Code :R7320101

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III B.Tech II Semester(R07) Regular & Supplementary Examinations, April/May 2011
GEOTECHNICAL ENGINEERING-I
(Civil Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE questions
All questions carry equal marks
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1. (a) Define: degrees of saturation; porosity; air content and density index.
   (b) A partially saturated soil sample has a moisture content of 14% and bulk unit weight of 20kN/m^3. Given that the specific gravity of solids is 2.70, determine the degree of saturation and void ratio. What will be the unit weight of the sample on complete saturation?

2. (a) Define the terms:
   (i) Liquidity index (ii) Flow index and (iii) Toughness index (iv) Activity
   (b) The Atterberg limits of a clay soil are: LL=63%; PL=40% and SL=27%. If the specimen of this soil shrinks from a volume of 10 cm^3 at liquid limit to 6.4 cm^3 at the shrinkage limit, determine the specific gravity of solids, shrinkage ratio and volumetric shrinkage.

3. (a) What are the various factors that affect the permeability of soil in the field?
   (b) In a variable head permeameter, the cross sectional area of the sample was 850 sq. cm and its length was measured as 11.2 cm. The head was noted to fall from 90 to 62 cm in 2 minutes. If the cross sectional area of the stand pipe was 2.8 sq.cm, find out the coefficient of permeability of the soil. If a drop of head is measured from 58 to 37 cm in the same experiment, determine the time required for the drop of head.

4. (a) Derive an equation for obtaining the discharge through an earth dam using flow nets.
   (b) Differentiate between neutral and effective stresses.
   (c) A concrete dam retains water to a height of 9m. It has rows of sheet piling at both heel and to a which extend half way down to an impervious stratum. From a flow net sketched as a transformed section, it is found that there are four flow channels and sixteen head drops. The average horizontal and vertical permeabilities of the soil are 6 x 10^{-3} mm/sec and 2 x 10^{-3} mm/sec, respectively. What is the seepage per day if the length of the dam is 160 metres ?

5. (a) What is pressure bulb? How to construct the pressure bulb diagram and what are its uses?
   (b) An overhead water tank is supported at a depth of 3.5m by four isolated square footings of 2.1m side each placed in a square pattern with a centre-to-centre spacing of 8m. Compute the vertical stress at the foundation level (i) at the center of the four footings and (ii) At the centre of one footing. Adopt Boussinesq's point load approximation. The load on each footing is 650 kN.

6. (a) Briefly describe the different methods of compaction in field and state their suitability of each type of soil.
   (b) A standard Proctor compaction test was carried out and the following values were recorded. The volume of the mould is 945 cc.

Weight of soil(gm)	1772	1837	1860	1871	1906	1865	1850
Water content(%)	17.5	19.0	20.0	20.8	21.8	22.4	24.2

   Plot the dry density verses moisture content curve and hence find the optimum moisture content and maximum dry density. What is relative compaction?

7. (a) State the assumptions made in Terzaghi's one dimensional consolidation.
   (b) Explain the logarithm of time fitting method to find coefficient of consolidation from a laboratory consolidation test.
   (c) The void ratio of clay is 1.56, and its compression index is found to be 0.8 at a pressure of 180 kN/m^2. What will be the void ratio if the pressure is increased to 240 kN/m^2?

8. (a) Discuss the relative advantages and disadvantages of the direct shear test and the triaxial compression test. How are triaxial tests classified based on drainage conditions?
   (b) In a direct shear test on sand, the sample fails at a shear stress of 75 kN/m^2, when the normal stress is 100 kN/m^2. Draw the Mohr's circle and determine (i) angle of internal friction and (ii) orientation of major principal plane.

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1. (a) Explain with sketches various types of soil structures
   (b) Derive an expression for bulk unit weight in terms of its void ratio, water content, specific gravity of solids, degree of saturation and unit weight of water
   (c) A soil sample has a water content of 31% and unit weight of 15 kN/m^3 with a specific gravity of solids of 2.70. Determine the voids ratio and degree of saturation.

2. (a) What is the use of classification of soils? Discuss Indian Standard classification system
   (b) A fully saturated clay has a water content of 40% and a mass specific gravity of 1.85. After oven drying, the mass specific gravity reduces to 1.75, determine the specific gravity of solids and shrinkage limit.

3. (a) State and explain Darcy's law.
   (b) Discuss the factors which affect the permeability of sands
   (c) A constant head permeability test was run on a cohesionless sample 30 cm in length and 36 sq. cm in cross sectional area under a head of 45 cm. The dischanrge was 300 cc in 150 seconds. The porosity of the sample was 55%. Determine the coefficient of permeability of the soil and the seepage velocity.

4. (a) Derive an expression for seepage in terms of number of flow channels and drops of a flow net
   (b) A 10 m layer of stiff saturated clay is underlain by a 3 m layer of sand under a hydraulic head of 6 m. Calculate the maximum depth of cut that can be made in the clay, given the unit weights of clay and sand as 19.25 kN/m^3, and 18.40 kN/m^3 respectively.

