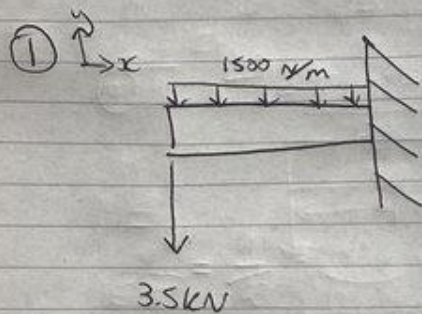


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$$L = 1.5\text{m}$$

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

$$F = 3500\text{ N}$$

$$w = 1500 \text{ N/m}$$

a) Deflection

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

$$-1.7898 \times 10^{-3} \text{ m} + -4.3146 \times 10^{-4} = -2.2213 \times 10^{-3}$$

$$\underline{\underline{-2.22 \text{ mm}}}$$

b) $5\text{ mm} - 4.3146 \times 10^{-4} = 0.00456854 \text{ mm}$

$$\frac{0.00456854 (3EI)}{L^3} = F$$

$$\frac{0.00456854 [3(2.2 \times 10^6)]}{1.5^3} = 8934 \text{ N}$$

point load

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② $D = 0.045\text{m}$
 $d = 0.035\text{m}$
 $p = 115\text{bar}$

a) the Navier Stokes boundary conditions would be applied

b)

~~$A = p \left(\frac{D}{2} \right)^2 - p \left(\frac{d}{2} \right)^2$~~

$$A = p \frac{\left(\frac{D}{2} \right)^2 - \left(\frac{d}{2} \right)^2}{\left(\frac{D}{2} \right)^2 - \left(\frac{d}{2} \right)^2} = \frac{115 \times 10^5 \left(\frac{0.045}{2} \right)^2 - 115 \times 10^5 \left(\frac{0.035}{2} \right)^2}{\left(\frac{0.045}{2} \right)^2 - \left(\frac{0.035}{2} \right)^2}$$

$$A = 11.5 \times 10^6$$

$$B = \frac{\left(\frac{D}{2} \right)^2 \left(\frac{d}{2} \right)^2 p - 0}{\left(\frac{D}{2} \right)^2 - \left(\frac{d}{2} \right)^2} = \frac{\left(\frac{0.045}{2} \right)^2 \left(\frac{0.035}{2} \right)^2 (115 \times 10^5)}{\left(\frac{0.045}{2} \right)^2 - \left(\frac{0.035}{2} \right)^2}$$

$$B = 8914$$

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③ $(-10 \times 10^{-6}, +13 \times 10^{-6})$

$\nu = 0.20$

$\lambda = 165 \times 10^9 \text{ Pa}$

a) $\text{Stress}_x = \lambda (-10 \times 10^{-6})$
 $= 165 \times 10^9 (-10 \times 10^{-6})$
 $= -1650000 \text{ Pa (Compressive stress)}$

$\text{Stress}_y = \lambda (13 \times 10^{-6})$
 $= 165 \times 10^9 (13 \times 10^{-6})$
 $= 2145000 \text{ Pa (Tensile stress)}$

b) $\text{Strain}_x = \frac{20 \times 10^{-6}}{165 \times 10^9} = 1.21 \times 10^{-4} \text{ Pa}$

$\text{Strain}_y = \frac{-15 \times 10^{-6}}{165 \times 10^9} = -9.09 \times 10^{-5} \text{ Pa}$

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④ $D = 0.2\text{m}$
 $L = 0.39\text{m}$
 $E = 0.0015\text{m}$
 $P = ?$
 $\sigma = 100 \times 10^6 \text{ Pa}$

$$\sigma_L + \sigma_c \leq 100 \times 10^6 \text{ Pa}$$

$$\frac{pD}{4E\eta_c} + \frac{pD}{2E\eta_L} = 100 \times 10^6$$

~~$$\frac{pD}{4E\eta_c} + \frac{pD}{2E\eta_L} = 100 \times 10^6$$~~

~~$$\frac{pD}{4E\eta_c} + \frac{pD}{2E\eta_L} = 100 \times 10^6 (4E\eta_c)$$~~

$$pD + \frac{pD(4E\eta_c)}{2E\eta_L} = 100 \times 10^6$$

$$pD + \frac{pD \cdot 2(0.6)}{0.9} = 100 \times 10^6$$

$$\frac{7}{3} pD = 100 \times 10^6$$

$$7pD = 300 \times 10^6$$

$$pD = \frac{300 \times 10^6}{7}$$

$$pD = 42.86 \times 10^6$$

$$p = \frac{42.86 \times 10^6}{2} = \underline{\underline{21.43 \times 10^6 \text{ Pa}}}$$

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⑤ $L = 0.35 \text{ m}$ Volume = $0.35^3 = 0.043 \text{ m}^3$
 $P = 50 \times 10^6 \text{ Pa}$ Area = $6(0.35^2) = 0.735 \text{ m}^2$
 $\nu = 0.3$
 $\lambda = 165 \times 10^9 \text{ Pa}$

a) $K = \frac{\sigma}{\epsilon_v} = \frac{\lambda}{3(1-2\nu)}$

$\sigma = \frac{P}{A} = \frac{50 \times 10^6}{0.735} = 68.03 \times 10^6 \text{ Pa}$

~~$K = \frac{165 \times 10^9}{3(1-2(0.3))} = 1.35 \times 10^{11}$~~

$\epsilon_v = \frac{\sigma_x + \sigma_y + \sigma_z}{E} (1-2\nu)$ $\sigma_x = \frac{50 \times 10^6}{0.35} = 142.9 \times 10^6 \text{ Pa}$
 ~~$\frac{3(142.9 \times 10^6)}{E} (1-2\nu)$~~
 $= 1.04 \times 10^{-3}$ volumetric strain

$K = \frac{68.03 \times 10^6}{1.04 \times 10^{-3}} = 6.54 \times 10^{10}$ bulk modulus

$\epsilon_v = \frac{\Delta V}{V}$ $V \epsilon_v = \Delta V$
 $0.043 (1.04 \times 10^{-3}) = 4.472 \times 10^{-5} \text{ m}^3$

b) An orthotropic material can have different material properties along 3 axis like wood having different strength between grains. change in volume