CSM – 18/17

Civil Engineering

Paper – I

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any ***three*** *of the remaining questions selecting at least* ***one*** *from each Section.*

SECTION – A

1. Answer any **three** of the following : 20×3 = 60

   (a) A vertical column AB, of uniform section, 10 meters high, is hinged at the top and the base. It carries a rigid horizontal bracket at C on the right hand side at a height of 6 meters from the base. The bracket carries a vertical load of 100 kN at a distance 1 meter from C. Taking account of bending only, determine the maximum moment in the column.

(b) Analyze the beam as shown in Fig. 1 by slope defection method and draw shear force and bending moment diagram.

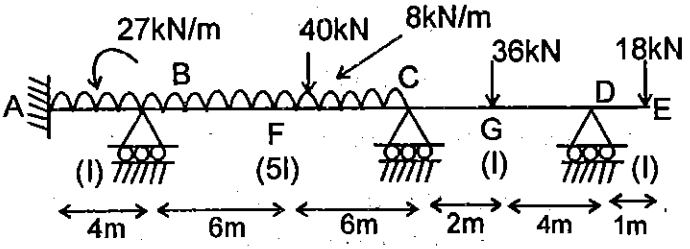

Fig. 1

(c) Design a simply supported slab for a room size 4.5m × 5.0m. Two adjacent edges are continuous and the remaining edges are discontinuous. The slab will be used as a floor of residential building and is supported on a 300mm thick masonry walls. Use M-20 grade of concrete and Fe-415 grade of steel. Draw reinforcement details also.

(d) Design of a laced column with two channels back to back of length of 10m to carry an

axial factored load of 1400kN. The column may be assumed to have restrained in position but not in direction at both the ends(hinged ends).

2. (a) The end moments of the members of the portal frame of Fig. 2 are to be obtained using moment distribution method. The relative values of EI are shown along the members.

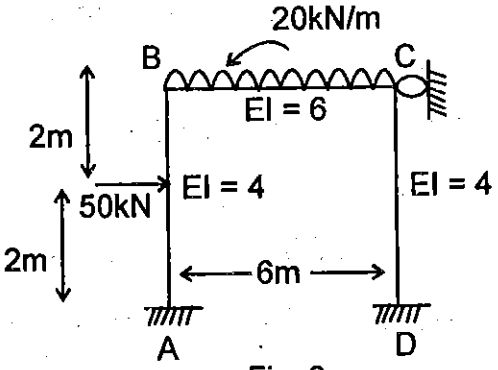

Fig. 2

(b) Design a rectangular isolated footing of uniform thickness for RCC column. This column is of 400mm × 600mm and resists an axial load of 600kN. Assume safe bearing

capacity of soils as 110kN/m^2. Use M-20 concrete and Fe-415 steel. Draw reinforcement details also.

(c) Design a simply supported gantry girder to carry one electric overhead travelling crane for the following data :

Span of gantry girder = 6.5m

Span of crane girder = 16m

Crane capacity = 500kN

Self weight of crane girder excluding trolley = 280kN

Self weight of trolley = 50kN

Minimum hook approach = 1.0m

Distance between wheels = 3.5m

Self weight of rails = 0.3kN/m $20 \times 3 = 60$

3. (a) Make neat diagram for influence lines for Shearing force and Bending moment at a section 3m from one end of a simply supported beam of 12m length. Use the diagram to calculate maximum shearing

force and the maximum bending moment at this section due to a uniformly distributed rolling load, 5m long and of 2kN/m intensity.

(b) A curved ring beam of width 300mm is subjected to B. M. = 50kN-m, Shear Force = 25kN and Torsional moment = 15kN-m points. Design the section and torsional reinforcement in the form of hoops and longitudinal reinforcement.

(c) Determine the design loads on the purlins of an industrial building near Udaipur for the following data :

Class of building = General with life of 50 years

Terrain = Category 2

Maximum dimension = 50m

Width of building = 30m

Height of eye level = 8m

Topography = θ less than 30^{o}

Permeability = Medium

Span of Truss = 30m

Pitch = 1 : 4

Sheeting = G. I. Sheets

Spacing of purlins = 1.4m

Spacing of trusses = 5m $20 \times 3 = 60$

4. (a) A parabolic three hinged arch at the springing and crown has a span of 20m. The central rise of the arch is 4m. It is loaded with a uniformly distributed load of intensity 2kN/m on the left 8m length. Calculate the direction and the magnitude of reaction at the hinges, the bending moment, normal thrust and shear at 4m and 15m from left end. Also, calculate the maximum positive and negative bending moment.

(b) A cylindrical water tank of 600kL of water with open at the top and the flexible joint at the base. The height of the tank including free board of 0.3m is 4.3m. Design the vertical wall of the tank using IS 3370. Use M-20 concrete and steel of grade Fe-415.

