

SOLUTIONS TO TUTORIAL EXAMPLES

CHAPTER 20

Question (a)

$$P = 64 \text{ kN}$$

$$A = (2.0 \text{ m} \times 2.6 \text{ m}) = 5.2 \text{ m}^2$$

$$M_x = (64 \text{ kN} \times 0.4 \text{ m}) = 25.6 \text{ kNm}$$

$$Z_x = bd^2/6 = 2.0 \times 2.6^2/6 = 2.25 \text{ m}^3$$

$$M_y = 0 \text{ kNm}$$

$$Z_y = db^2/6 = 2.6 \times 2.0^2/6 = 1.73 \text{ m}^3$$

$$\sigma = \frac{P}{A} \pm \frac{M_x}{z_x} \pm \frac{M_y}{z_y}$$

$$\sigma = \frac{64}{5.2} \pm \frac{25.6}{2.25} \pm \frac{0}{1.73}$$

$$\sigma = 12.31 \pm 11.38$$

$$\sigma_A = 12.31 + 11.38 = +23.67 \text{ kN/m}^2$$

$$\sigma_B = 12.31 + 11.38 = +23.67 \text{ kN/m}^2$$

$$\sigma_C = 12.31 - 11.38 = +0.95 \text{ kN/m}^2$$

$$\sigma_D = 12.31 - 11.38 = +0.95 \text{ kN/m}^2$$

As all these values are positive, tension does not occur anywhere in this section.

Question (b)

$$P = 100 \text{ kN}$$

$$A = (4 \text{ m} \times 2 \text{ m}) = 8 \text{ m}^2$$

$$M_x = + (100 \text{ kN} \times 0.2 \text{ m}) = 20 \text{ kNm}$$

$$Z_x = bd^2/6 = 4 \times 2^2/6 = 2.67 \text{ m}^3$$

$$M_y = - (100 \text{ kN} \times 0.3 \text{ m}) = -30 \text{ kNm}$$

$$Z_y = db^2/6 = 2 \times 4^2/6 = 5.33 \text{ m}^3$$

$$\sigma = \frac{P}{A} \pm \frac{M_x}{z_x} \pm \frac{M_y}{z_y}$$

$$\sigma = \frac{100}{8} \pm \frac{20}{2.67} \pm \frac{(-30)}{5.33}$$

$$\sigma = 12.5 \pm 7.5 \pm (-5.63)$$

$$\sigma_A = 12.5 + 7.5 - (-5.63) = +25.63 \text{ kN/m}^2$$

$$\sigma_B = 12.5 + 7.5 + (-5.63) = +14.37 \text{ kN/m}^2$$

$$\sigma_C = 12.5 - 7.5 + (-5.63) = -0.63 \text{ kN/m}^2$$

$$\sigma_D = 12.5 - 7.5 - (-5.63) = +10.63 \text{ kN/m}^2$$

Tension occurs at corner C.

Question (c)

$$P = 100 \text{ kN}$$

$$A = (3 \text{ m} \times 2 \text{ m}) = 6 \text{ m}^2$$

$$M_x = (100 \text{ kN} \times 0.25 \text{ m}) = 25 \text{ kNm.}$$

$$Z_x = bd^2/6 = 3 \times 2^2/6 = 2 \text{ m}^3$$

$$M_y = (100 \text{ kN} \times 0.3 \text{ m}) = 30 \text{ kNm}$$

$$Z_y = db^2/6 = 2 \times 3^2/6 = 3 \text{ m}^3$$

$$\sigma = \frac{P}{A} \pm \frac{M_x}{z_x} \pm \frac{M_y}{z_y}$$

$$\sigma = \frac{100}{6} \pm \frac{25}{2} \pm \frac{30}{3}$$

$$\sigma = 16.67 \pm 12.5 \pm 10.0$$

$$\sigma_A = 16.67 + 12.5 - 10.0 = +19.17 \text{ kN/m}^2$$

$$\sigma_B = 16.67 + 12.5 + 10.0 = +39.17 \text{ kN/m}^2$$

$$\sigma_C = 16.67 - 12.5 + 10.0 = +14.17 \text{ kN/m}^2$$

$$\sigma_D = 16.67 - 12.5 - 10.0 = -5.83 \text{ kN/m}^2$$

Tension occurs at corner D.

Question (d)

$$P = (50 + 100) = 150 \text{ kN}$$

$$A = (0.25 \text{ m} \times 0.4 \text{ m}) = 0.1 \text{ m}^2$$

$$M_x = (50 \text{ kN} \times 0.08 \text{ m}) - (100 \text{ kN} \times 0.12 \text{ m}) = -8 \text{ kNm}$$

$$Z_x = bd^2/6 = 0.25 \times 0.4^2/6 = 6.67 \times 10^{-3} \text{ m}^3$$

$$M_y = (100 \text{ kN} \times 0.06 \text{ m}) - (50 \text{ kN} \times 0.06 \text{ m}) = +3 \text{ kNm}$$

$$Z_y = db^2/6 = 0.4 \times 0.25^2/6 = 4.17 \times 10^{-3} \text{ m}^3$$

$$\sigma = \frac{P}{A} \pm \frac{M_x}{Z_x} \pm \frac{M_y}{Z_y}$$

$$\sigma = \frac{150}{0.1} \pm \frac{-8}{6.67 \times 10^{-3}} \pm \frac{3}{4.17 \times 10^{-3}}$$

$$\sigma = 1500 \pm (-1200) \pm 719$$

$$\sigma_A = 1500 + (-1200) - 719 = -419 \text{ kN/m}^2$$

$$\sigma_B = 1500 + (-1200) + 719 = +1019 \text{ kN/m}^2$$

$$\sigma_C = 1500 - (-1200) + 719 = +3419 \text{ kN/m}^2$$

$$\sigma_D = 1500 - (-1200) - 719 = +1981 \text{ kN/m}^2$$

Tension occurs at corner A.