{yy} = 2.5\,Mpa\ (C)$
$D = \sigma_0 - \sigma b_{xx} - \sigma b_{yy} = -1.1\,Mpa\ (T)$ } (2)

b



$I_{xx} = \dfrac{bd^3}{12}$, $Z = \dfrac{bd^2}{6}$, $A = bd$

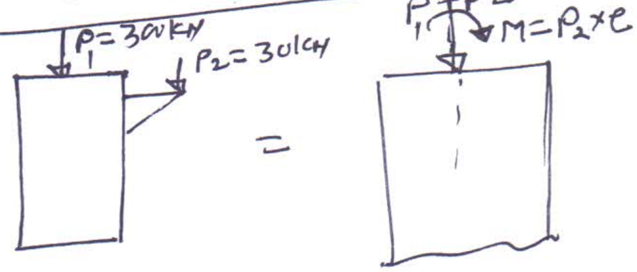
To have no-tension condition
$\sigma_0 = \sigma_b$ ——— (1)

$\dfrac{W}{A} = \dfrac{W \cdot e}{I} \cdot y \quad \therefore e = \dfrac{I}{Ay}$ ——— (2)

$e = \dfrac{bd^3/12}{bd \times d/2} = d/6$ ——— (1)

$\therefore e_{xx} \le d/6 \qquad e_{yy} = b/6$

c



$\sigma_0 = \dfrac{P_1 + P_2}{A} = \dfrac{330 \times 10^3}{15000} = 22\,Mpa$ ~ (1)

$\sigma_b = \dfrac{M}{Z} = \dfrac{30 \times 10^3 \times 600}{10^6} = 18\,Mpa$ ~ (1)

$\sigma_{max} = \sigma_0 + \sigma_b = 40\,Mpa$ ~ (1)

$\sigma_{min} = \sigma_0 - \sigma_b = 4\,Mpa$ ~ (1)

23/10/18