UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: February 2020

Module Number: CE 4204 **Module Name: Structural Analysis II**

[Three Hours]

[Answer **all questions,** each Question carries 20 Marks]

Q1. (a) Indicate the difference between an Ideal Strut and a Real Strut, and how it affects the buckling load.

[4 Marks]

(b) A vertical slender strut of length L is fixed rigidly at its lower end and it has a horizontal arm fixed to its upper end which is free. A vertical load W is carried at the end of the horizontal arm, and a horizontal force H acts at the upper end in the plane of bending, producing bending in a sense opposite to that produced by W. If the action of H is such that the line of action of W passes through the centre of fixture of the lower end of the strut, show that;

$$H = \frac{W\ e\alpha \sec \alpha L}{\tan \alpha L - \alpha L}$$

Where e is the length of the horizontal arm fixed at the upper end of the strut and

$$\alpha^2 = \frac{W}{EI}$$

[16 Marks]

Q2. (a) A continuous beam ABCD has two hinges located in spans AC and CD. Using first principles, draw the influence lines for;

(i) Reaction at C (R_C)

[4 Marks]

(ii) Bending Moment at E (M_E)

[6 Marks]

(iii) Shear force at E (S_E)

[6 Marks]

(b) When a distribution load of intensity 10 kN/m traverses the beam, determine the maximum bending moment at E, when the length of the load is

(i) 2.0 m

[2 Marks]

(ii) 4.0 m

[2 Marks]

Q3. (a) Describe what is meant by failure of brittle materials and explain the theory of "Mohr's Modified Shear Stress".

[4 Marks]

(b) Draw the boundaries of the failure criteria without proof in the (σ_1, σ_2) plane

[3 Marks]

(c) Indicate the equations of the boundaries of the failure envelope

[8 Marks]

(d) Determine the factors of Safety of the loading cases as indicated in the Figure Q3.
All stresses are in N/mm^2,
Tensile strength at fracture = 400 N/mm^2
Compressive strength at fracture = 700 N/mm^2

[5 Marks]

Q4. (a) Explain what is meant by:

(i) Plastic moment capacity

[2 Marks]

(ii) Plastic Region

[2 Marks]

(b) The plane frame shown in Figure Q4 has plastic moment capacities as indicated.

(i) Determine the independent Mechanisms

[3 Marks]

(ii) Write work equations for (i) above

[6 Marks]

(iii) Hence find the combined mechanisms and determine the probable Collapse Load

[7 Marks]

Q5. A suspension bridge has been constructed over a wide river. It has two suspension cables with the maximum dip of 8 m from the left support level. The bridge supports a two lane highway and each lane is designed for an imposed load of 25 kN/m per lane. The dead load, including weight of the suspension cables, hangers, stiffening girder and the deck, is estimated as 30 kN/m. The suspension cables are supported at two points, 120 m apart. The left support is 2 m above the right support. Figure Q5 shows the details of the cable arrangement. Consider above loads as final factored design loads.

a) Calculate the maximum tension in a cable.

[4 Marks]

b) Determine the minimum diameter of the cable if the allowable stress in the cable is 400 N/mm^2.

[4 Marks]

c) Determine the force in a backstay assuming that it is inclined 40° to the horizontal and also that it is anchored to the cable through a pulley.

[6 Marks]

d) Determine the maximum bending moment in the pier. The height of the pier is 20 m.

[6 Marks]

