

Exam 11/05/20 13:00 - 15:00
Advanced Stress Analysis + FEA
(M6X00420)

Sion Evans (P150600) 2/20

Two

b i) $30 \times 10^3 \times 20 \times 10^3 \text{ m}$ Thickness $2.5 \times 10^{-3} \text{ m}$
 $L = 2.4 \text{ m}$ $\sigma = 480 \times 10^6 \text{ Pa}$ $E = 190 \times 10^9$

$$U = \frac{P^2 L}{2AE} = \frac{\sigma^2 AL}{2E}$$

$$A = (25 \times 10^{-3})(15 \times 10^{-3})$$
$$= 3.75 \times 10^{-4} \text{ m}^2$$

$$A = (30 \times 10^{-3})(20 \times 10^{-3}) = 3.75 \times 10^{-4}$$

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

$$= \underline{\underline{2.25 \times 10^{-4} \text{ m}^2}}$$

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

ii) $P.E = mgh$ $U = \frac{P^2 L}{2AE}$ $P.E = U$

$$Mgh = \frac{P^2 L}{2AE}$$

$$P = \sigma A$$

$$Mg = W$$

$$Wh = \frac{\sigma^2 A^2 L}{2AE} = \frac{\sigma^2 AL}{2E}$$

$$AL = V$$

$$h = \frac{\sigma V}{2WE}$$

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Two

b iii) $\sigma = \frac{h z w E}{\sqrt{}}$ $M = 20 \text{ kg}$ $h = 450 \times 10^{-3} \text{ m}$

$$\sigma = \frac{(450 \times 10^{-3}) (2) (20) (9.81) (190 \times 10^9)}{(2.25 \times 10^{-4}) (2.4)}$$

$$\sigma = 6.21 \times 10^{16} \text{ Pa}$$

iv) $\sigma_{\max} = 6.21 \times 10^{16}$ $d = 20 \times 10^{-3}$ $L = 2.4$

$$V = \frac{h z w E}{\sigma} = \frac{(450 \times 10^{-3}) (2) (20) (9.81) (190 \times 10^9)}{6.21 \times 10^{16}}$$

$$5.4 \times 10^{-4} = \frac{\pi d e^2}{4} - \frac{\pi d i^2}{4} \cdot L$$

$$\frac{5.4 \times 10^{-4}}{2.4} = \frac{\pi (20 \times 10^{-3})^2}{4} - \frac{\pi d i^2}{4}$$

$$\cancel{2.25 \times 10^{-4}} \frac{\pi d i^2}{4} = \frac{\pi (20 \times 10^{-3})^2}{4} - 2.25 \times 10^{-4}$$

$$d i = \sqrt{\frac{(8.916 \times 10^{-5}) (4)}{\pi}} = 10.65 \times 10^{-3} \text{ m}$$

Advanced Stress Analysis + FEA (16x00420)

$$\frac{4}{20}$$

iv) continued. . . .

$$\begin{aligned}\text{Wall thickness} &= D_o - D_i \\ &= 20 \times 10^{-3} - 10.65 \times 10^{-3} \\ &= \frac{9.35 \times 10^{-3} \text{ m}}{2} \\ &= \underline{\underline{4.68 \times 10^{-3} \text{ m}}}\end{aligned}$$

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Four

a) Plates 300 x 12 mm C-channel ^{wide} 100 x ^{tall} 200 mm

C-channel $I_{xx} = 26.2 \times 10^6 \text{ mm}^4$ $I_{yy} = 1.57 \times 10^6 \text{ mm}^4$
 $A = 4400 \text{ mm}^2$

8m long

xx C-channel =

$$(2)(26.2 \times 10^6) = \underline{\underline{52.4 \times 10^6 \text{ mm}^4}}$$

$$\text{plate} = (2)(1 + Ah^2)$$

$$= (2) \left(\frac{(300)(12)^3}{12} + (300)(12)(106)^2 \right)$$

$$= 80.986 \times 10^6 \text{ mm}^4$$

$$I_{xx} = \underline{\underline{132.986 \times 10^6 \text{ mm}^4}} \quad 132.986 \times 10^6 \text{ mm}^4$$

yy channel = $(2)(1.57 \times 10^6 + (4400)(79^2))$
 $= \underline{\underline{58.06 \times 10^6 \text{ mm}^4}}$

$$\text{plate} = (2) \left[\frac{(12)(300)^3}{12} \right] = \underline{\underline{54 \times 10^6 \text{ mm}^4}}$$

$$I_{yy} = 112.06 \times 10^6 \text{ mm}^4$$

$I_{xx} > I_{yy}$, will buckle about yy