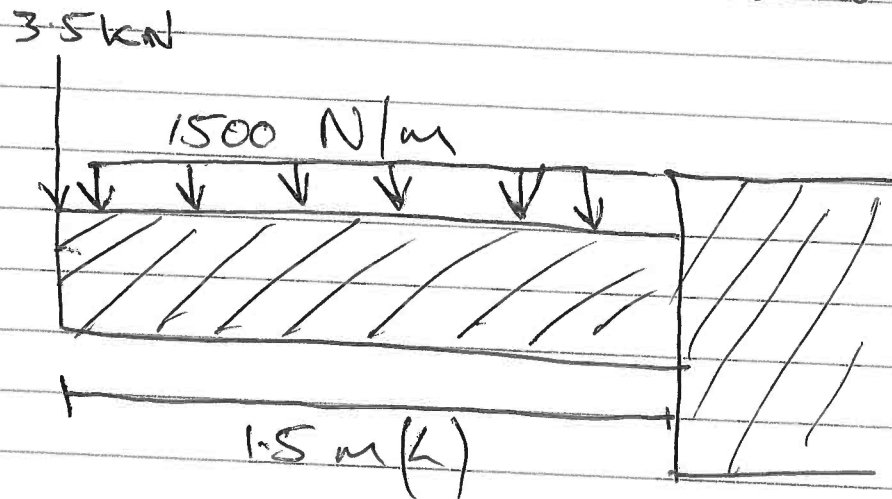


# Question 1

Robert Morse  
1806186 11/1/21



$$\text{Max Deflection} = \frac{FL^3}{3EI}$$

## Question 2

Robert Morse  
1806186 11/1/21

outside  $D = 0.045$

inside  $d = 0.035$

$$r_i = 0.0175$$

$$r_o = 0.0225$$

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

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

### Boundary Conditions

(A)

Inside Surface  $= r = r_i = 0.0175 \text{ m}$

$$\sigma_r = 115 \times 10^5 \text{ N/m}^2$$

Outside Surface  $= r = r_o = 0.0225 \text{ m}$

$$\sigma_r = 0$$

(b) Inside Surface

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

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

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

(-1)

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

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

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

outer Surface

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

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

$$0 = 0.0225^2 a - b$$

$$0 = b - 0.0225^2 a$$

$$b = 0.0225^2 a$$

$$a = \frac{115 \times 10^5 \times 0.0175^2}{0.0225^2 - 0.0175^2} = 69567.90$$

$$b = 0.0225^2 a = 0.0225^2 \times 69567.90$$

$$b = 35.23$$

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

$$\sigma_c = 69567.90 + \frac{35.23}{r^2}$$

$$\sigma_{ci} = 69567.90 + \frac{35.23}{\frac{0.115^2}{0.0175^2}} = 184604.63 \text{ Pascals}$$

$$\sigma_{co} = 69567.90 + \frac{35.23}{0.0225^2} = 139158.02 \text{ Pascals}$$

### Question 3.

Robert Morse  
1806186. 11/1/21

$$\epsilon_1 x = -10 \times 10^{-6}$$

$$\epsilon_2 y = +13 \times 10^{-6}$$

$$\nu = 0.20$$

$$E = 165 \times 10^9$$

### Stress For x.

$$\sigma_x = \frac{E}{1-\nu^2} (\epsilon_1 + \nu \epsilon_2)$$

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

$$\sigma = 1.719 \times 10^9 \times (-10 \times 10^{-6} + 2.6 \times 10^{-6})$$

$$\sigma_x = -12720.6 \text{ MPa} \text{ Compressive}$$

### Stress For y

$$\sigma_y = \frac{E}{1-\nu^2} (\epsilon_2 + \nu \epsilon_1)$$

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

$$\sigma_y = 1.719 \times 10^9 \times (13 \times 10^{-6} - 2 \times 10^{-6})$$
$$\sigma_y = 1.719 \times 10^9 \times (11 \times 10^{-6})$$

$$1.1 \times 10^{-5}$$

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

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

$$\sigma_y = 1.719 \times 10^9 \times 1.1 \times 10^{-5}$$

$$\sigma_y = 18909 \text{ pascals tensile.}$$

⑥

$$\sigma_x = 20 \times 10^6$$

$$\sigma_y = -15 \times 10^6$$

$$\epsilon_1 = \frac{1}{E} (\sigma_1 - \nu \sigma_2)$$

$$\epsilon_1 = \frac{1}{165 \times 10^9} \times 20 \times 10^6 - \left[ (0.2) \times (-15 \times 10^6) \right]$$

$$\epsilon_1 = 6.06 \times 10^{-12} \times 20 \times 10^6 - -3 \times 10^6$$

$$\epsilon_1 = 3 \times 10^6 \text{ Tensile.}$$

$$\epsilon_2 = \frac{1}{E} (\sigma_2 - \nu \sigma_1)$$

$$\epsilon_2 = \frac{1}{165 \times 10^9} \times (-15 \times 10^6 - \left[ (0.2) \times (20 \times 10^6) \right])$$

$$\epsilon_2 = 6.06 \times 10^{-12} \times -15 \times 10^6 - 4 \times 10^6$$

$$\epsilon_2 = -4 \times 10^6 \text{ Compressive}$$

# Question 4

Robert Morse  
1806186 11/1/21

$$d = 0.2 \text{ m}$$

$$L = 0.39 \text{ m}$$

$$t = 0.0015 \text{ m}$$

$$P_{\max} = ?$$

$$\sigma_{\max} = 100 \times 10^6$$

$$\eta_L = 0.9$$

$$\eta_C = 0.6$$

$$\sigma_C = \frac{P D}{2 t \eta_L}$$

$$\frac{2 t \eta_L \times \sigma_C}{D} = P$$

$$P = \frac{2 \times 0.0015 \times 0.9 \times 100 \times 10^6}{0.2} = 1350000$$

$$1.35 \times 10^6 \text{ pascals}$$
$$1.35 \text{ mpa}$$

$$\sigma_L = \frac{P D}{4 t \eta_C}$$

$$\frac{4 t \eta_C \times \sigma_L}{D} = P$$

$$P = \frac{4 \times 0.0015 \times 0.6 \times 100 \times 10^6}{0.2} = 1800000$$

$$1.8 \times 10^6 \text{ Pascals}$$
$$1.8 \text{ mpa}$$

Max allowable pressure = 1.35 mpa

## Question 5

Robert Morse  
1806186 11/1/21

$$\textcircled{a} \quad K = \frac{2G(1+\nu)}{3(1-2\nu)}$$

$$G = 165 \times 10^9$$

$$\nu = 0.3$$

~~E~~

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

$$K = \frac{3.3 \times 10^{11} \times 1.3}{3 \times 0.4}$$

$$K = 3.575 \times 10^{11} \text{ pa}$$

$\textcircled{b}$  Orthotropic - Stress and Strain properties differ in different axis for example wood has a grain in one direction so is easier to split than across the grain.