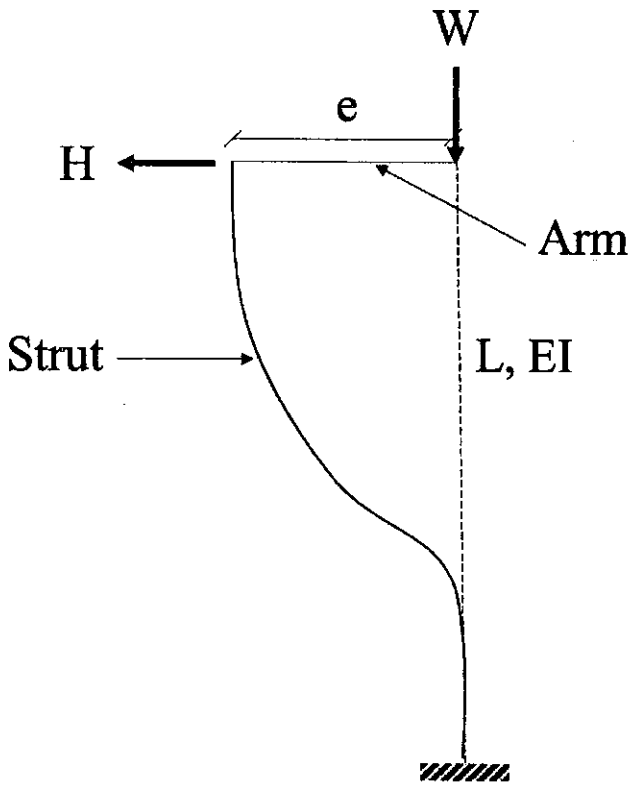


Figure Q1.

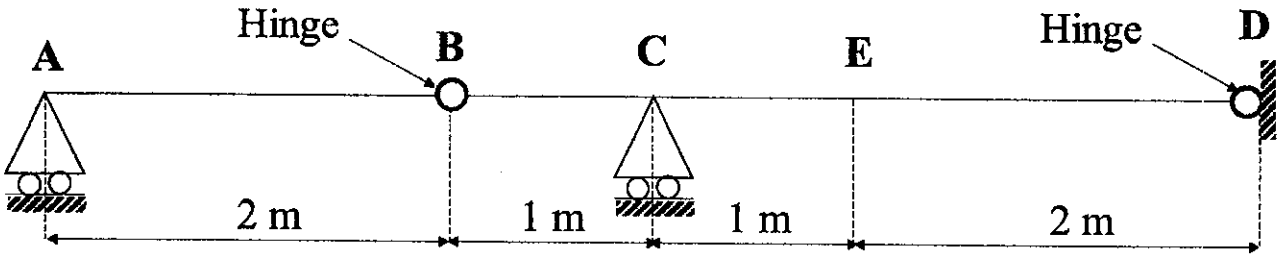
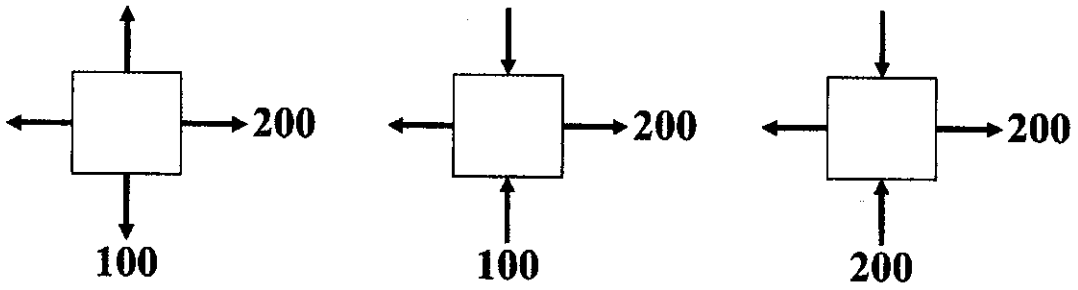


Figure Q2.



All stresses are in N/mm^2

Figure Q3.

