2016-17

CIVIL ENGINEERING

FIRST PAPER

Full Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

GROUP—A

Answer *any* **five** questions

1. Draw the BM and SF diagrams for the overhanging beam carrying loads as shown in Fig. 1 below. Mark the values of the principal ordinates and locate the point of contraflexure : 20

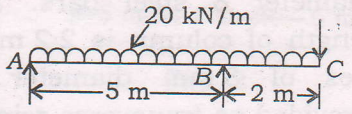

Fig. 1

2. A cylindrical thin drum 80 cm in diameter and 3 meters long has a shell of 1 cm. If the drum is subjected to an internal pressure of 25 kg/cm^2, determine—

(a) the change in diameter, *(b)* change in length and *(c)* change in volume. Take $E = 2 \times 10^6$ kg/cm^2; Poisson's ratio = $\frac{1}{4}$. 20

3. *(a)* Explain why doubly-reinforced beams are required. 5

(b) A simply-supported beam with clear span 6 m is loaded with a uniformly distributed load of 25 kN/m over the entire span. The width of supports is 300 mm. Design the beam if the overall depth D is limited to 400 mm. Use M20 concrete and Fe500 steel. 15

4. *(a)* Define long columns and short columns. 5

(b) A 400×200 mm rectangular concrete column is reinforced with 20 mm diameter 8 steel bars. The effective length of column is 2·2 m. The lateral ties of 8 mm diameter have been provided as transverse reinforcement at appropriate spacing. Determine whether the column is a long column or a short column. Determine the ultimate load-carrying capacity of the column. Consider M20 concrete and Fe500 steel. 15

5. A masonry dam of trapezoidal section is 10 meters high. It has a top width of 1·5 metres and a bottom width of 6·5 metres. The water face of the dam has a batter of 1 in 10. If the water level is at the top of the dam, find the maximum and minimum normal pressures at the base. Weight of masonry is 20·8 kN/m^3 and weight of water is 10 kN/m^3. 20

6. Analyse the building frame as shown below in Fig. 2 by cantilever method when the frame is subjected to horizontal loading as shown : 20

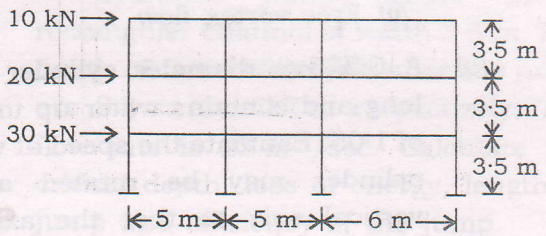

Fig. 2

7. (a) With the help of a neat sketch, describe the various parts of a grillage foundation. 10

(b) Describe briefly how design wind pressure on buildings gets determined. 10

GROUP—B

Answer *any* **three** questions

8. A pipe 200 mm long slopes down at 1 in 100 and tapers from 600 mm diameter at the higher end to 300 mm diameter at the lower end, and carries 100 liters/sec of oil (specific gravity = 0·8). If the pressure gauge at the higher end reads 60 kN/m^2, determine—

   (a) velocities at the two ends;

   (b) pressure at the two ends.

   Neglect all losses. 20

9. *(a)* Define the following terms : 3+3=6

   (i) Forced vortex flow

   (ii) Free vortex flow

   (b) A 0·225 m diameter cylinder is 1·5 m long and contains water up to a height of 1·05. Estimate the speed at which the cylinder may be rotated about its vertical axis so that the axial depth becomes zero. 14

10. *(a)* A trapezoidal channel having side slopes equal to 60° with the horizontal and laid on a slope of 1 in 750, carries a discharge of 10 m^3/sec. Find the width at the base and depth of flow for most economical section. Take the value of Chezy's resistance coefficient $C = 0 \cdot 66$. 14

(b) Define what are subcritical flow, critical flow and supercritical flow. 2+2+2=6

11. (a) Find the discharge through a trapezoidal notch which is 1 m wide at the top and 0·4 m wide at the bottom and is 0·3 m in height. The head of water on the notch is 0·2 m. Assume C_d for rectangular portion as = 0·62 while for triangular portion = 0·6. 12

(b) Define boundary layer and explain the fundamental causes of its existence. 8

12. (a) Write about the practical uses of hydraulic jump. 6

(b) A hydraulic jump occurs in a rectangular channel of width 3·5 m. The depth of flow before and after the jump are 0·8 m and 2·2 m respectively. The flow rate is 25 m^3/sec. Calculate the critical depth, loss of energy, length of jump and efficiency of the jump. 14

GROUP—C

Answer *any* **two** questions

13. (a) The *in-situ* voids ratio of a sand deposit is 0·515. For determining the density index or relative density dried sand from the stratum was first filled loosely in a

1000 cm^3 mould and was then vibrated to give a maximum density. The loose dry mass in the mould was 1610 g and the dense dry mass at maximum compaction was found to be 1980 g. Determine the relative density if the specific gravity of the sand particles is 2·67. 10

(b) A 20 m high homogeneous anisotropic earth dam is constructed on an impermeable foundation. The coefficients of permeability of soil used for the construction of the dam in the horizontal and vertical direction are $7 \cdot 6 \times 10^{-7}$ m/sec and $3 \cdot 6 \times 10^{-7}$ m/sec respectively. The water level on the upstream side is 18 m from the base of the dam. The downstream side is dry. It is seen that there are 4 flow channels and 18 equipotential drops in a square flownet drawn in the transformed dam section. Estimate the quantity of seepage per unit length in m^3/sec through the dam. 10

14. *(a)* Define the terms 'normally consolidated soil' and 'overconsolidated soil'. 5

(b) Two identical soil specimens were tested in a triaxial apparatus. First specimen failed at a deviator stress of 770 kN/m^2 when the cell pressure was 2000 kN/m^2. Second specimen failed at a deviator stress of 1370 kN/m^2 under a cell pressure of 400 kN/m^2. Determine the value of the c parameter and the ϕ parameter analytically. If the same soil is tested in a direct shear apparatus with a normal stress of 600 kN/m^2, estimate the shear stress at failure. 15

15. (a) Define ultimate bearing capacity and net ultimate bearing capacity. 5

(b) Determine the ultimate bearing capacity of a square footing 2 m × 2 m size placed at a depth of 1·5 m below the ground surface in a sandy soil deposit. The water table is at the ground surface. Saturated unit weight of the sand deposit = 18 kN/m^3, $\varphi = 38°$, $N_y = 75$ and $N_q = 60$. Use Terzaghi's theory. 15

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