COMBINED COMPETITIVE EXAMINATION (MAIN)

CIVIL ENGINEERING

Paper—I

Time : 3 hours *Full Marks* : 200

Note : *(1) The figures in the right-hand margin indicate full marks for the questions.*

*(2) Attempt **five** questions in all.*

*(3) Question No. **1** is compulsory.*

1. Answer any *ten* from the following : 4×10=40

(a) What are the differences between static and kinematic indeterminacy?

(b) A propped cantilever of length L carrying a u.d.l. of w kN/m. Find the moment at the fixed end. Assume EI is constant.

(c) What are the differences between slope deflection and moment distribution method?

(d) Write down the theorems of moment area methods.

(e) Define Newtonian fluids.

(f) Two horizontal plates are spaced 12·5 mm apart with the space between them being filled with a oil of viscosity 14 poise. Calculate the shear stress in the oil if the upper plate moves with a velocity 2·5 m/s relative to the lower one.

(g) A square surface of size 3 m × 3 m is submerged in water and lies in a vertical plane. Determine the position of the centre of pressure and the total force on the surface when its upper edge coincides with free surface of water.

(h) How does clay absorb water? Explain.

(i) The density index of a granular soil tested under two different conditions is found to be 30% and 75% respectively. Interpret the result.

(j) Explain 'piping' under a hydraulic structure.

(k) Describe suitability of vane shear test for determination of shear strength.

(l) What is bore-log in soil investigation? Why is it important?

2. Answer any *eight* from the following : 5×8=40

(a) Triaxial tests were conducted on to saturated soil samples, A and B, under drained condition with linear deformation rate of 1·2 mm/min. Sample A is made of a cohesive soil and sample B is made of cohesionless soil. Write a note on the acceptability of each of the test results. Give justification for your answer.

(b) Describe different types of settlements of shallow foundation.

(c) What is the fundamental assumption in flexural theory?

(d) Write down the advantages and disadvantages of bolted connections.

(e) What do you understand by the term 'free body diagrams'? Draw the free body diagram of a simply supported beam carrying a point load at the centre.

(f) Why is it undesirable to design over reinforced sections in *(i)* limit state method and *(ii)* working stress method?

(g) Derive the expression for fixed end moments for a fixed beam of length L carrying a u.d.l. of w kN/m.

(h) Why does the code specify an effectively higher modular ratio for compression reinforcement as compared to tension reinforcement?

(i) The velocity potential for a two-dimensional flow is given by $\phi = 3xy$. Determine the x and y components of flow velocity at (1, 3).

(j) Define laminar and turbulent flow.

3. Answer any *five* from the following : 8×5=40

(a) A 4 cm diameter orifice in the vertical side of a tank discharges water. The water surface in the tank is at a constant level of 2 m above the centre of the orifice. If the head loss in the orifice is 0·2 m and the coefficient of contraction can be assumed as 0·63, calculate the coefficient of velocity and coefficient of discharge.

(b) The velocity distribution in a laminar boundary layer is given by

$$\frac{u}{U} = 3\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^2$$

In which, u is the velocity at a distance y from the boundary and U is the velocity at a distance δ, i.e., the thickness of the boundary layer. Determine the value of displacement thickness (δ^*).

(c) A discharge of 100 L/s is to be measured by a triangular notch of vertex angle 60°. What would be the head over the vertex of the notch? If the accuracy of reading the head is 1 mm, what will be the percentage error in discharge computation?

(d) What do you mean by pre-stress losses? Write down the different pre-stress losses.

(e) Write a detailed note on negative skin friction of piles.

(f) What is reinforced earth retaining wall? Describe its advantages and applicability.

(g) What is meant by normally consolidated clay, over-consolidated clay and under-consolidated clay? Explain.

4. Answer any *four* from the following : 10×4=40

(a) Discuss the different factors affecting the compressibility of soil.

(b) A short square column of size 350 mm × 350 mm is reinforced with 4 bars of 25-ϕ, placed with a clear cover of 50 mm. Assuming M-25 concrete and Fe-415 steel, determine the maximum eccentricity with which a factored load of 1300 kN can be safely applied. Use limit state method.

(c) A 6 cm diameter pipe carries a discharge of 450 L/min. A section of the pipe has a sudden expansion to a size of 9 cm diameter. If the pressure just upstream of the expansion is 20 kN/m^2, calculate the pressure just after the expansion. Assume the pipe to be horizontal at the expansion region.

(d) Explain hydraulic grade line (HGL) and total energy line (TEL).

(e) At a certain section *A* of a pipeline carrying water, the diameter is 1 m, the pressure is 98·1 kN/m^2, and the velocity is 3 m/s. At another section *B* which is 2 m higher than *A*, the diameter is 0·7 m and the pressure is 59·2 kN/m^2. Determine the direction of flow.

5. Answer any *two* from the following : 20×2=40

(a) Design the reinforcement in a circular column of 500 mm diameter subjected to a factored load of 2000 kN. The column has an unsupported length of 3·4 m and is effectively held in position at both the ends. Use M-25 grade concrete and Fe-415 steel. Use limit state method.

