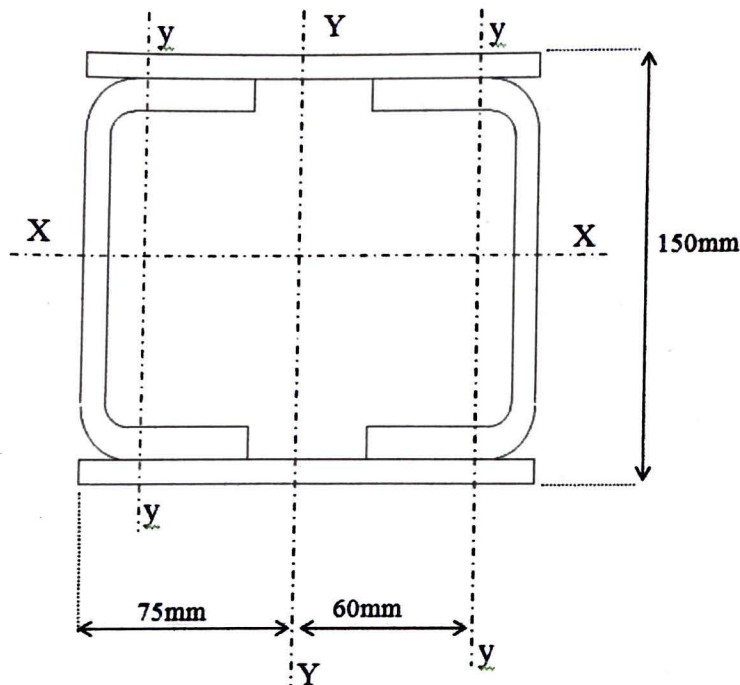


THREE

A vertical strut is to be used in the construction of a storage platform in a warehouse. The strut is fabricated from steel ($E = 200 \text{ GPa}$) and is 3.5 m in length. The fabricated strut is constructed from two flat 4 mm steel plates and two 'C' section folded steel sheets as shown in the figure below. Given that the compressive yield stress, σ_c , is 325 MPa, and the end condition constant ' a ' is assumed to be 1/15000 (i.e. lower end fixed and the other end pinned), determine the following;



Properties of ONE folded sheet steel 'C' section:

$$I_{xx} = 1.5 \times 10^6 \text{ mm}^4$$

$$I_{yy} = 5.5 \times 10^5 \text{ mm}^4$$

$$A = 384 \text{ mm}^2$$

- About which axis will the fabricated strut tend to buckle? Show your calculations and values for both I_{xx} and I_{yy} .
[5 marks]
- What is the radius of gyration of the strut about this axis?
[1 mark]
- What is the value of the slenderness ratio for the strut?
[1 mark]
- According to Euler theory, what load will this strut buckle at?
[3 marks]
- According to Rankine-Gordon theory, what load will this strut buckle at?
[3 marks]
- Comment on the results obtained in parts (d) & (e), and with the use of a suitable diagram, explain the difference between experimental results and buckling loads according to Euler theory.
[5 marks]
- Without any increase in material volume, suggest how the loading capacity of the strut may be increased.
[2 marks]



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD
MAY 2018

CYFNOD ARHOLIADAU
MAI 2018

MODULE CODE: M6X00420
ADVANCED STRESS ANALYSIS AND FEA (FULL TIME)

TIME: 2 HOURS

ANSWER THREE OUT OF FOUR QUESTIONS

Equipment or materials required – None

Adnoddau neu ddefnyddiau sydd eu hangen – Dim

A formula sheet is provided for reference.

Calculators are permitted.

Assume 'g' = 9.81 m/s^2 .

TWO

A circular bar of constant cross-section, and length L , is subjected to uniaxial tensile loading.

- (a) (i) By means of a suitable sketch of a load (P) – extension (δ) graph, prove that the strain energy, U , (neglecting the weight of the bar) is given by;

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

[6 marks]

- (ii) What is meant by the term Resilience, as applied to strain energy? Hence, for the strain energy equation given above, prove that resilience may be defined as;

$$\text{Resilience} = \frac{\sigma^2}{2E}$$

[4 marks]

- (b) (i) Determine the strain energy in a steel rod of diameter 19.05 mm and length 3.05 m, when it is subjected to a tensile load that produces a stress of 280 MPa within the rod. Take Young's Modulus of the steel rod as 210 GPa.

[3 marks]

- (ii) If the rod was fixed vertically at its upper end and a rigid collar fitted securely at the lower end, if a mass ' m ' is dropped from a vertical height ' h ' onto the collar, show that the energy transferred from the falling mass due to the height, is related to stress ' σ ' in the rod, by the following relationship;

$$h = \frac{\sigma^2 V}{2Emg} - \frac{\sigma L}{E}$$

Assume that the instantaneous extension of the bar is significant in the energy transfer, and should not be neglected from the relationship.

[5 marks]

- (iii) If the stress in the bar should not exceed a value of 65 MPa, from what height could a mass of 120 kg fall onto the collar, without exceeding this stress? Use dimensions and properties of the steel bar as given in part (b)(i).

[2 marks]