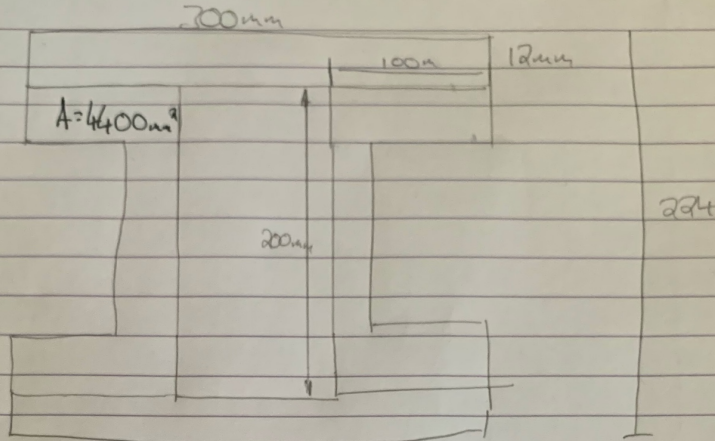


# Advanced Stress Analysis + FEA M6X00420

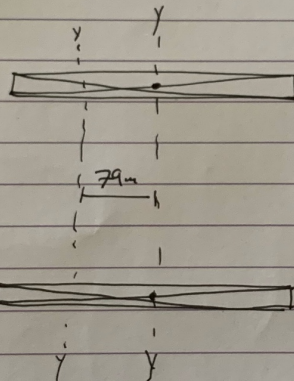
Joshua Grant Brinegar 1701440

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Q Four) a)



See long



$$300 \times 224$$

$$E = 200 \text{ GN/m}^2$$

C channel

$$I_{yy}^{\text{local}} = 1.57 \times 10^6 \text{ mm}^4$$

Parallel axis theorem

$$I_{yy}^{\text{Global}} = 1.57 \times 10^6 + (4400 \times 79^2)$$

$$= 1580641$$

Plate

$$I_{yy} = \frac{bd^3}{12} = \frac{100 \times 12^3}{12} = 12000$$

$$I_{yy} = I_{yy}^{\text{channel}} + 2(I_{yy}^{\text{plate}} + A_{\text{plate}} \times d^2)$$

$$2(29 \times 10^6) + 2(27 \times 10^6) = 112 \times 10^6$$

$$I_{yy} = 112 \times 10^6 + 2(43200) = 112086400 = 3,247,682 \text{ mm}^4$$

$$I_{xx} = I_{xx}^{\text{plate}} + I_{xx}^{\text{plate}} + I_{xx}^{\text{channel}} + I_{xx}^{\text{channel}}$$

$$I_{xx} = 2(27 \times 10^6) + 2(63 \times 10^6) = 180 \times 10^6$$

C channel

$$I_{xx} = 26 \times 10^6 \text{ mm}^4$$

Plate

$$I_{xx}^{\text{local}} = \frac{bd^3}{12} = \frac{100 \times 12^3}{12} = 12000$$

$$= 43200$$

$$I_{xx}^{\text{Global}} = 27 \times 10^6 + (200 \times 100 \times 100^2)$$

$$= 63 \times 10^6$$

It is likely to buckle around xx axis as

$I_{xx}$  is greater than  $I_{yy}$

With  $I_{xx}$  is the Greatest so the beam will bend around it along the Y axis.

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Four

b)

$$K = \sqrt{\frac{I_{xx}}{A}}$$

$$= \sqrt{\frac{18 \times 10^{-7}}{16 \times 10^{-3}}}$$

$$K = 106.066 \text{ mm}$$

$$A = 4400 \times 2$$

$$3600 \times 2 = (3600 \times 2)$$

$$= 16000 \text{ mm}^2$$

$$I_{xx} \text{ from part (a)} = 18 \times 10^{-7} \text{ mm}^4$$

c)

$$\frac{L}{K} = \frac{8 \times 10^{-2}}{106.066} = 75.425 \text{ mm}$$

d)

$$P_e = \frac{\pi^2 E I_{xx}}{L^2}$$

$$E = 200 \text{ GPa} = 200 \times 10^9 \text{ N/m}^2$$

$$I_{xx} = 18 \times 10^{-7} \text{ mm}^4 = 18 \times 10^{-11} \text{ m}^4$$

$$P_e = 5.551652476 \times 10^5 \text{ N/m}^2 \quad L = 8 \text{ m}$$

e)

$$P_R = \frac{\sigma_y A}{1 + a(L/K)^2}$$

$$\sigma_y = 320 \text{ MPa} = 320 \times 10^6 \text{ N/m}^2$$

$$A = 16000 \text{ mm}^2 = 16 \text{ m}^2$$

$$a = 1/7500$$

$$L = 8 \text{ m}$$

$$K = 106.066 \text{ mm} \quad 0.106066 \text{ m}$$

$$P_R = 2911541295 \text{ N/m}^2$$

f)