(b) Determine the ultimate moments of resistance for a doubly reinforced beam with b = 300 mm, D = 600 mm, A_{st} = 1963 mm^2 and effective cover of 50 mm. The materials used are M-20 grade concrete and steel of grade Fe-415. The salient points on stress strain curve are—

Strain, MPa	*Stress*, MPa
0·00000	0·0
0·00144	288·7
0·00163	306·7
0·00192	324·8
0·00241	342·8
0·00276	351·8
≥ 0·00380	360·9

(c) A simply supported beam has a span of 20 m. Uniformly distributed load of 50 kN/m and 6 m long crosses the girder from left to right. Draw the influence line diagram for shear force and bending moment at a section 8 m from left end. Also calculate the maximum shear force and bending moment at this section.

6. Answer any *four* from the following : 10×4=40

(a) Write a detailed note on different types of shallow foundations along with suitability of each type.

(b) A single under-reamed pile is to be installed in a hard clay deposit. The undrained shear strength, c_u, was found to be given by the relation $c_u = 50 + 8D$ in kN/m^2, where D is depth in metres from ground surface. The diameters of the pile shaft and the bulb are 1 m and 3 m respectively. The centre of the bulb is located at 16 m from the ground surface. Determine the allowable load on the pile to ensure an overall factor of safety of 2·0. Neglect the resistance offered by the shaft beneath the bulb. Given that, adhesion reduction factor for hard clay = 0·3 and bearing capacity factor, N_c = 9.

(c) Describe the seismic refraction method of subsoil exploration.

(d) What are the different modes of shear failure of soil supporting footings? Explain.

(e) Prove that in case of steady laminar flow through a circular pipe of radius R_0, the flow velocity (u) at a radial distance (r) from the centre of the pipe is given by

$$u = u_{max}\left[1-\left(\frac{r}{R_0}\right)^2\right]$$

where u_{max} is the maximum velocity.

7. Answer any *two* from the following : 20×2=40

(a) Analyse the beam as shown in Fig. 1 below by moment distribution method :

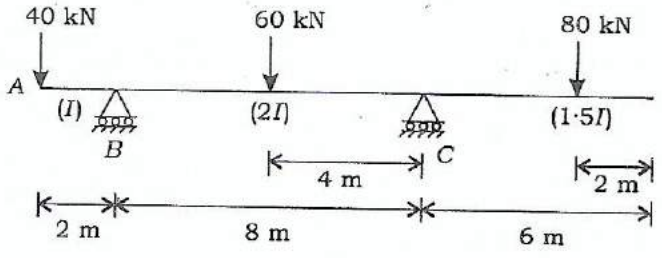

Fig. 1

(b) Analyse the beam as shown in Fig. 2 below by slope deflection method :

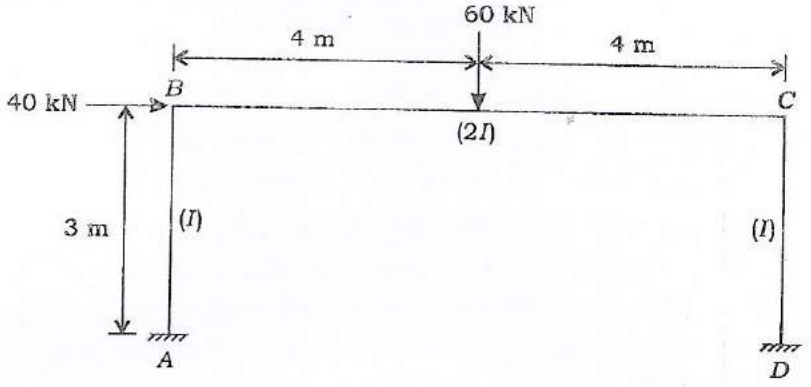

Fig. 2

(c) Define hydraulic jump. For a hydraulic jump occurring in a horizontal rectangular channel, the discharge per unit width is 2·5 $m^3/s/m$ and the depth before the jump is 0·25 m. Calculate the conjugate depth and energy loss.

8. What do you mean by computer language? What are the different types of languages used in programming? Explain any one of the programming languages in detail. 40

9. A hydraulic model of the spillway of Bhakra dam was made to a scale of 1 : 200 for studying the performance of the prototype. Assume the flow in the model and prototype to be insensitive to changes in Reynolds number.

(a) State under what conditions the model may be expected to predict adequately the behaviour of the prototype.

(b) The velocity at the bottom of the model spillway was measured to be 1·25 m/s corresponding to a model discharge of 30 L/s. What are the corresponding prototype quantities? 40

10. In a triaxial test on saturated clay, the sample was consolidated under a cell pressure of 150 kN/m^2. After consolidation, the cell pressure was increased to 350 kN/m^2, and the sample was failed under undrained condition. If the shear strength parameters of the soil are $c' = 16 \cdot 1\ kN/m^2$ and $\phi = 27°$ and pore pressure parameters are $B = 1$ and $A_f = 0 \cdot 29$, determine the effective major and minor principal stresses at the time of failure of the sample.

Also write a note on the points to be considered while deciding the magnitude of the cell pressure to be applied for a particular test. 40

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