

The hydrometer reading $R_h = 15.00$ after a lapse of time of 120 min after the start of the test. Determine the particle size ' D ' and percentage finer ' N ' %.

4 + 8 = 12

Group – D

6. (a) The sub-soil profile at a site is shown in the Fig.1. The ground water table (GWT) is at a depth of 3 m below ground level (GL). The soil is saturated below the capillary fringe. Without considering the effect of porosity, calculate the effective stresses at GL, 3 m, 5.4 m and 20.6 m below GL. Take $G = 2.7$.

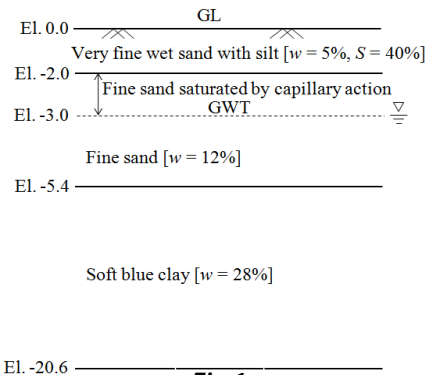


Fig.1

(b) The horizontal cylinder of soil is shown in the Fig.2. Determine (i) head loss in soil - I and II and (ii) pressure head at B and E.

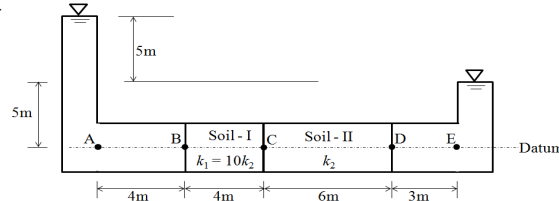


Fig.2

(c) A flow net for flow around a single row of sheet piles in a soil layer ($k = 5 \times 10^{-3}$ cm/sec) is shown in the Fig.3. Determine (i) how high (above the ground surface) the water will rise if piezometers are placed at points 'a' and 'b', (ii) The total rate of seepage through the permeable layer per unit length and (iii) The average hydraulic gradient at point 'c'. In the figure ' l ' and ' b ' are the length and width of each element in the respective flow channel.

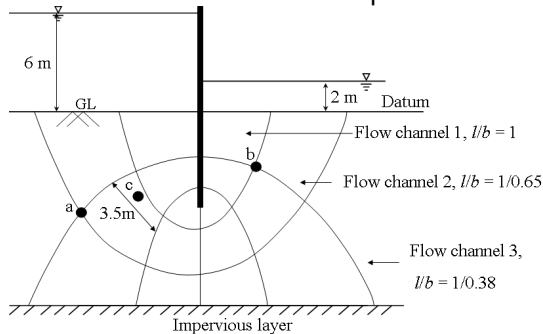


Fig.3

4 + 4 + 4 = 12

**SOIL MECHANICS - I
(CIVL 2102)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
 - (i) Constant head permeability test is primarily applicable to

| | |
|-------------------------|-----------------------|
| (a) coarse-grained soil | (b) fine-grained soil |
| (c) rock | (d) all of the above. |
 - (ii) If the void ratio of a soil is ' e ', then the seepage velocity (v_s) and discharge velocity (v) for flow through it are related as

| | | | |
|-----------------------------|-----------------------------|-----------------------------|------------------------------|
| (a) $v_s = \frac{1-e}{e} v$ | (b) $v_s = \frac{e}{1+e} v$ | (c) $v_s = \frac{1+e}{e} v$ | (d) $v_s = \frac{1+e}{2e} v$ |
|-----------------------------|-----------------------------|-----------------------------|------------------------------|
 - (iii) If the effective stress at a particular depth within a soil layer is 30 kN/m² and the total stress is 55 kN/m², then the pore water pressure at that depth is

| | |
|--------------------------|--------------------------|
| (a) 20 kN/m ² | (b) 25 kN/m ² |
| (c) 85 kN/m ² | (d) 35 kN/m ² |
 - (iv) A rectangular footing, 2 m × 3 m in size has to carry a uniformly distributed load of 100 kN/m². The vertical stress at a depth of 2 m below the base of footing by 2:1 dispersion method is

| | |
|--------------------------|--------------------------|
| (a) 30 kN/m ² | (b) 32 kN/m ² |
| (c) 34 kN/m ² | (d) 36 kN/m ² |
 - (v) For total head loss of 12m, the seepage loss per unit length through a soil, if N_f , N_d and k are 6, 12, and 8×10^{-5} m/min, respectively is

| | |
|---|---|
| (a) 4.80×10^{-4} m ³ /min | (b) 4.85×10^{-4} m ³ /min |
| (c) 4.90×10^{-4} m ³ /min | (d) 4.75×10^{-4} m ³ /min |

 Where, the symbols have their usual meanings.

- (vi) For soils containing gypsum or organic matter maximum oven drying temperature for water content determination should be
 - (a) 40°-60°C
 - (b) 80°-100°C
 - (c) 60°-80°C
 - (d) 105°-110°C.
- (vii) If the soil is dried beyond its shrinkage limit, it will show
 - (a) high volume change
 - (b) low volume change
 - (c) moderate volume change
 - (d) no volume change.
- (viii) Hardest silicate-mineral in the Moh's scale of hardness is
 - (a) Diamond
 - (b) Feldspar
 - (c) Corundum
 - (d) Topaz.
- (ix) Streak of a mineral is
 - (a) Its tendency to split along certain direction yielding smooth surfaces
 - (b) Its appearance on a broken surface of a mineral
 - (c) Colour of its powder
 - (d) Colour of the mineral itself.
- (x) Three direction of cleavage at 90° angle is found in
 - (a) Gypsum
 - (b) Fluorite
 - (c) Feldspar
 - (d) Galena.

