CIV3221 Building structures and technology (Clayton and Sunway)
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Introduction

This exam is an open-book assessment. The answers provided to all questions must be submitted through Moodle. You are allowed to use computational aid (including calculators), and to refer to lecture notes or other materials (that must be properly cited and referenced in order to avoid plagiarism).

Exam duration: 2 hours and 10 mins
Scanning time: 30 mins

QUESTION 1 [10 marks]

a) Identify differences between first and second order elastic analysis. **[5 marks]**

b) What are the reasons that may cause the movement of facade. **[5 marks]**

QUESTION 2 [10 marks]

For a continuous beam ABC shown in Figure Q2, the following loads are applied:

- External moment at Point A, M = 20 kNm anti-clockwise
- Uniformly distributed load (UDL) between Points A and B, w = 3 kN/m
- Point load at midspan of BC, P = 12 kN

Point A is free (unsupported), Support B is a roller and Support C is fixed.

Given: E = 200,000 MPa, I_{AB} = 10.8 $\times 10^8$mm^4, I_{BC}=21.6 $\times 10^8$mm^4, L_{AB} = 8 m, L_{BC} = 4 m

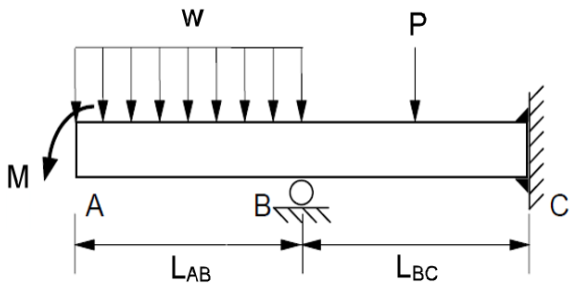

Figure Q2

a) Using the moment distribution method, calculate the support reactions at B and C. **[5 marks]**

b) Plot the bending moment and shear force diagrams. **[5 marks]**

QUESTION 3 [20 marks]

A simply supported composite slab in a composite floor structure of an office building is given below in Figure Q3. The live load is 5 kPa. The dead load consists of the floor self-weight plus a super-imposed dead load of 2 kPa . Take f'$_c$ = 40 MPa , E_c = 28000 MPa and unit weight of reinforced concrete = 25 kN/mm^3 and L = 2780 mm.

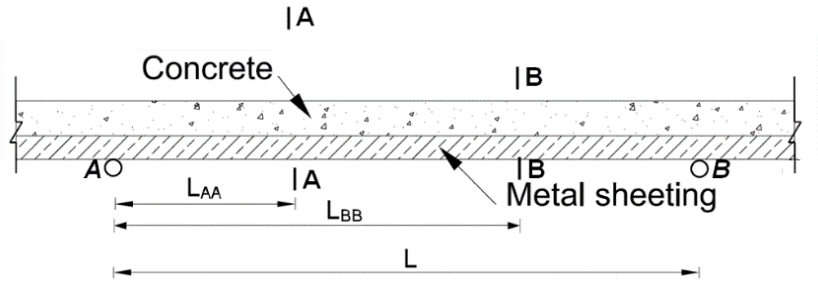

Figure Q3

a) Check the serviceability limit state condition of this span using the deemed-to-comply span to depth ratio method. Take the overall depth of slab D = 120 mm. **[10 marks]**

b) What is the sagging bending moment capacity for the section A-A with a distance of L_{AA} = 700 mm from the left support (A), and is it safe there in terms of bending moment capacity? **[5 marks]**

c) What is the sagging bending moment capacity for the section B-B with a distance of L_{BB} = 1880 mm from the left support (A), and is it safe there in terms of bending moment capacity? **[5 marks]**

QUESTION 4 [16 marks]

The layout of a reinforced concrete floor is shown in Figure Q4 below for building construction. The overall depth of reinforced concrete slab is 120 mm. 460 UB 67.1 is used as the support steel girder for the secondary composite beam (nominal depth =460 mm, A_s = 8580 mm^2, f_{sy} = 300 MPa). All secondary beams are simply supported with a span length L of 8500 mm. The dead load consists of the floor self-weight plus a super-imposed dead load of 1 kPa. Take f'_c = 28 MPa, E_c = 26,800 MPa and unit weight of reinforced concrete = 24 kN/m^3.

a) What is the maximum live load that the composite beam can resist? **[8 marks]**

b) Calculate the number and spacing of welded shear studs that ensure complete shear connection. Use studs with d_{bs} = 19 mm and f_{uc} = 410 MPa. **[8 marks]**

