UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: December 2015

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

[Three Hours]

[Answer **all questions**. Each question carries 16 marks]

All Standard Notations denote their regular meanings

Q1. a) State two advantages and disadvantage of using arch as a major structural component of a bridge instead of beam.

[2 Marks]

b) A two hinged parabolic arch of constant cross section is subjected to a soil fill, as shown in Figure Q1. The span and rise of the arch are 20 m and 4 m respectively. Neglect the horizontal pressure developed by soil. Assume, soil density is 2000 kg/m^3. Determine the horizontal trust at the support due to soil pressure.

[14 Marks]

Hint: For a two-hinged parabolic arch, horizontal thrust, H, (with usual notations and sign convention) is given by the equation;

$$H = \frac{-\int \frac{M_0 \bar{y}}{EI} dx}{\int \frac{\bar{y}^2}{EI} dx} \qquad \text{where } \bar{y} = \frac{4dx(L-x)}{L^2}$$

Q2. A suspension bridge of 100m span is supported by two sets of cables hanging in a parabolic form and has a central dip of 10m. It is stiffened with a three-hinged girder. The self-weight of the bridge is 1000 kN and it is uniformly distributed throughout the span. It is to be designed to carry a single rolling load of 100 kN. The loads may be assumed to be equally divided between the two suspension cables.

a) Determine the maximum tensile force acting on each suspension cable.

[7 Marks]

b) If the permissible stress in the cables is 150 MPa, determine the required cross-sectional area of the cable.

[2 Marks]

c) When rolling load located at middle of the girder, find the maximum bending moment in the stiffing girder.

[7 Marks]

Hint: horizontal component of force at any point along the cable is given by the equation;

$$F_H = \frac{w_0 L^2}{2h}$$

Q3. a) A symmetrical two-hinged parabolic arch-rib has its supports in the same elevation and l distance apart from each other as shown in Figure Q3. Rise to the crown of the arch from the level of the support is h. Show that expression for the horizontal thrust developed at the supports due to a load W placed on the arch kl distance from the left support is given by;

$$H = \frac{5Wl}{8h}(k^4 - 2k^3 + k)$$

[6 Marks]

b) Draw the influence line of the bending moment developed at the crown of the arch, for a moving load. Arch span and crown rise are 40 m and 5 m, respectively.

[4 Marks]

c) Determine the bending moment developed at the crown of the arch shown, due to the wheel loads of a moving truck indicated on the Figure Q3. Take that truck travels from right to left.

[6 Marks]

Q4. A section of I-beam made of ductile material (yield strength, σy = 420 MPa) is shown in Figure Q4(a).

a) Calculate the elastic moment (M_Y) and plastic moment (M_P) of the given beams.

[5 Marks]

b) Determine the shape factor for the beam.

[1 Mark]

c) If the beam is propped cantilever with two point loads as shown in the Figure Q4(b), find the maximum value for 'P' before beam collapsed.

[8 Marks]

d) Show that, value for 'P' obtains in Q4.(c) is a unique solution.

[2 Marks]

Q5. a) Briefly discuss the three important criteria in plastic analysis to identify the correct load factor.

[3 Marks]

b) A portal frame (ABCD) is shown in Figure Q5. Frame supports a vertical load, 40 kN, at the centre of the beam BC. Member AB is subjected to a to a triangular distributed load of intensity zero at support A and 10 kN/m at B. Plastic moment capacity of the beam (BC) and columns (AB, CD) are 200 kNm and 150 kNm respectively. Determine;

I. The collapse load factor for portal frame.

II. Sketch the bending moment diagram for corresponding critical collapse mechanism.

[13 Marks]

