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11/01/21

Stress analysis and CAD

ACHA 5015

①

$$L = 1.5 \text{ m}$$

$$EI = 2.2 \times 10^6 \text{ Nm}^2$$

a.

$$\text{Deflection} = \frac{FL^3}{3EI} + \frac{wl^4}{8EI}$$

~~Deflection =~~

$$= \frac{3500 \times 1.5^3}{3 \times 2.2 \times 10^6} + \frac{1500 \times 1.5^4}{8 \times 2.2 \times 10^6}$$

$$= 0.00099$$

$$= 0.00222$$

$$y_{\text{max}} = 0.00222 \approx 2.22 \times 10^{-3}$$

b.

~~y = y_{\text{PL}} + y_{\text{DL}}~~

$$y = y_{\text{PL}} + y_{\text{DL}}$$

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

$$y_{\text{PL}} = -0.004569$$

$$y_{\text{PL}} = 4.57 \times 10^{-3}$$

$$y_{\text{PL}} = \frac{FL^3}{3EI} \Rightarrow F = \frac{y_{\text{PL}} \times 3EI}{L^3}$$

$$= \frac{4.57 \times 10^{-3} \times 3 \times 2.2 \times 10^6}{1.5^3}$$

$$F = 8936.88 \text{ N}$$

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③

$$E_x = -10 \times 10^{-6}$$

$$E_y = 13 \times 10^{-6}$$

$$\nu = 0.20$$

$$E = 165 \text{ GPa} = 165 \times 10^9 \text{ N/m}^2$$

a.

$$\sigma_x = \frac{E}{1-\nu^2} (E_x + \nu E_y) = \frac{165 \times 10^9}{1-0.20^2} (-10 \times 10^{-6} + (0.20 \times 13 \times 10^{-6}))$$

(tensile)

$$= \cancel{42968750} \quad 42968750 = 4.29 \times 10^7 \text{ N/m}^2$$

$$\sigma_y = \frac{E}{1-\nu^2} (E_y + \nu E_x) = \frac{165 \times 10^9}{1-0.20^2} (13 \times 10^{-6} + (0.20 \times -10 \times 10^{-6}))$$

$$= \cancel{32140625} \quad -32140625$$

$$= -3.2 \times 10^7 \text{ N/m}^2 \text{ (compressive)}$$

b. $\sigma_x = 20 \times 10^6 \text{ N/m}^2$

$$\sigma_y = -15 \times 10^6 \text{ N/m}^2$$

$$E_x = \frac{1}{E} (\sigma_x - \nu \sigma_y) = \frac{1}{165 \times 10^9} (20 \times 10^6 - (0.20 \times -15 \times 10^6))$$

$$E_x = 7.87 \times 10^{-5}$$

$$E_y = \frac{1}{E} (\sigma_y - \nu \sigma_x) = \frac{1}{165 \times 10^9} (-15 \times 10^6 - (0.20 \times 20 \times 10^6))$$

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

②

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Stress analysis and CHD ACHA 5015

(5) $L = 0.35 \text{ m}$
 $P = 50 \times 10^6 \text{ N/m}^2$
 $\nu = 0.3$
 $E = 165 \times 10^9 \text{ N/m}^2$

$$k = \frac{E}{3(1-\nu)} = \frac{165 \times 10^9}{3(1-(2 \times 0.3))}$$
$$= 1.375 \times 10^{11} \text{ N/m}^2$$

$$k = \frac{\sigma}{\epsilon} = \frac{-P}{\epsilon \nu}$$

$$\epsilon \nu = \frac{-P}{k} = \frac{-50 \times 10^6}{1.375 \times 10^{11}}$$
$$= -3.63 \times 10^{-4}$$

For ~~stress~~

$$\Delta V = L^3 \times \epsilon \nu = 0.35^3 \times -3.75 \times 10^{-4}$$
$$= -1.607 \times 10^{-10} \text{ m}^3$$

b.

Orthotropic has different elastic properties in different directions. This is due to ~~its~~ its structural properties. An example is a plank of wood or the structure of the fiber.

(3)