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Anthony Hau

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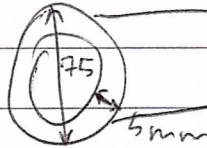
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Advanced stress Analysis & FEA

~~Q2a)~~ ~~T = T~~

Q3



out $\varnothing$ 75 mm

Ind $\varnothing$ 65 mm

mean $\varnothing$ 70 mm

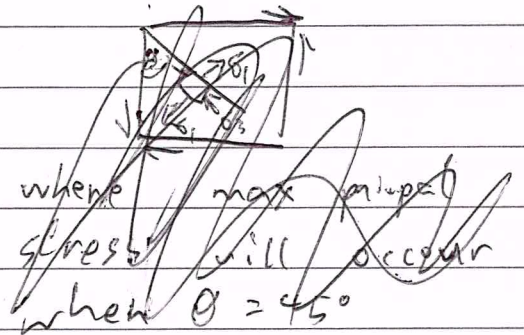
$$\sigma_y = E = 325 \times 10^6 \text{ N/m}^2$$

$$\nu = 0.3$$

$$n = 6$$

$$\sigma_1 = \tau_{xy} \sin 2\theta$$

$$\sigma_{1,3} = \pm \tau_{xy} \sin 2\theta$$



$$\sigma_1 = \tau_{xy}$$

$$\sigma_3 = -\tau_{xy}$$

assume 2D stress plane $\therefore \sigma_2 = 0$

$$\frac{T}{J} = \frac{\tau}{R} = \left(\frac{G\theta}{L} \right) \therefore T = \frac{\tau R}{J}$$

$$J = \frac{\pi}{32} (D^4 - d^4)$$

$$J = \frac{\pi}{32} (75^4 - 65^4)$$

$$J = 31353830.084 \text{ mm}^4$$

$$\tau = \frac{TR}{J} = \frac{T (37.5 \times 10^{-3})}{31353830.084}$$

$$\tau = 2.7699 \times 10^{-7} T$$

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$$J = \frac{\pi}{32} (\cancel{0.075^4} 0.075^4 - 0.065^4)$$

$$J = 1.3538 \times 10^{-6} \text{ m}^4$$

$$\tau = \frac{TR}{J}$$

$$\tau = \frac{T (37.5 \times 10^{-3})}{1.3538 \times 10^{-6}}$$

$$\therefore \tau = 27699.19 \text{ T}$$

3a) Tresca

$$\sigma_1 - \sigma_3 = \frac{\sigma_y}{n}$$

$$\tau_{xy} - (-\tau_{xy}) = \frac{325 \times 10^6}{6}$$

$$\tau_{xy} = \frac{325 \times 10^6}{12}$$

$$\tau_{xy} = 27083333.33 \text{ N/m}^2$$

$$\therefore \tau = 27699.19 \text{ T}$$

$$\therefore \tau = \frac{27083333.33}{27699.19}$$

$$\tau = 977.77 \text{ Nm}$$

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b) von Mises

$$2 \left(\frac{\sigma}{n} \right)^2 = [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]$$

$$2 \times \left(\frac{325 \times 10^6}{6} \right)^2 = [\tau_{xy}^2 + (-(-\tau_{xy}))^2 + (-\tau_{xy} - \tau_{xy})^2]$$

$$\cancel{5.868 \times 10^{15}} = \cancel{6 \tau_{xy}^2} = 6 (27699.19 T)^2$$

$$T = \sqrt{\frac{5.868 \times 10^{15}}{6 \times 27699.19^2}}$$

$$5.868 \times 10^{15} = 6 \tau_{xy}^2$$

$$5.868 \times 10^{15} = 6 (27699.19 T)^2$$

$$T = \sqrt{\frac{5.868 \times 10^{15}}{6 \times 27699.19^2}}$$

$$T = 1129.027 \text{ Nm}$$

$$T = 1.13 \text{ k Nm}$$

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3c)

$$D = 50 \text{ mm}$$

$$d = 44 \text{ mm}$$

$$n = 2.75$$

$$E = \sigma_y = 80 \times 10^6 \text{ N/m}^2$$

$$J = \frac{\pi}{32} (D^4 - d^4)$$

$$J = \frac{\pi}{32} (\cancel{0.05}^4 - 0.044^4)$$

$$J = 2.456 \times 10^{-7} \text{ m}^4$$

$$\tau = \frac{TR}{J}$$

$$\tau = \frac{T \cdot 0.05}{2.456 \times 10^{-7}}$$

$$\tau = 203563.2934 T$$

$$\sigma_1 = \tau_{xy}$$

$$\sigma_2 = -\tau_{xy}$$

$$\sigma_2 = 0$$

Von Mises

$$2 \left(\frac{\sigma_y}{n} \right)^2 = 6 \tau_{xy}^2$$

$$2 \left(\frac{80 \times 10^6}{2.75} \right)^2 = 6 (203563.2934 T)^2$$

$$T = \sqrt{\frac{1.6426 \times 10^{15}}{6 \times 203563.2934^2}}$$

$$T = 82.51 \text{ Nm}$$

3d)

$$82.5 / 1129.027$$

$$= 7.320$$

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Q 4

$$a) I_{xx} = 2(I_{xx} \text{ (section)}) + 2(I_{xx} \text{ plates})$$

$$I_{xx} = 2(6.2 \times 10^6) + 2(I_{gs} + Ah^2)$$

$$= 12.4 \times 10^6 + 2\left[\frac{300 \times 12^3}{12}\right] + (300 \times 12 \times (200+6)^2)$$