Two a) i)  $\gamma = \frac{Q}{AG}$

$$G = \text{shear modulus} = \frac{\text{shear stress}}{\text{shear strain}}$$

$$\text{Shear modulus} = \frac{Q}{A} \div \gamma$$

$$\text{Stress} = \frac{\text{Force/load}}{\text{Area}}$$

$$G = \frac{Q}{A} \div \gamma$$

$$= \frac{Q}{A}$$

$$G \times \gamma = \frac{Q}{A}$$

$$\gamma = \frac{Q}{A} \times \frac{1}{G}$$

$$\gamma = \frac{Q}{A} \times \frac{1}{G}$$

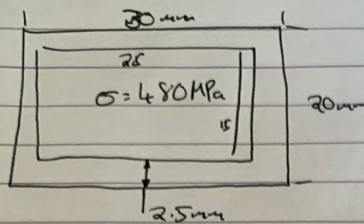
$$\gamma = \frac{Q}{AG}$$

ii)

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Two

b):)



$$L = 2.4 \text{ m}$$

$$E = 190 \text{ GPa}$$

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

$$U = \frac{450 \times 10^6 \times 2.25 \times 10^{-4} \times 2.4}{2 \times 190 \times 10^9}$$

$$U = 6.821 \text{ N m}^2$$

$$A = 20 \times 10^{-3} \times 30 \times 10^{-3} = 6 \times 10^{-4}$$

$$A = 6 \times 10^{-4} - (15 \times 10^{-3} \times 25 \times 10^{-3}) =$$

$$A = 2.25 \times 10^{-4}$$

ii)

$$\sigma = \sqrt{\frac{2WEh}{AL}}$$

$$V = AL$$

$$\sigma = \sqrt{\frac{2WEh}{V}}$$

$$\sigma^2 = \frac{2WEh}{V}$$

$$\sigma^2 V = 2WEh$$

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

$$\text{iii)} \quad \sigma = \sqrt{\frac{2WEh}{AL}} = \sqrt{\frac{2 \times (20 \times 9.81) \times 190 \times 10^9 \times 450 \times 10^{-7}}{2.25 \times 10^{-4} \times 2.4}}$$

$$\sigma = 249.259 \text{ MPa}$$

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Two iv)  $\sigma^2 = \frac{2WEh}{AL}$

$$A\sigma^2 = \frac{2WEh}{L}$$

$$A = \frac{2WEh}{\sigma^2 L} = \frac{2 \times (20 \times 9.81) \times (190 \times 10^{-6}) \times (450 \times 10^{-4})}{249.25 \times 10^6 \times 2.4}$$

$$A = 2.2499 \times 10^{-4}$$

$$\pi d^2 - A = \left( \pi (20 \times 10^{-3})^2 \right) - 2.2499 \times 10^{-4}$$

$$= 1.0316 \times 10^{-3}$$

$$\sqrt{\frac{1.0316 \times 10^{-3}}{\pi}} = 18.12 \text{ mm}$$

$$20 \text{ mm} - 18.12 \text{ mm} = 1.88 \text{ mm}$$

One

a) Element Mesh types are chosen based on the geometry modelled. 1-D and 2-D Meshes require 1-D and 2-D elements, with 3-D Meshes requiring 3-D elements. Element shapes such as: tetrahedral, octagonal and cuboidal meshes have advantages at fitting into different volumes.

I would evaluate my geometry and required analysis to determine which mesh is suitable. Physical property information can be determined by material choice and material property data.

B) ~~Element size~~<sup>An</sup> iterative process can be used to reduce Mesh size in specific areas to increase analysis and accuracy around and near problem areas and areas of interest. Software automation and a basic mesh can be used as a starting point or specific element size can be chosen based on ratio of accuracy to geometry size.

C) I would use first order elements for initial simulations and analysis, as they use less computational time. Once element size and shape was defined I would use second order elements to run accurate analysis and simulations for final runs.

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D)  $h$ -adaptive meshes, refine mesh density by reducing mesh size in areas of problem geometry and ~~the~~ areas with high error numbers. Whereas,  $p$ -adaptivity increases element order to fit geometry more accurately.