(c) Design of a laced column with two channels back to back of length of 10m to carry an axial factored load of 1400kN. The column may be assumed to have restrained in position but not in direction at both ends (hinged ends). $20 \times 3 = 60$

SECTION – B

5. Answer any **three** of the following :

(a) (i) Derive an expression for drag and lift force on a body in the real fluid. 10

(ii) 250 liters/s of water is flowing in a pipe having a diameter of 300mm. If the pipe is bent by 135°, find the magnitude and direction of the resultant force on the bend. The pressure of water flowing is 39.24 N/cm^2. 10

(b) (i) Define Earth Pressure. What are the assumptions in Coulomb's theory ? Compare Ranking theory and Coulomb's theory. 8

(ii) A retaining wall 4.0m high supports a smooth vertical back the back fill has a horizontal surface in level with the top of the wall. There is a uniformly distribution surface load of 34kN/m^2 over the back fill. The water table is at an elevation of 2.5m about the base. Taking $\gamma = 17.8 kN/m^3$, $\gamma_{sub} = 11.9 kN/m^3$. Angle of internal friction $\phi = 30^o$ and the soil behind the wall is cohesion less. Determine the magnitude and point of application of active earth pressure per m length of the wall. 12

(c) (i) Derive an expression for total pressure and centre of pressure for a plane lamina submerged in a liquid. 12

(ii) Two points in a horizontal water pipe are connected to a manometer which has the form of an inverted U-tube. The space above water in two limbs of manometer is filled with oil(S = 0.8). If the difference of water column in the two limbs reads as 12cm, find the difference of pressure in N/m^2. 8

(d) (i) Define safe bearing capacity. Explain, in detail, Terzaghi's analysis for bearing capacity. 10

(ii) A square footing 1.5m × 1.5m is located at a depth of 1m. The soil has the following properties :

$\gamma = 17.5 kN/m^3$, $c = 20 kN/m^2$ and $\phi = 20^\circ$. Find ultimate bearing capacity of the soil. Taking footing base and ground are horizontal. $N_c = 14.83$, $N_q = 6.4$, $N_\gamma = 2.9$. 10

6. (a) (i) Define coefficient of discharge of an orifice. A pitot tube having a coefficient of 0.98 is used to measure velocity at the centre line of the pipe. The stagnation pressure is 5.67m and the static pressure head in the pipe is 4.72m. What is the velocity ? 10

(ii) Water flows upward through vertical 300mm × 150mm venturi meter whose coefficient C_d is 0.99. The differential gauge deflection is 1.18m of liquid of relative density 1.23. Determine the flow rate. The distance between throat and inlet of venturi meter is 457 mm. 10

(b) (i) 1 cm thick laboratory soil sample reaches 60% consolidation in 32.5 seconds under double drainage

condition. Find how much time will be required for 10m thick layer in the field to reach the same degree of consolidation, if it has drainage face on one side only. 10

(ii) A slope is to laid at an angle 30^{o} with its horizontal. Find safe height of slope for a factor of safety of 1.5, if the soil properties are $c = 15kN/m^2$, $\phi = 22^{o}$, $\gamma = 18kN/m^3$. 10

(c) (i) Explain the terms hydraulic gradient and total energy line. 8

(ii) Derive the Darcey-Weishback equation for finding out the loss of head due to friction in pipes. 12

7. (a) (i) Differentiate between void ratio and porosity. Develop a relationship between void ratio and porosity. 10

(ii) Describe the method of obtaining particle size distribution curve by sieve analysis. 10

(b) (i) Explain Mohr-Coulomb theory for failure of soil. 8

(ii) Determine the shear strength in terms of effective stress on a plane within a saturated soil mass at a point where the total normal stress is 200kN/m^2 and the pore water pressure is 80kN/m^2. The effective stress shear strength parameters for the soil are $C' = 16kN/m^2$ and $\phi' = 30^o$. 12

(c) (i) Show that for a steady laminar flow between two fixed parallel plates, the velocity distribution across a section is parabolic and the average velocity is 2/3 of the maximum velocity. 10

(ii) Two parallel plates kept 0.1m apart have laminar flow of oil between them with a maximum velocity of 1.5m/sec. Calculate the discharge per meter width, the shear stress at the plates and the difference in pressure in Pascals between two points 20m apart, the velocity gradients at the plates and velocity at 0.2m from the plate. Take viscosity of oil to be $2.453 Ns/m^2$. 10

8. (a) (i) Explain the significance of channels of most Economics section and derive the condition under which rectangular section of an open channel will be most economical. 10

(ii) An open channel of V-shaped, each side being inclined at 45° to the vertical. If it carries a discharge of $.04m^3/sec$ at the depth of flow at centre being 225mm.

Calculate the slope of the channel assuming C = 50. 10

(b) (i) Discuss Triaxial test to determine the shear strength of soil in various conditions. 10

(ii) Two identical soil specimens were tested in a triaxial apparatus. First specimen failed at a deviator stress of 770kN/m^2, when the cell pressure was 200kN/m^2. Second specimen failed at a deviator stress of 1370kN/m^2 under a cell pressure of 400kN/m^2. Determine the value of c and ϕ analytically. If the same soil is tested in a shear apparatus with a normal stress of 600kN/m^2, estimate the shear stress at failure. 10

(c) (i) Describe Boussinesq's theory and also discuss the assumption and limitation of Boussinesq's theory. 8

(ii) A concentrated load of 20kN acts on the surface of a homogenous soil mass of large extent. Determine the stress intensity at a depth of 10m (a) directly under the load and (b) at a horizontal distance of 5m using Boussinesq's and Westergaard's Analysis. 12