$$I_{xx} = 12.4 \times 10^6 + 2(43200 + 152769600)$$

$$I_{xx} = 12.4 \times 10^6 + 305625600$$

$$I_{xx} = 318,025,600 \text{ mm}^4$$

$$I_{yy} = 2(I_{yy} \text{ (section)}) + 2(I_{yy} \text{ plates})$$

$$I_{yy} = 2\left[1.57 \times 10^6 + (4400)(79)^2\right] + 2\left(\frac{12 \times 300^3}{12}\right)$$

$$I_{yy} = 2(1.57 \times 10^6 + 27460400) + 2(27000000)$$

$$I_{yy} = 58060800 + 54000000$$

$$I_{yy} = 112,060,800 \text{ mm}^4$$

~~is not a~~ ~~bucket~~ ~~with~~

$\therefore$ buckle in about I_{yy} axis.

$$b) k = \sqrt{\frac{I}{A}}$$

$$k = \sqrt{\frac{112060800}{(2 \times 4400) + (2 \times 12 \times 300)}}$$

$$k = 108.49 \text{ mm}$$

$$k = 0.108 \text{ m}$$

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Q4 c) slenderness ratio = $\frac{L}{r}$
 $= \frac{8}{0.108}$
 $= 74.078$

d) ~~$P_e = \frac{2\pi^2 EI}{L^2}$~~

$P_{in} P_{in}$
 $P_e = \frac{\pi^2 EI}{L^2}$

$P_e = \frac{\pi^2 (200 \times 10^9) (1/2060800 \times 10^{-12})}{8^2}$

$P_e = 3456236.765 \text{ N}$

$P_e = 3456.24 \text{ kN}$

e) $P_R = \frac{6 \gamma A}{1 + \alpha (L/r)^2}$

$P_R = \frac{320 \times 10^6 (0.0016)}{1 + \frac{1}{7500} (74.078^2)}$

$P_R = 295694.756 \text{ N}$

$P_R = 295.69 \text{ kN}$

$A = 2 \times 4400 + 2 \times 300 \times 12$

$= 1600 \text{ mm}^2$

$= 0.0016 \text{ m}^2$

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$$Q4 \quad f) \quad I_{xx} = 318025600 + \left(\frac{6 \cdot 224^3}{12} \right)$$

$$= 318025600 + 5619712$$

$$= 323,645,312 \text{ mm}^4$$

$$I_{yy} = 112060800 + \left(\frac{224 \cdot 6^3}{12} + (224 \times 12 \times 153^2) \right)$$

$$= 112060800 + 62927424$$

$$= 174,988,224 \text{ mm}^4$$

buckle still happen I_{yy} axis

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

$$P_{cr} = \frac{\pi^2 (200 \times 10^9) (174,988,224 \times 10^{12})}{8^2}$$

$$P_{cr} = 5397076.705 \text{ N}$$

$$P_{cr} = 5397.08 \text{ kN}$$

$$5397.08 - 3456.24$$

$$= 1940.84 \text{ kN}$$

$\therefore$ 1940.84 kN of Euler Buckling load has increase

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Q2 a i)

a ii)

$$U = \frac{1}{2} Y Q L$$

$$Y = \frac{Q}{AG}$$

$$U = \frac{1}{2} \left(\frac{Q}{AG} \right) Q L$$

$$U = \frac{Q^2 L}{2 AG}$$

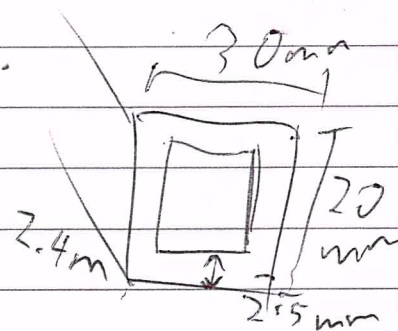
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Q 2 b i)

$$\sigma = 480 \times 10^6 \text{ Pa}$$
$$E = 190 \times 10^9 \text{ Pa}$$



$$\text{Area} = 0.03 \times 0.02 - 0.025 \times 0.015$$
$$= 2.25 \times 10^{-4} \text{ m}^2$$

$$U = \frac{P^2 L}{2 A E}$$

$$P = \sigma \cdot A$$

$$U = \frac{(\sigma \cdot A)^2 L}{2 A E}$$

$$U = \frac{(480 \times 10^6 \times 2.25 \times 10^{-4})^2 \times 2.4}{2 (2.25 \times 10^{-4}) 190 \times 10^9}$$

$$U = 327.41 \text{ J}$$

ii)

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Q 2

iii)

$$h = \frac{\sigma^2 V}{2EW}$$

$$W = mg$$

$$\sigma = \sqrt{\frac{h 2EW}{V}}$$

$$\sigma = \sqrt{\frac{(0.45)(2)(190 \times 10^9)(20 \times 9.81)}{54 \times 10^{-4}}}$$

$$\sigma = 78822585.6 \text{ Pa}$$

$$\sigma = 78822585.6 \text{ Pa}$$

$$V = A \cdot L$$

$$V = 2.25 \times 10^{-4} \cdot 2.4$$
$$= 54 \times 10^{-4} \text{ m}^3$$

iv)

iv)

