

Lamylos Frangos (1802755) ACHASOIS

Questio 4

$$d = 280 \text{ mm} = 0.28 \text{ m}$$

$$t = 600 \text{ mm} = 0.6 \text{ m}$$

$$u_L = 55\% = 0.55$$

$$u_C = 65\% = 0.65$$

$$P = 14.2 \text{ Bar} \times 10^5 \text{ N/m}^2$$

$$\sigma_{max} = 150 \text{ MPa} \times 10^6 \text{ N/m}^2$$

$$(i) \sigma_c = \frac{Pd}{2tu_L}$$

$$\Rightarrow t = \frac{Pd}{2\sigma_c u_L}$$

$$\Rightarrow t = \frac{(14.2 \times 10^5)(0.28)}{2(150 \times 10^6)(0.55)}$$

$$t = 0.0024945 \text{ m}$$

$$\Rightarrow \boxed{t = 2.494 \text{ mm}}$$

(ii)

t_{min}

$$= 1.055 \text{ m}$$

$$(ii) \sigma_c = \frac{Pd}{4tu_C} \Rightarrow t = \frac{Pd}{4\sigma_c u_C}$$

$$\Rightarrow t = \frac{14.2}{4}$$

$$\Rightarrow t = \frac{(14.2 \times 10^5)(0.28)}{4(150 \times 10^6)(0.65)} = 0.0010553$$

$$\Rightarrow \boxed{t = 1.0553 \text{ m}}$$

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Q2

Q3

(v) $EI = 1.75 \text{ MPa} \times 10^6$
 $x = 1.55 \text{ m (center)}$

$\Rightarrow$

$$\begin{aligned} 1.75 \times 10^6 y &= \frac{1969.9(1.55)^3}{6} - \frac{450(1.05)^4}{24} \\ &+ \frac{450(1.05)^4}{24} - \frac{300(1.05)^4}{24} \\ &- \frac{2300(1.05)^3}{6} \quad \text{A} \quad \frac{300(1.05)^4}{24} \\ &+ 9187.68(1.55) \end{aligned}$$

$$\Rightarrow 1.75 \times 10^6 y = 1199509.1 + (-17.7261) - 1468.66$$

$$\Rightarrow y = -7.72 \times 10^{-3} \text{ m}$$

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Q. 3

(iv) $y=0$ $x=3.1$

$$\Rightarrow \frac{1969.4(3.1)^3}{6} - \frac{450(3.1-0.5)^4}{24}$$

$$+ \frac{450(3.1-1.5)^4}{24} - \frac{800(3.1-1.5)^4}{24}$$

$$- \frac{2300(3.1+1.5)^3}{6} + \frac{800(3.1-2.5)^4}{24} + Ax$$

$$= 3921.569 + (-95.573) - \frac{37307.81}{24}$$

$$= -28481.814 + 3.1A$$

$$\Rightarrow 3.1A = -28481.814$$

$$\Rightarrow A = -9187.68$$

$$\Rightarrow A = -28481.814$$

$$- 3.1$$

$$y=0 \quad x=0$$

$$\Rightarrow B=0$$

$$\Rightarrow A=9187.68$$

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Q. 3

(iii)

Deflection

$EI y$

$$\begin{aligned} &= \frac{1969.4 (x)^3}{6} - \frac{450 (x - 0.5)^4}{24} \\ &+ \frac{450 (x - 1.5)^4}{24} - \frac{800 (x - 1.5)^4}{24} \\ &- \frac{2300 (x + 1.5)^3}{6} + \frac{800 (x - 2.5)^4}{24} \\ &+ Ax + B \end{aligned}$$

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Q3

(i) $R_A = 1969.4 \text{ N}$
 $R_B = 2580.6 \text{ N}$

(i)

Bending moment

$$EI \frac{d^2y}{dx^2} = 1969.4(x) - \frac{450(x-0.5)^2}{2} + \frac{450(x-1.5)^2}{2} \\ - \frac{800(x-1.5)^2}{2} - 2300(x-1.5) + \frac{800(x-2.5)^2}{2}$$

(ii) Slope

$$EI \frac{dy}{dx} = \frac{1969.4(x)^2}{2} - \frac{450(x-0.5)^3}{6} + \frac{450(x-1.5)^3}{6} \\ - \frac{800(x-1.5)^3}{6} - \frac{2300(x-1.5)^2}{2} \\ + \frac{800(x-2.5)^3}{6} + A$$

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$$\sigma_z = \frac{\sigma_x + \sigma_y}{2} - \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2 xy}}{2}$$