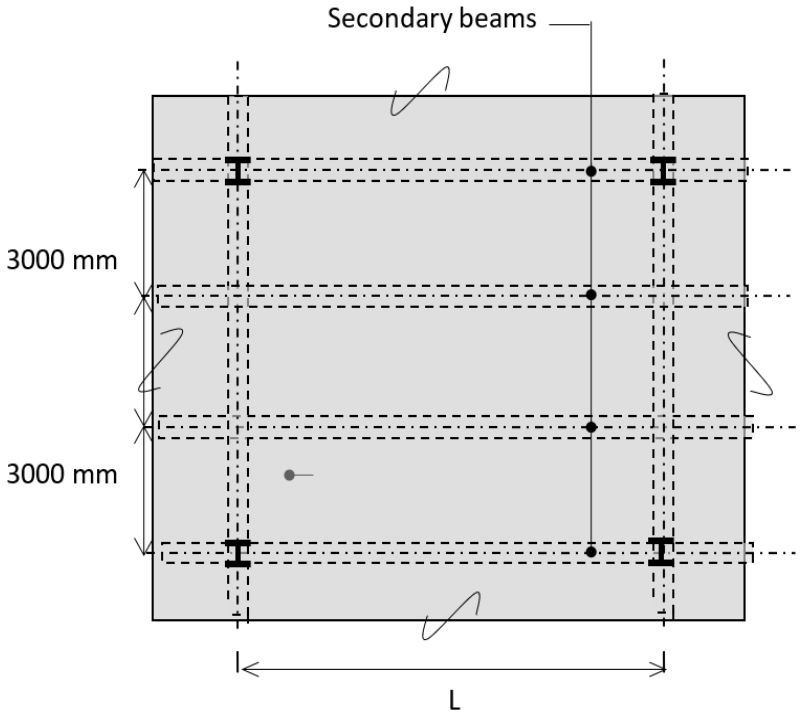

Figure Q4

QUESTION 5 [30 marks]

A 310UC158 (BHP 300 PLUS) is under combined compression force (N^*) and bending moment (M_x^*) about its major x-axis. The capacity factor ϕ = 0.9. The moment ratio β_m = 1.0.

The applied compression force N^* is 2500 kN. The bending moment M_x^* is the product of N* and the load eccentricity (e) which is 100 mm. The column length L = 3000 mm. The boundary condition of the column can be assumed as fixed at both ends. Section constant α_b = 0. Assume FLR is provided.

(a) Calculate the design column member capacity about x-axis (ϕN_{cx}). **[5 marks]**

(b) Determine the design in-plane section and member capacities ϕM_{rx} and ϕM_i using the special formulae. Check if the member capacity is adequate. **[15 marks]**

(c) Compare the maximum eccentricities (e) can be applied to the member for the given N^* based on the general and special formulae? **[10 marks]**

QUESTION 6 [14 marks]

Assuming that a typical column rests on a rectangular footing through a $X_c \times Y_c$ (500×450) mm base plate, calculate the maximum design column load N^* the footing can support in terms of bending and punching shear. Assume planar dimensions of the footing to be $X_b \times Y_b$ (1700×1700) mm and its overall depth D = 500 mm with a concrete cover thickness of 75 mm. The concrete compressive strength f'_c is 32 MPa and the steel reinforcements (f_y=500 MPa) are placed as shown in Fig. Q6.

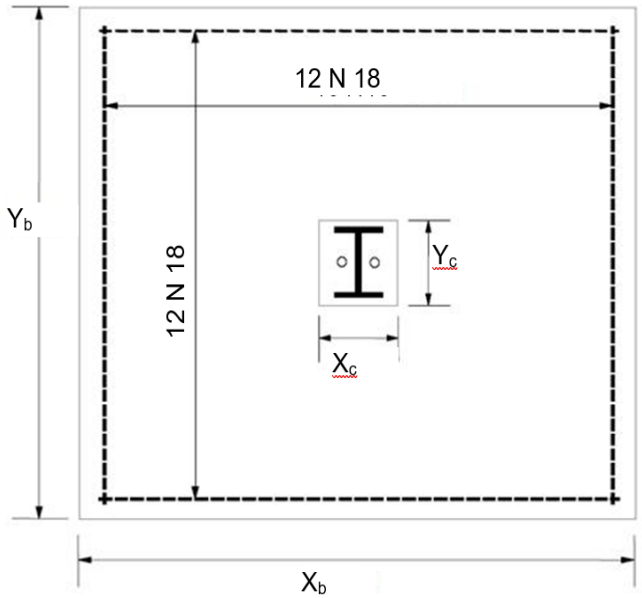

Figure Q6. Plan view of the footing for a single column (not to scale), with steel reinforcements N18 (diameter 18 mm) in each direction

End of exam paper