

2021

CIVIL ENGINEERING

PAPER-I

Time Allowed — 3 Hours

Full Marks — 200

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.

Answers may be written either in English or in Bengali but all answers must be in one and the same language.

All notations / symbols have their usual meanings, unless otherwise specified.

Group-A

Answer any four questions.

32×4=128

- (a) What are the assumptions in Euler's theory of long column? State the relationships between actual length and effective length of columns for different end conditions. 4+3=7

(b) A mild steel tube, 5 m long, 30 mm internal diameters and 4 mm thick, is used as a strut, with both ends hinged. Find collapse load. Assume  $E = 2 \times 10^5 \text{ N/mm}^2$ . 13

(c) Determine the vertical deflection of the load for the structure shown in Fig. 1. The tension members are stressed to  $150 \text{ N/mm}^2$  and the compression members to  $80 \text{ N/mm}^2$ . Assume  $E = 2 \times 10^5 \text{ N/mm}^2$ . 12

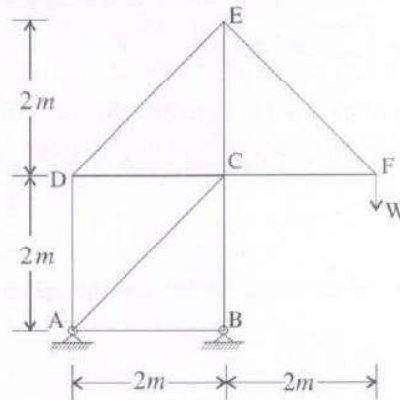


Fig. 1 Structure in Q 1 (c).

- (a) An undisturbed soil sample was collected in the field in a sampling tube of internal diameter of 5 cm. The length of the extracted soil sample was 10.2 cm and its weight was 387 gm. The specific gravity of soil solids was found to be 2.7 and the weight of dried soil sample was 313 gm. Liquid limit and plastic limit of the soil were determined to be 51% and 20% respectively. Find the porosity, void ratio, degree of saturation, dry density and liquidity index of the soil. 15

- (b) State the assumptions made in Boussinesq's solution of vertical stress in soil at a point inside the soil mass due to a vertical concentrated load on surface. 3
- (c) Find the expression for vertical stress at a point below the centre of a circular area loaded uniformly at surface. 14
3. (a) What is meant by Influence line diagram for bending moment at any section of a beam? State the uses of such a diagram. 3+4=7
- (b) A simply supported girder has a span of 10 m. A 100 kN wheel load moves from one end to the other on the span of the girder. Find the maximum bending moment which can occur at a section at a distance of 4 m from the left hand end. 11
- (c) State the conditions for adopting doubly reinforced concrete beam. 5
- (d) What is meant by balanced section of a reinforced concrete beam? Differentiate between under reinforced and over reinforced sections. 4+5=9
4. (a) A 20 cm thick specimen of clay takes 20 min to reach 50% consolidation in the laboratory when drained bothways. If the coefficient of volume change is  $2.5 \times 10^{-2}$  cm<sup>2</sup>/kg, evaluate the coefficient of consolidation and the coefficient of permeability of the soil. 7+7=14
- (b) Explain the differences between discharge and seepage velocity in flow through porous soils. Find the relation between the two. 5+5=10
- (c) Over-dry mass of a pot of clay is 10.8 gm and the mass of mercury displaced on immersion is 84.2 gm. If specific gravity of the soil solid is 2.72, calculate the shrinkage limit of the soil. 8
5. (a) Explain different types of caissons. What are the advantages and disadvantages of open caisson? 3+5=8
- (b) The soil at the toe of a dam, is fully saturated and has water content of 40% and specific gravity of soil solids is 2.66. For safety measure against piping, the exit gradient is to be restricted to 30% of critical hydraulic gradient. Find the permissible exit gradient. 8
- (c) Explain the slump test for finding the consistency of concrete. Indicate the values of slump for different types of construction. 6+2=8
- (d) State the requirements for good concrete. 8

Group-B

Answer any four questions.

18×4=72

6. Draw the shear force and bending moment diagram for the loaded beam shown in Fig 2. 18

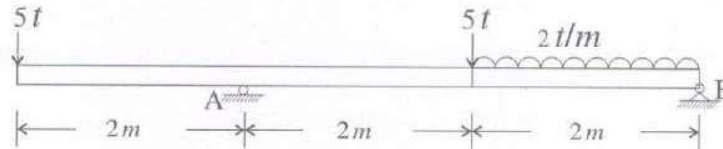


Fig. 2 Beam for Q 6.

7. Foundation for a column consists of a pile group of 4 piles. Arranged in square pattern at a spacing of 1 m c/c. The diameter of the pile is 400 mm and the length of the pile is 12 m. The subsoil consists of clay with  $q_u = 1.0 \text{ kg/cm}^2$ . Assuming  $\gamma = 2 \text{ gm/c.c}$ , estimate the allowable vertical column load. 18
8. (a) An excavation is to be made in a clay having  $C = 16 \text{ kN/m}^2$  and  $\phi = 0^\circ$ . Unit weight of the clay is  $18 \text{ kN/m}^3$ . What will be the depth of vertical cut that can be made without any support? 9
- (b) If  $e$  is void ratio of a soil,  $S$  is the degree of saturation,  $G_s$  is the specific gravity of soil solids, and  $w$  is the water content of the soil, prove that  $S.e = G_s.w$ . 9
9. An ISA  $70 \times 70 \times 10$  is connected to a gusset plate of 15 mm thickness with 14 mm diameter bolts in single row. Determine the maximum tension which the angle section can resist safely. Permissible tensile stress may be assumed to be  $1500 \text{ kg/cm}^2$ . 18
10. For singly reinforced beams, describe the general requirements for effective span, maximum and minimum reinforcements, spacing of bars and cover to reinforcements. 18