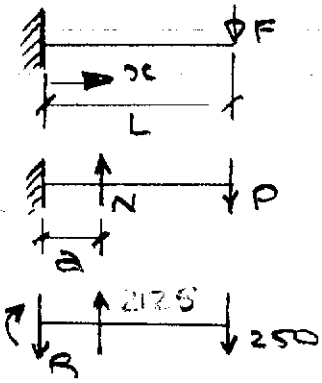
3

a) Problem is statically indeterminate - first have to resolve this to find reaction at joint.



For a cantilever, the deflection at x is:

$$\delta = \frac{F}{6EI} \cdot x^2(3L - x).$$

For the propped cantilever, the net deflection at the prop is zero, so

$$0 = P a^2(3L - a) - N a^2(3a - a)$$

$$\therefore N = \tfrac{1}{2}P(3L/a - 1). \rightarrow \text{here} = \tfrac{1}{2} \cdot 250(3 \times 6 - 1)$$

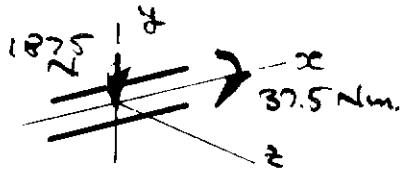
$$= 212.5 \text{ N}.$$

So support reaction is:

$$R = 212.5 - 250 = -37.5 \text{ N}$$

$$M = 212.5 \times 60 - 250 \times 360 = 37.5 \text{ Nm}.$$

Can now study the joint, the load on the joint is as shown

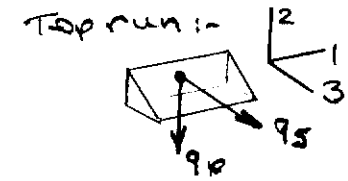


On top run at any point

$$q_2 = -q_{10} = -1875/2 \times 50 = -18.75 \text{ N/mm}.$$

$$q_3 = q_5 = My/I_{xx} = \frac{37.5 \times 10^3 \times 7.5}{2 \times 50 \times 7.5^2}$$

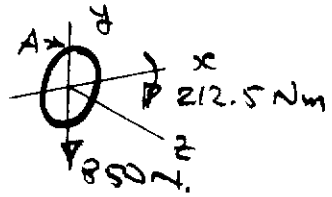
$$= 50 \text{ N/mm}$$



$$\therefore q_E = 43.8 \text{ N/mm} \quad \text{so, from (1):}$$

$$\sigma_E = 2q_E/w = \underline{17.5} \text{ MPa}.$$

b) Centroidal loading is as shown.

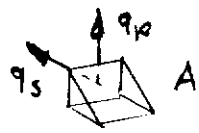


Again, out of plane loading, maximum q_{10} at points on y-axis. Consider A.

$$q_2 = q_{10} = F/L = 850/32\pi = 8.46 \text{ N/mm}$$

$$q_3 = -q_5 = -My/I = 212.5 \times 10^3 \times 16/\pi \times 16^3$$

$$= -264.2 \text{ N/mm}.$$



From (1) $q_E = 260.1$ N/mm

$$\sigma_E = 2 \times 260.1/5 = \underline{104} \text{ MPa}.$$