GEOTECHNICAL & FOUNDATION ENGINEERING

***Time**: Three Hours*

***Maximum Marks**: 100*

Answer five questions, taking ANY TWO from Group A, any two from Group B and all from Group C.

All parts of a question (a, b, etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches.

Unnecessary long answer may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) Prove the relationship Se = wG 6

   (b) A soil is saturated at 52% moisture content and has a unit weight of 16.5 KN/m^3. Calculate its soil ratio, specific gravity, dry unit weight and submerged unit weight. 6

   (c) Classify the soil, with the following properties, according to ISC system 8

Liquid limit	40%
Plasticity Index	10%
% Passing 4.75 mm sieve	60%
% Passing 75μ sieve	45%

2. (a) A concentrated load of 200 kN is applied at the ground surface. Determine the vertical stress at a point P which is 6 m directly below the load. Also, calculate the vertical stress at a point X at a depth of 6 m and at a horizontal distance of 5 m from the axis of load. 6

   (b) What is quick sand? Obtain an expression for the critical hydraulic gradient. 6

   (c) What is flow net? Enumerate the important properties and applications of flow nets. Derive the relation $q = kh(N_f / N_d)$ for a given flow net. 8

3. (a) Compute the quantity of water seeping under the weir per day, if the coefficient of permeability is 3.5×10^{-4} cm/sec. Number of flow channels in the flow net is 3 and the number of equipotential drops is 10. The head causing flow is 6.3 m and the weir is 50 m. Compute the exit gradient, if the length of the last field is 3 m. 6

(b) Define the terms 6

(i) consolidation

(ii) coefficient of compressibility

(iii) coefficient of volume compressibility

(iv) compression index

(v) over consolidated soil

(vi) pre consolidation pressure

(c) A saturated clay overlying an impervious stratum and below a pervious stratum is 10 m thick. Its coefficient of permeability is 3.3×10^{-8} cm/second $C_c = 0.24$. At a stress of 100 kPa, its void ratio is 1.6. What would be its equilibrium void ratio under a stress of 200 kPa ? What would be settlement in the soil stratum in view of the stress increase? What is coefficient of consolidation of the clay layer? 8

4. (a) Time required for a 3 m thick clay layer with double drainage condition for 20% consolidation is two months. What is the time required in months for 50% consolidation ? Also, calculate time required for 90% consolidation of $T_{90} = 0.848$. 6

(b) Explain the principle of direct shear test. What are the advantages and limitations? 6

(c) The following results were obtained from a consolidated undrained triaxial test on a clay soil. 8

Cell Pressure, σ_3 (kN/m^2)	100	250	400
Deviator stress at failure (kN/m^2)	340	410	474
Pore water pressure at failure (kN/m^2)	-42	64	177

Determine the effective cohesion and effective angle of internal friction of the soil.

Group B

5. (a) Differentiate critically between Rankine and Coulomb earth pressure theories. 6

(b) What are assumptions in Coulomb's theory? 6

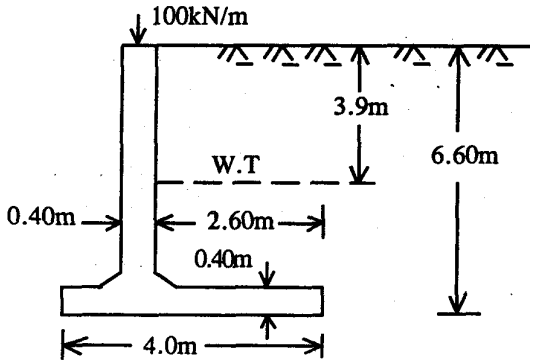
(c) How do you determine the Resultant active thrust on the back of a retaining wall supporting a c-ϕ backfill material 8

(i) before the formation of the tension cracks

(ii) after the formation of tension cracks?

What is the location of the Resultant active thrust in each case?

6. (a) Details of a cantilever retaining wall are shown in following figure. Calculate the maximum and minimum pressures under the base if the water table rises behind the wall to a level 3.90 m from top of the wall. The shear strength parameters for the soil are: c' = 0 and $\phi' = 38^0$. The saturated unit weight of the soil is 20 kN/m^3 and above the water table the unit weight is 17 kN/m^3; the unit weight of concrete is 23.5 kN/m^3. If $\delta = 25^0$ on the base of the wall, what is the factor of safety against sliding? 6



(b) A retaining wall, 7.5 m high, retains a cohesionless backfill. The top 3 m of the fill has a unit weight of 18 kN/m^3 and $\phi = 30^0$ and the rest has unit weight of 24 kN/m^3 and $\phi = 20^0$. Draw the active earth pressure distribution diagram. Also find the total active thrust and its location from the bottom of the wall. 6

(c) A retaining wall of 6 m high retains soil with following properties: 8

Cohesion = c = 20 kN/m^2

Angle of internal friction = $\phi = 30^0$

Unit weight of soil γ = 18 kN/m^3

Wall is vertical and smooth. Draw earth pressure diagram. Find total earth

pressure and its point of application for active case for following conditions:

(i) tension cracks are not developed

(ii) tension cracks are developed

7. (a) Discuss the various factors that affect the bearing capacity of shallow foundations based on Terzaghi's theory. 6

(b) Define Terzaghi's equation for bearing capacity of footing. List the factors on which ultimate bearing capacity depends in case of cohesive and non cohesive soils. 6

(c) Describe the procedure for carrying out standard penetration test according to current Indian standard specifications. Discuss its utility and limitations. 8

8. (a) List out various soil improvement techniques that are used in civil engg practice. Describe any one method. 6

(b) The observed SPT value in a deposit of fully submerged fine silty sand was 45 at a depth of 20 m. The average saturated unit weight of the soil is 19.5 kN/m^3. Find the corrected SPT value for dilatency and overburden effect. 6

(c) Determine the safe bearing capacity of footing with a factor of safety of 2 using the following plate load test data on a sandy soil: 8

Loading (kN/m^2)	0	100	200	300	400	500	600	700
Settlements (mm)	0	1.2	2.55	4.05	5.75	8.5	11.12	17.00

Size of plate 0.3 m x 0.3 m, width of footing, B_f = 1.20 m, Depth of foundation, D_f = 1.50 m. No water table is encountered with.

Group C

9. Answer the following in brief: 20

(i) Can water content of a soil be more than 100%? Justify your answer.

(ii) Find the critical hydraulic gradient of a saturated sand with moisture content of 40% and specific gravity of solids of 2.7.

(iii) Find the ratio between coefficient of passive earth pressure and that of active earth pressure for an angle of internal friction of 30^0.

(iv) Write the formula for coefficient of permeability in the falling head method and explain various terms in the formula.

(v) A sampler of 45 cm long is pushed into the soil for collection of soil sample. If 40 cm of soil sample is recovered in the sampler, determine the sample recovery ratio.

(vi) Write any three differences between compaction and consolidation.

(vii) At a site, the water-table is located at the ground surface and the submerged unit weight of soil is 10 kN/m^3. If water-table rises 2 m above the ground surface, determine the change in effective stress at 5 m below the ground surface.

(viii) An annular circular raft has outer and inner diameters as 20 m and 15 m, respectively. If the load intensity on the rat) is 200 kPa, estimate the increase in vertical stress at a depth of 5 m from the ground surface and exactly below the centre of the raft.

(ix) Furnish shear strength envelop of a soil.

(x) List different types of retaining walls.

(Refer our course material for answers)