Group – B

- 2. (a) What is cleavage? Describe briefly the different types of cleavage in minerals with examples.

(2 + 4) + (3 + 3) = 12
- (b) Classify sedimentary rocks on the basis of its textures. Describe its salient features.
- 3. (a) Define a fault. Draw a diagram to show the hanging wall, footwall, heave and throw of a fault.

(1 + 5) + (2 + 4) = 12
- (b) What is physical weathering? Write short notes on any two types of physical weathering.

Group – C

- 4. (a) The following results were obtained from the sieve analysis carried out on a dry soil sample weighing 300 gm.

| | | | | | | | | | |
|---------------------------|---------|---------|---------|-------|-------|-------|-------|-------|------|
| I.S Sieve size | 4.75 mm | 2.40 mm | 1.20 mm | 600µ | 425µ | 300µ | 150µ | 75µ | Pan |
| Wt. of soil retained (gm) | 11.02 | 30.45 | 46.26 | 48.73 | 50.27 | 45.49 | 40.21 | 20.33 | 7.24 |

Draw the particle size distribution curve of the soil and compute the following:

- (i) Percentage of gravel, coarse sand, medium sand, fine sand and finer fraction as per IS system (IS: 1498-1970).
 - (ii) Uniformity co-efficient and co-efficient of curvature.
 - (b) A sample of wet silty clay soil has a mass of 126 kg. The following data were obtained from laboratory tests on the sample. Wet density = 2.1 gm/cc, $G = 2.7$, water content = 15%. Determine (i) dry density (ii) porosity (iii) void ratio and (iv) degree of saturation.
- 5 + 7 = 12**
- 5. (a) The following data refers to silty clay that was assumed to be saturated in the undisturbed condition.

| Index property | Undisturbed | Remoulded |
|--|-------------|-----------|
| Unconfined compressive strength, q_u kN/m ² | 244 | 144 |
| Water content, % | 22 | 22 |
| Liquid limit, % | | 45 |
| Plastic limit, % | | 20 |
| Shrinkage limit, % | | 12 |
| % passing no.200 sieve | | 90 |
| % finer than 0.002 mm | | 18% |

- (i) Classify the soil according to the AASTHO systems. Assume, $G = 2.76$.

| AASHTO SOIL CLASSIFICATION | | | | | | | | | | | |
|---|--|-------|-----------|---------------------------------|--------------|--------------|--------------|---|--------------|--------------|----------------|
| GENERAL CLASSIFICATION | GRANULAR MATERIALS (35% OR LESS PASSING 0.075 SIEVE) | | | | | | | SILT-CLAY MATERIALS (MORE THAN 35% PASSING 0.075 SIEVE) | | | |
| | A-1 | | A-3 | A-2 | | | | A-4 | A-5 | A-6 | A-7-5 A-7-6 |
| GROUP CLASSIFICATION | | A-1-a | | A-1-b | A-2-4 | A-2-5 | A-2-6 | | | | |
| SIEVE ANALYSIS, PERCENT PASSING: 2.00 mm (No. 10) 0.425 mm (No. 40) 0.075 mm (No. 200) | ≤ 50 | — | — | — | — | — | — | — | — | — | — |
| | ≤ 30 | ≤ 50 | ≥ 51 | — | — | — | — | — | — | — | — |
| | ≤ 15 | ≤ 25 | ≤ 10 | ≤ 35 | ≤ 35 | ≤ 35 | ≤ 35 | ≥ 36 | ≥ 36 | ≥ 36 | ≥ 36 |
| CHARACTERISTICS OF FRACTION PASSING 0.425 SIEVE (No. 40): LIQUID LIMIT PLASTICITY INDEX * | — 6 max | | — NP | ≤ 40 ≤ 10 | ≥ 41 ≤ 10 | ≤ 40 ≥ 11 | ≥ 41 ≥ 11 | ≤ 40 ≤ 10 | ≥ 41 ≤ 10 | ≤ 40 ≥ 11 | ≥ 41 ≥ 11 |
| USUAL TYPES OF CONSTITUENT MATERIALS | STONE FRAGMENTS, GRAVEL, SAND | | FINE SAND | SILTY OR CLAYEY GRAVEL AND SAND | | | | SILTY SOILS | | CLAYEY SOILS | |
| GENERAL RATING AS A SUBGRADE | EXCELLENT TO GOOD | | | | | | | FAIR TO POOR | | | |

*Plasticity index of A-7-5 subgroup is equal to or less than LL-30. Plasticity index of A-7-6 subgroup is greater than LL-30. NP = Non-plastic (use '0'). Symbol '-' means that the particular sieve analysis is not considered for that classification.

- (b) A 500 gm of dry soil was used for combined sieve and hydrometer analysis. The soil mass passing through 75µ sieve was 130 gm. Hydrometer analysis was carried out on a mass of 40 gm soil that passed through 75µ sieve. The average temperature recorded during the test was 31°C. Given: $G = 2.65$, $C_m = 0.5$, $C_d = 0.6$, $C_t = 0.915$, $\mu = 8.15 \times 10^{-3}$ poise, $H_{e1} = 22.0$ cm for $R_h = 0$, $H_{e2} = 10.0$ cm for $R_h = 30$, $A_j = 30$ cm² and $V_h = 40$ cm³.