UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: November 2016

Module Number: CE4203 **Module Name**: **Structural Analysis II**

[Time: Three Hours]

[Answer all questions, each question carries TWELVE marks]

All Standard Notations denote their regular meanings

Q1. a) State the Mohr's modified theory for concrete as a structural material?
Note: you may adopt a yield criterion as a fracture criterion for brittle materials

[1.5 marks]

b) Draw the failure envelope in the (σ_1, σ_2) plane for concrete as a 2D system.
Note: Strength in tension is σ_t and strength in compression is σ_c

[2.5 marks]

c) Define the boundaries of the failure envelope.

[3.5 marks]

d) Shown in figure Q1 are several stress states a precast concrete member is subjected to.
You are required to determine the factor of safety for each case and arrange them in the diminishing order.
Note: It is suggested to use a special concrete with following properties: Compressive strength = 150 N/mm^2; Tensile strength = 30 N/mm^2.

[4.5 marks]

Q2. a) Discuss briefly what you understand by "an intermediate strut."

[2.0 Marks]

b) A vertical slender strut of length L is fixed rigidly at its lower end, and it has a rigid horizontal arm fixed to its upper end which is free as shown in figure Q2. 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 boarding, 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 if fixture of the lower end of the strut, show that:

$$H = \frac{We\,\alpha \sec \alpha L}{\tan \alpha L - \alpha L}$$

Where e is the length of the horizontal arm fixed at the upper end of the strut and $\alpha^2 = \frac{w}{EI}$

[10.0 Marks]

Q3. a) Explain what is meant by an Influence Line and compare with similar action diagram.

[2.0 marks]

b) A train of loads resulting from a heavy truck is shown in Figure Q3. If this loading is to cross a simply supported box girder bridge of 20m in length:

i) Determine the bending moment and shear force at a location 8m away from the left support

[6.0 marks]

ii) Also determine the absolute maximum bending moment.

Note: You may use relevant criteria without proof to establish the critical conditions.

[4.0 marks]

Q4. a) Indicate what you understand by plastic moment capacity.

[1.5 marks]

b) Determine the plastic moment capacity of a rectangular beam.

[1.5 marks]

c) A plane frame ABCDEF of constant plastic moment capacity M_P is loaded as shown in Figure Q4. It is required to design the structure with structural steel as the construction material.

i) What is the number of locations required of specify the bending moment diagram?

[1.0 mark]

ii) Determine the degree of statical indeterminacy.

[1.0 mark]

iii) Evaluate the relationship between W and M_P at collapse.

[3.0 mrks]

iv) Confirm the failure mechanism by conducting a statical analysis and illustrate with a valid Bending Moment Diagram.

[4.0 mark]

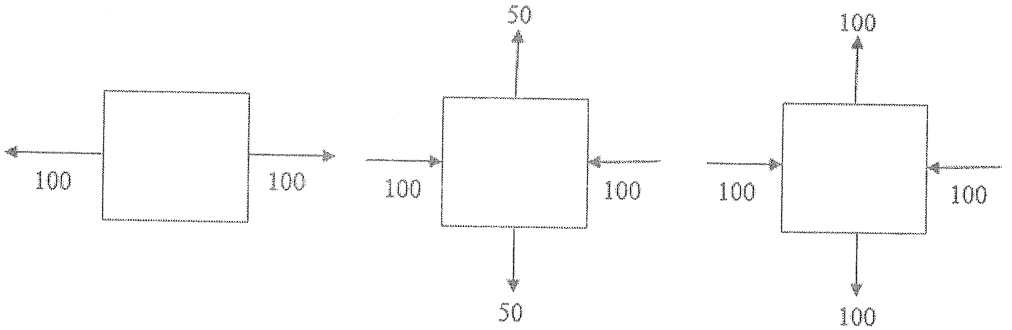
Q5. Fig. 5(a) shows a three-hinged parabolic arch ACB subjected to a uniform distributed load of intensity 10 kN/m over the portion AC of its span. The supports A and B of the arch are at different elevations.

a) Derive an expression for profile of the parabolic arch ACB and hence determine parameters h_B, h_D, and slope $\alpha°$ at the point D.

[5.0 marks]

b) Calculate the values of the normal force, shear force and bending moment at the point D.

[7.0 marks]



Note: All stress values are in N/mm².