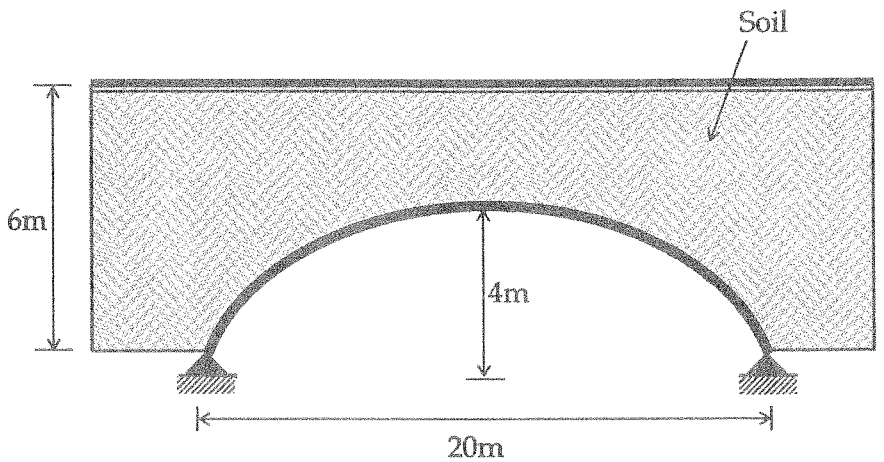

Figure Q1

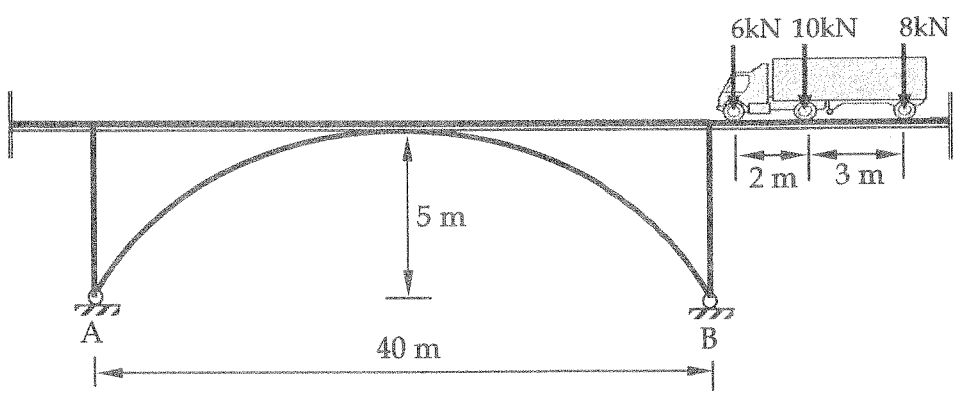

Figure Q3

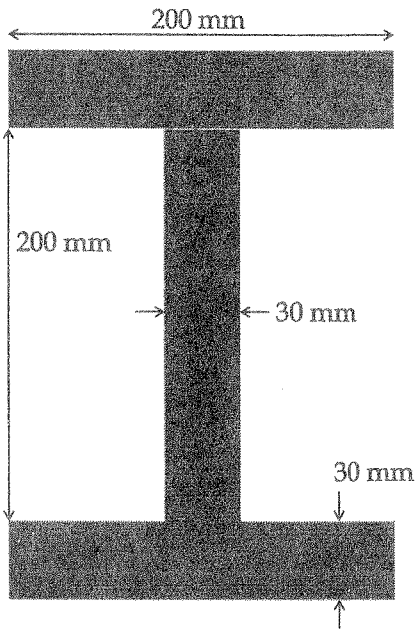

Figure Q4(a)

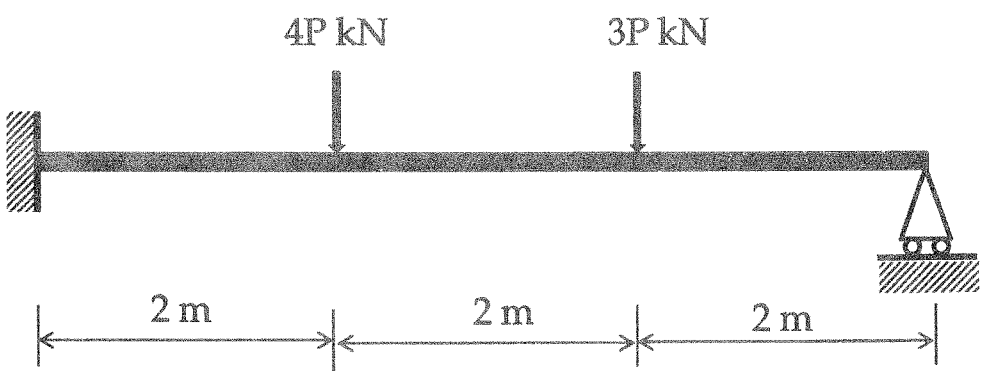

Figure Q4(b)

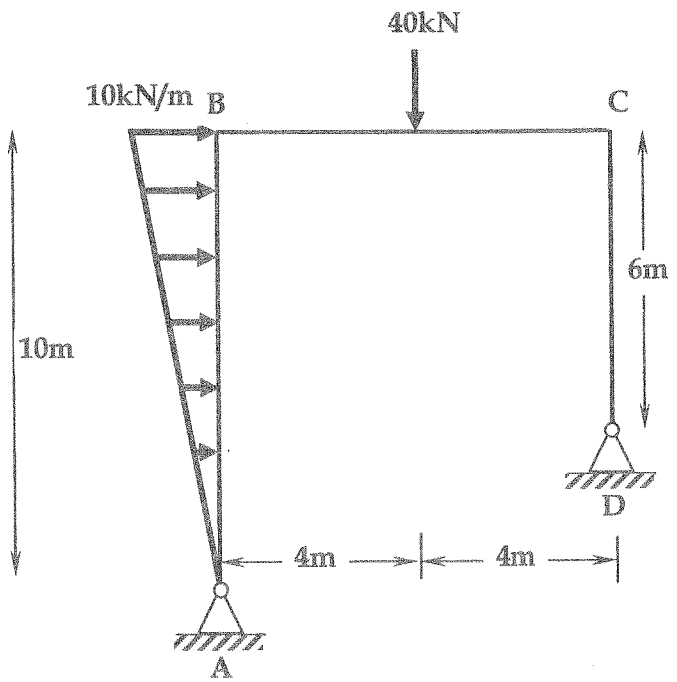

Figure Q5