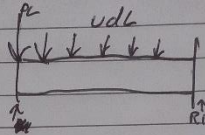


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P1

Q1

$L = 1.5m$ Point Load = $3.5kn$ UDL = $1500Nm/m$

$IE = 2.2 \times 10^6 Nm$



(a) Find y

(b) Find New Load.

$$(a) \quad \frac{-FL^3}{3EI} + \frac{WL^4}{8EI} = \frac{-(3500)^3}{3(2.2 \times 10^6)} + \frac{1500(1.5)^4}{8(2.2 \times 10^6)}$$

$$-2.22 \times 10^{-3} m$$

(b) If $y = -5$

$$y = y_{PL} + y_{udl}$$

$$y_{PL} = y - y_{udl}$$

$$y_{PL} = \frac{-3500^3}{3(2.2 \times 10^6)}$$

$$F = \frac{y_{PL}(3EI)}{L^3}$$

$$= -6496.2$$

$$F = -5 \times 10^{-3}$$

$$y_{udl} = \frac{1500(1.5)^4}{8(2.2 \times 10^6)}$$

$$y_{PL} = y - y_{udl}$$

$$y_{PL} = -5 - (4.31 \times 10^{-4})$$

$$= -4.31 \times 10^{-4}$$

$$= 4.99$$

$$y_{PL} = 5 \times 10^{-3} - (4.31 \times 10^{-4})$$

$$= 4.569 \times 10^{-3}$$

$$F = \frac{y_{PL}(3EI)}{L^3}$$

$$4.569 \times 10^{-3} (3 \times 2.2 \times 10^6)$$

$$= \frac{30155.4}{1.5^3} = \frac{30155.4}{1.5^3}$$

$$\rightarrow 8934.9N$$

$$F = -8934.9N$$

$$\rightarrow 3500 N$$

$$= 5434.9N$$

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P2

Q2 a $OD = 45 \text{ mm} \therefore r_o = 0.0225 \text{ m}$
 $ID = 35 \text{ mm} \therefore r_i = 0.0175$
 $P = 115 \times 10^5$

Find σ_c

(a) in this case. $P = 0$ (outside Pressure.)
 $P = 115 \times 10^5 \text{ N/m}^2$

Lame's

$$\sigma_R = \frac{a-b}{r^2}$$

$$\sigma_c = \frac{a+b}{r^2}$$

$$\sigma_R = -P = -115 \times 10^5 \text{ N/m}^2$$

$$-P = \frac{a-b}{r^2}$$

$$P \sigma_c = \frac{a+b}{r^2}$$

$$-115 \times 10^5 = \frac{a-b}{0.0175^2}$$

$$0 = \frac{a+b}{0.0225^2}$$

$$b = -0.0225^2 a$$

$$-115 \times 10^5 = (-0.0175^2 a) - b$$

$$-115 \times 10^5 = (-0.0175^2 a) - (-0.0225^2 a)$$

Factorise ~~$a(-0.0175^2)$~~

$$a(-0.0175^2 - 0.0225^2)$$

$$a = \frac{115 \times 10^5 (0.0175^2)}{(-0.0175^2 - 0.0225^2)}$$

$$= -17607375$$

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P3

Q3 $\epsilon_x = -10 \times 10^{-6}$ $\nu = 0.2$
 $\epsilon_y = 13 \times 10^{-6}$ $E = 165 \text{ GPa} = 165 \times 10^9$

(a) $\sigma_x = \frac{E}{1-\nu^2} \times \epsilon_x + \nu(\epsilon_y)$

$$\frac{165 \times 10^9}{1-(0.2)^2} \times -10 \times 10^{-6} + (0.2)(13 \times 10^{-6})$$

$$= -1.27 \times 10^6 \text{ Pa. compressive.}$$

(ii) $\sigma_y = \frac{E}{1-\nu^2} \times \epsilon_y + \nu(\epsilon_x)$

$$= \frac{165 \times 10^9}{1-(0.2)^2} \times 13 \times 10^{-6} + (0.2)(-10 \times 10^{-6})$$

$$= 1.89 \times 10^6 \text{ Pa tensile.}$$

(b) turn over

Q3 (b) $\sigma_x = 20 \text{ MPa}$
 $\sigma_y = -15 \text{ MPa}$

(ii) $\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y)$

$$= \frac{1}{165 \times 10^9} (20 \times 10^6 - (0.2)(-15 \times 10^6))$$

$$= 1.39 \times 10^{-4}$$

(ii) $\epsilon_y = \frac{1}{E} (\sigma_y - \nu \sigma_x)$

$$= \frac{1}{165 \times 10^9} (-15 \times 10^6 - (0.2)(20 \times 10^6))$$

$$= -1.15 \times 10^{-4}$$

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P6

Q4

$$\phi = 200 \text{ mm} \quad L = 390 \text{ mm} \quad G = 1.5 \text{ mm}$$

$$\sigma_{\max} = 100 \text{ MPa}$$

$$n_c = 0.4$$

$$n_c = 0.6$$

$$P? \quad \sigma_c = \frac{(P)(\phi)}{Q(L)n_p} \quad P = \frac{2(L)(n_c)(\sigma_c)}{\phi}$$

$$P = \frac{2(1.5)(0.7)(\sigma_{\max})}{0.2} \rightarrow 100 \times 10^6 \text{ Pa} \quad \checkmark$$

divide by ϕ

$$= 270 \times 10^6 \text{ N/m}^2 \quad \frac{270 \times 10^6}{0.2} = 1.35 \times 10^6 \text{ N/m}^2$$
$$\sigma_c = P\phi / (4(L)(n_c))$$

$$Q \phi = P = \sigma_c = \frac{P\phi}{4(L)(n_c)} \quad P = \frac{4(L)(n_c)(\sigma_c)}{\phi}$$

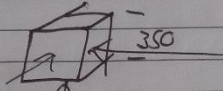
$$P = \frac{(4)(1.5)(0.6)(\sigma_{\max})}{0.2} \quad 100 \text{ MPa} = 1.8 \times 10^6 \text{ N/m}^2$$

$$P = 1.35 \times 10^6 \text{ N/m}^2$$

bank will fail at $1.35 \times 10^6 \text{ N/m}^2$

Q5.(b) orthotropic implies that, E Youngs modulus is not equal in x y z $E_x \neq E_y \neq E_z$
There will be different value.

(a)



$E = 165 \text{ GPa}$, $P = 50 \text{ MPa}$, $\nu = -0.3$

Find K , E_v and Δ_v

Original Volume = $L \times B \times h$, 350^3

$350 \text{ mm} = 0.35 \text{ m}$, $= 0.043 \text{ m}^3$

$K = \frac{E}{3} (1 - (2\nu))$ $\frac{165 \times 10^9}{3} (1 - (2(-0.3)))$

$= 1.38 \times 10^{11} \text{ N/m}^2$

$E_v = \frac{3}{E} (-P - \nu(2P))$ $E_v = \frac{-P}{K}$

$E_v = \frac{-50 \times 10^6}{1.38 \times 10^{11}} = -3.64 \times 10^{-4}$

$\Delta_v = E_v \frac{\Delta_v}{V}$ $-3.64 \times 10^{-4} = \frac{\Delta_v}{V}$

$-3.64 \times 10^{-4} (350 \times 10^{-3})^3 = \Delta_v = -1.56 \times 10^{-5} \text{ m}^3$