Figure Q1

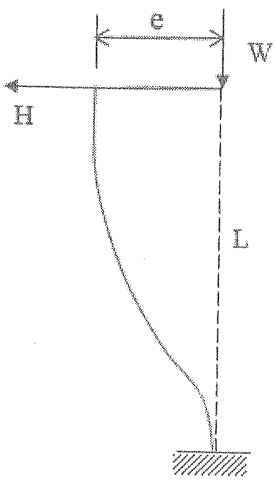


Figure Q2

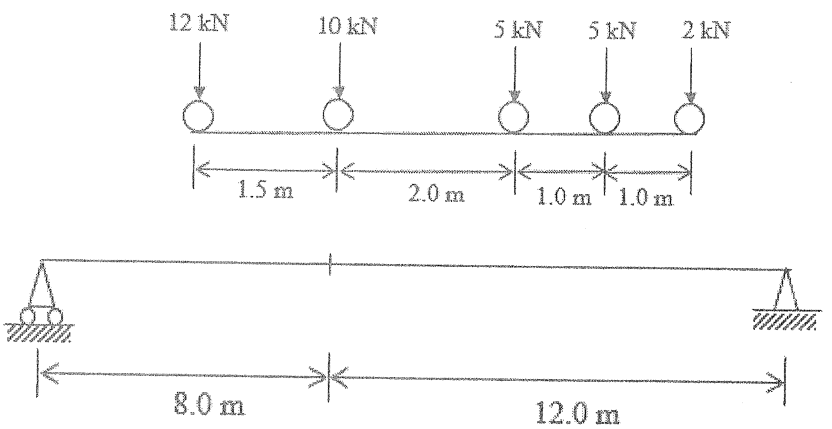


Figure Q3

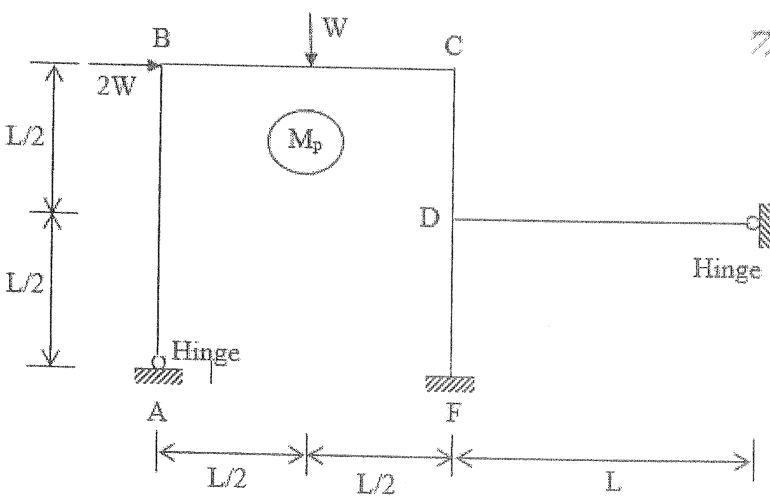


Figure Q4

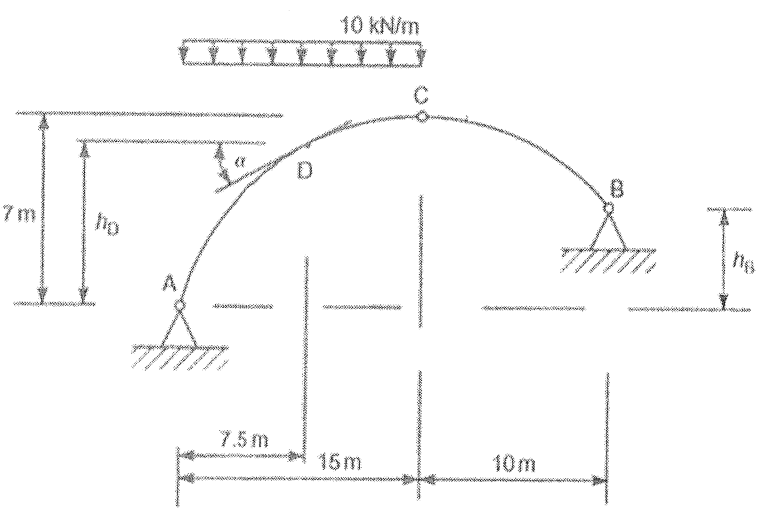


Figure Q5