~~$\Rightarrow \sigma_z =$~~

$$\Rightarrow \sigma_z = \frac{(107 \times 10^6) + (207 \times 10^6)}{2} - \frac{\sqrt{(107 \times 10^6 - 207 \times 10^6)^2 + 4(125 \times 10^6)}}{2}$$

$$\Rightarrow \sigma_z = 157 \times 10^6 - 134.63 \times 10^6$$

$$\Rightarrow \boxed{\sigma_z = 22.37 \times 10^6}$$

$$(ii) \quad \epsilon_{max} = \frac{\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2 xy}}{2} = \frac{\sigma_1 - \sigma_2}{2}$$

$$\Rightarrow \epsilon_{max} = \frac{291.63 \times 10^6 - 22.37 \times 10^6}{2}$$

$$\Rightarrow \boxed{\epsilon_{max} = 9.155 \times 10^9}$$

$$\epsilon_{min} = -9.155 \times 10^9$$

$$\epsilon_{min} = -\left[\frac{\sigma_1 - \sigma_2}{2}\right]$$

$$\Rightarrow \epsilon_{min} = -\left[\frac{291.63 \times 10^6 - 22.37 \times 10^6}{2}\right]$$

~~$\Rightarrow \epsilon_{min} = -9.155 \times 10^9$~~

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Question 2

$$(1) \begin{aligned} \sigma_x &= 102 \text{ MPa} \times 10^6 \\ \sigma_y &= 203 \text{ MPa} \times 10^6 \\ \tau_{xy} &= 125 \text{ MPa} \times 10^6 \end{aligned}$$

$$\Rightarrow \sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \frac{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}{2}$$

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \frac{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}{2}$$

$$\sigma_1 = \frac{(102 \times 10^6) + (203 \times 10^6)}{2} + \frac{((102 \times 10^6)^2 - (203 \times 10^6)^2) + 4(125 \times 10^6)^2}{2}$$

~~$\Rightarrow \sigma_1 = 159 \times 10^6$~~

$$\Rightarrow \sigma_1 = 159 \times 10^6 + \frac{(1 \times 10^6 + 4(125 \times 10^6)^2)}{2}$$

$$\Rightarrow \sigma_1 = 159 \times 10^6 + \frac{2.25 \times 10^6}{2}$$

$$\Rightarrow \sigma_1 = 159 \times 10^6 + 134.63 \times 10^6$$

$$\Rightarrow \sigma_1 = 291.63 \times 10^6 \text{ Pa}$$

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(ii)

$$\sigma_x = 85 \text{ MPa} \times 10^6$$

$$\sigma_y = 45 \text{ MPa} \times 10^6$$

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

$$\Rightarrow \epsilon_x = \frac{1}{170 \times 10^9} (85 \times 10^6 - (0.23)(45 \times 10^6))$$

$$\Rightarrow \epsilon_x = 5.88 \times 10^{-12} (85 \times 10^6 - 12.6 \times 10^6)$$

$$\Rightarrow \epsilon_x = 5.88 \times 10^{-12} (72.4 \times 10^6)$$

$$\Rightarrow \boxed{\epsilon_x = 4.25712 \times 10^{-4}}$$

~~$\Rightarrow \epsilon_x =$~~

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

$$\Rightarrow \epsilon_y = \frac{1}{170 \times 10^9} (45 \times 10^6 - (0.23)(85 \times 10^6))$$

$$\Rightarrow \epsilon_y = 5.88 \times 10^{-12} (21.2 \times 10^6)$$

$$\Rightarrow \boxed{\epsilon_y = 1.24656 \times 10^{-4}}$$

Romylos François (1802955) ACHA SOLS

Q1

$$\epsilon_x = 25 \times 10^{-6}$$

$$\epsilon_y = -15 \times 10^{-6}$$

$$\nu = 0.28$$

$$E = 120 \text{ GPa} = 120 \times 10^9$$

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

$$\Rightarrow \sigma_x = \frac{120 \times 10^9}{1-0.28^2} (25 \times 10^{-6} + 0.28)(-15 \times 10^{-6})$$

$$\Rightarrow \sigma_x = 1.84 \times 10^{11} (25 \times 10^{-6} + (-4.2 \times 10^{-6}))$$

$$\Rightarrow \sigma_x = 1.84 \times 10^{11} (2.08 \times 10^{-5})$$

$$\Rightarrow \sigma_x = 3.83 \times 10^6 \text{ MPa (tensile)}$$

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

$$\Rightarrow \sigma_y = \frac{120 \times 10^9}{1-0.28^2} (-15 \times 10^{-6} + 0.28)(25 \times 10^{-6})$$

$$\Rightarrow \sigma_y = 1.84 \times 10^{11} (-15 \times 10^{-6} + 7 \times 10^{-6})$$

$$\Rightarrow \sigma_y = 1.84 \times 10^{11} \times (-8 \times 10^{-6})$$

$$\Rightarrow \sigma_y = -1.47 \times 10^6 \text{ (compressive) MPa}$$