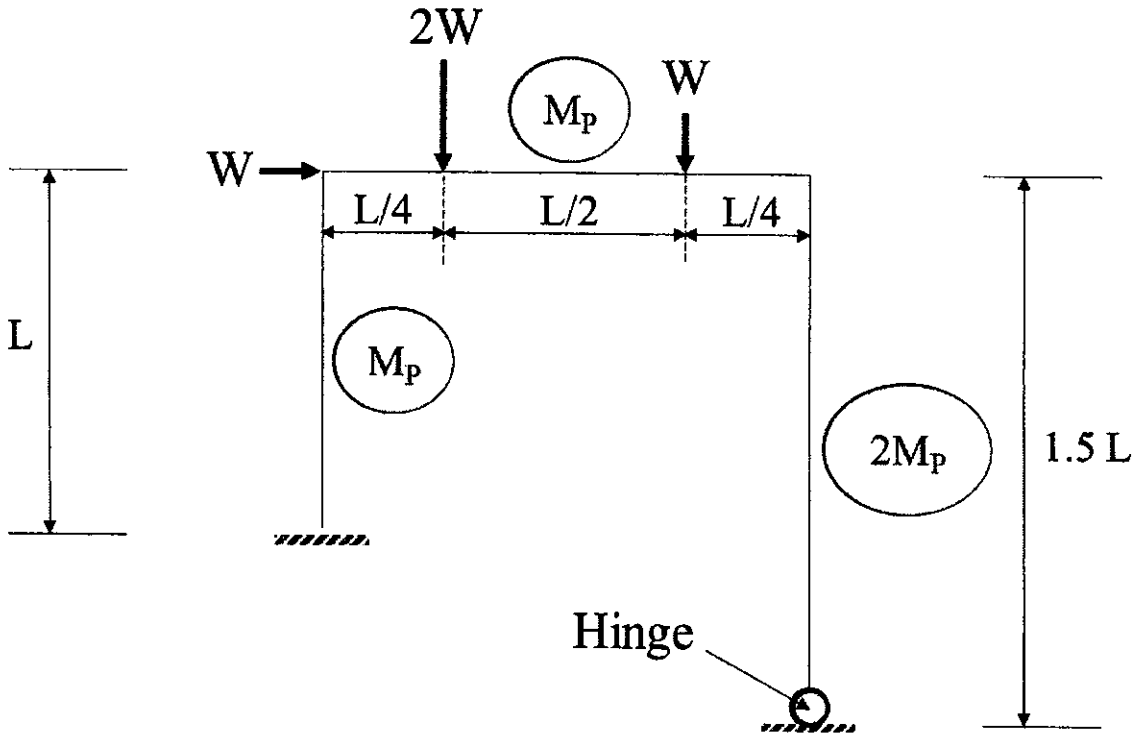


Figure Q4.

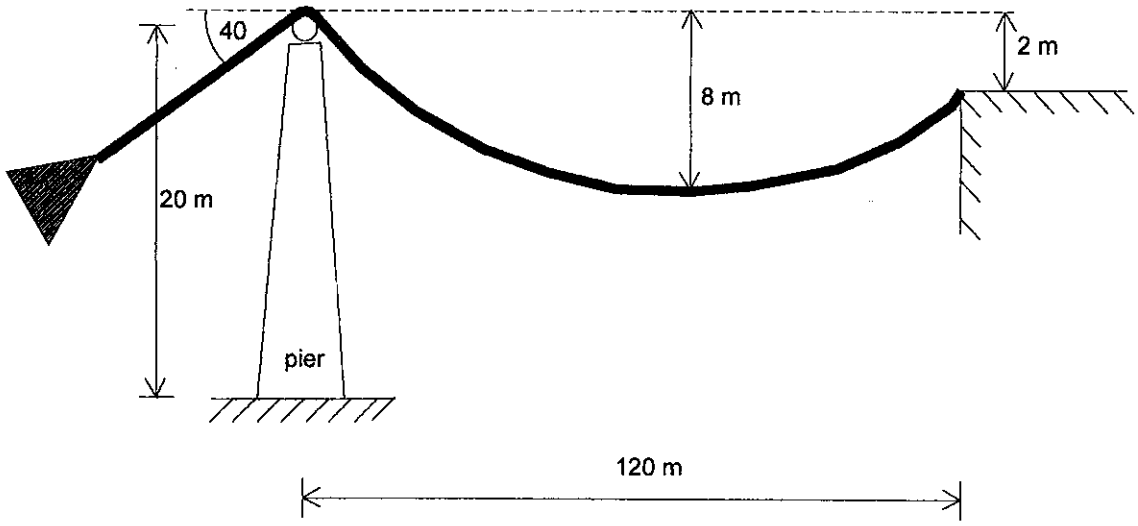


Figure Q5