

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.

Answer may be written either in **English** *or in* **Bengali** *but all answer must be in one and the same language.*

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

Group-A

Answer *any four* questions. 35×4=140

1. (a) A group of 9 piles, 12 m long and 250 mm in diameter, is to be arranged in a square form in a clay soil with an average unconfined compressive strength of 60 kN/m^2. Determine the centre to centre spacing of the piles for a group efficiency factor of 1. Take adhesion factor as 0.9. Neglect bearing action at the tip of the piles. 15

   (b) A partially saturated soil sample from a borrow pit has a natural moisture content of 15% and bulk density of 1.9 gm/cc. The specific gravity of solids is 2.70. Determine the degree of saturation and void ratio. What will be the density of the soil sample on saturation? 10

   (c) A retaining wall, 8 m high, with a smooth vertical back, retains a clay backfill with $c' = 15$ kN/m^2, $\phi = 15°$ and $\gamma = 10$ kN/m^3. Calculate the total active thrust on the wall assuming that tension cracks may develop to the full theoretical depth. 10

2. (a) A 8 m thick clay layer with single drainage settles by 120 mm in 2 years. The coefficient of consolidation for this clay was found to be 6×10^{-3} cm^2/s. Calculate the likely ultimate consolidation settlement and find out how long it will take to undergo 90% of this settlement. 15

   (b) An unconfined compression test was conducted on an undisturbed sample of clay. The sample had a diameter of 37.5 mm and was 80 mm long. The load at failure measured by the proving ring was 28 N and the axial deformation of the sample at failure was 13 mm. Determine the unconfined compressive strength and the undrained shear strength of clay. 10

   (c) The *in situ* void ratio of a granular soil deposit is 0.50. The maximum and minimum void ratios of the soil were determined to be 0.75 and 0.35. Specific gravity of the soil was 2.67. Determine the relative density and relative compaction of the deposit. 10

3. A horizontal beam of uniform cross-section is pinned at its ends which are at the same level and is loaded at the left hand pin with an anticlockwise moment of M and at the right hand pin with a clockwise moment of 2M both in the same vertical plane. The length between the pins is l. Find the angles of slope at each end and the deflection of the midpoint of the span in terms of M, l, E, I. Symbols used have their own meaning. 35

4. Draw the shear force and bending moment diagrams for the beam shown in Fig.-1. 35

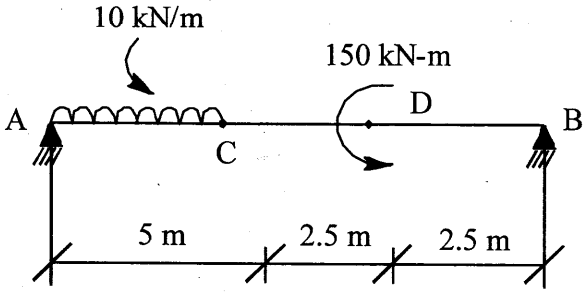

Fig.-1

5. (a) For the subsoil conditions shown in Fig.-2 determine total stress, neutral stress and effective stresses at 3 m, 5 m and 8 m depth below ground level. Also draw the stress distribution diagram for total stress, neutral stress and effective stress. Given that, unit weight of water is 10 kN/m^3. 15

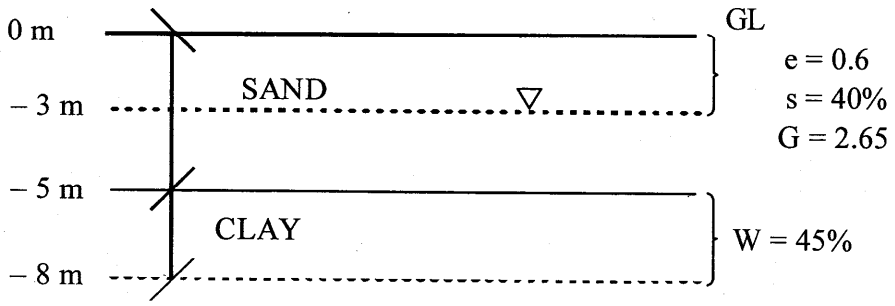

Fig.-2

(b) A clay soil, tested in a consolidometer, showed a decrease in void ratio from 1.20 to 1.10 when the pressure was increased from 0.25 to 0.50 kgf/cm^2. Calculate the coefficient of compressibility (a_v) and coefficient of volume compressibility (m_v).

If the coefficient of consolidation (c_v) determined in the test for the given stress increment was 10 m^2/year, calculate the coefficient of permeability in cm/s.

If the sample tested at the site was taken from a clay layer of 3.0 m in thickness, determine the consolidation settlement in 'mm' resulting from the given stress increment. 10

(c) Determine the safe load that can be carried by a squre footing of 2.2 m × 2.2 m size, placed at a depth of 1.6 m below GL. The foundation soil has the following properties:

$\gamma = 1.65$ t/m^3, $c = 1.1$ t/m^2, $\phi = 20°$

Assume a factor of safety of 2.5. Given for $\phi = 20°$, $N_c = 17.7$, $N_q = 7.4$, $N_\gamma = 5.0$

$N'_c = 11.8$, $N'_q = 3.8$, $N'_\gamma = 1.3$ 10

Group-B

Answer *any four* questions. 15×4=60

6. An RCC beam, 200 mm × 400 mm (effective) is reinforced with 3 nos. 16 mm diameter bars of Fe415 steel. Find the ultimate uniformly distributed load which the beam can carry safely over a span of 5 m. Use M20 grade concrete. Use limit state method of design. 15

7. A cast iron test beam 20 mm × 20 mm in section and 1 metre long and simply supported at the ends fails when a central load of 640 N is applied. What uniformly distributed load will break a cantilever of the same material of 50 mm wide, 100 mm deep and 2 metres long? 15

8. For a field pumping test, a well was sunk through a horizontal stratum of sand 14.5 m thick and underlain by a clay stratum. Two observation wells were sunk at horizontal distances of 16 m and 34 m respectively from the pumping well. The initial position of water table was 2.2 m below ground level. At a steady state pumping rate of 925 litres/min, the draw downs in observation wells were found to be 2.45 m and 1.20 m respectively. Calculate the cofficient of permeability of the sand. 15

9. In an *in situ* vane shear test on a saturated clay, a torque of 35 Nm was required to shear the soil. The diameter of the vane was 50 mm and length 100 mm. Calculate the undrained shear strength of the clay.

   The vane was then rotated rapidly to cause remoulding of the soil. The torque required to shear the soil in the remoulded state was 5 Nm. Determine the sensitivity of the clay. 15

10. Calculate the coefficient of permeability of a soil sample 6 cm in height and 50 cm^2 in cross sectional area, if a quantity of water equal to 450 ml passed down in 10 minutes under an effective constant head of 40 cm. On oven drying, the test specimen weighs 495 gm. Taking the specific gravity of soil as 2.65 calculate the seepage velocity of water during the test. 15