5. (a) What is the purpose of and what is the principle of construction of Newmark's influence chart? How it used and what are the limitations or drawbacks?
   (b) Two columns P and Q are 6m apart. The loads are 400 kN on column P and 300 kN on column Q. Treat the loads as column loads and find the vertical stresses in the soil 3m below the foundations, vertically below P and Q.

6. (a) What are the various factors that affect the compaction of soil in the field? How will you measure compaction in the field? Describe a method with its limitations
   (b) Write a detailed note on Proctor's needle method for determining water content of the soil.

7. (a) Explain Terzaghi's one dimensional consolidation theory with the help of spring analogy.
   (b) A clay layer of 5 m thick has double drainage. It was consolidated under a load of 127kN/m^2. The load is increased to 197kN/m^2. The coefficient volume compressibility 5.8*10^{-4} m^2/kN and coefficient of permeanility is 1.6*10^{-8}m/min. Find the total settlement and settlement at 50% consolidation. If the 2 cm thick sample attains 100% consolidation in 24 hours, what is the time requirement for 100% consolidation in the actual layer?

8. (a) Describe the triaxial shear test. What are the advantages of triaxial shear test over the direct shear test?
   (b) A cylinder specimen of saturated soil fails under an axial stress 150 kN/m^2 in an unconfined compression test. The failure plane makes an angles of 52^0 with the horizontal. Calculate the cohesion and angle of internal friction of the soil.

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1. (a) Describe the clay mineral structure of any two clay minerals
   (b) Differentiate between the following:
      i. True specific gravity and mass specific gravity
      ii. Standard unit weight and Submerged unit weight
   (c) Derive the relationship between γ, γ_d and w.
2. (a) How will you determine moisture content of soil sample by pycnometer method?
   (b) The plastic limit of soil is 30% and its plasticity index is 10%. When the soil is dried from its state to plastic limit, the volume change is 27% of its volume at plastic limit. Similarly, the corresponding volume change from the liquid limit to the dry state is 36% of its volume at liquid limit. Determine the shrinkage limit and the shrinkage ratio.
3. (a) Derive an expression for coefficient of permeability for use in variable head method
   (b) A constant head permeability test has been run on a sand sample 25 cm length and 30 sq.cm in area under a head of 40cm. The discharge was found to be 200 cc in 116 sec. The specific gravity of grains 2.65 the dry weight of sand is 1320 gms. Determine (i) Coefficient of permeability (ii) Seepage velocity (iii) Discharge velocity.
4. (a) Differentiate between neutral stress and effective stress. Explain quick sand phenomenon.
   (b) A stratified soil deposit consists of two layers. The top layer is 2.5 m thick having a bulk density of 17 kN/m^3 and the bottom layer is 3.5 m thick having a saturated density of 21 kN/m^3. The water table is at a depth of 3.5 m from the surface and the zone of capillary saturation is 1 m above the water table. Draw the diagrams showing the variation of total, neutral and effective stresses.
5. (a) Explain the difference between Boussinesq's and Westergaard's methods of calculating stresses in a soil mass due to an external loading. Discuss which method you would prefer and why?
   (b) A water tower is founded on a circular ring type foundation. The width of the ring is 4m and its internal radius in 8m. Assuming the distributed load per unit area as 300 kN/m^2, determine the vertical pressure at a depth of 6m below the centre of the foundation.
6. (a) Describe standard Proctor test and modified Proctor test. How would you decide the type of test to be conducted in laboratory?
   (b) What is the effect of compaction on engineering properties of soils?
7. (a) Describe a suitable procedure for determining preconsolidation pressure.
   (b) A 24 mm thick undisturbed sample of saturated clay is tested in the laboratory with drainage allowed on both faces. The sample reaches 50% degree of consolidation in 45 minutes. If the clay layer from which the sample was obtained is 4.8 m thick and is free to drain at both of its faces, calculate the time required for the clay layer to undergo the same degree of consolidation. What would have been the time of consolidation if the clay layer has only single drainage? Assume uniform distribution of consolidating pressure.
8. (a) Describe direct shear test. What are its merits and demerits?
   (b) Three identical specimens of partially saturated clay were subjected to an unconsolidated undrained triaxial test and the following results were obtained.

Test No.	Cell pressure, σ_3(kN/m^2)	Deviator stress, σ_d(kN/m^2)
1	50	80
2	100	97
3	150	113

Determine the shear parameters of the soil.

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1. (a) Establish a relationship between dry unit weight, bulk unit weight and water content
   (b) A soil sample in its natural state has a volume of $3.10*10^{-4}m^3$ and a weight of 5.28N. On oven drying its weight was 4.90N. Determine its void ratio, porosity, water content and degree of saturation. Assume the specific gravity of soil grains to be 2.67. Also determine the bulk unit weight and water content at fully saturation condition.

2. (a) State Stokes law. What is its use in the sedimentation method of analysis? What are its limitations?
   (b) The Atterberg limits of a given soil are : LL=68%;Pl=37%;SL=22%. If the moisture content of this soil at the site be 42% then determine: Plasticity index, Consistency index and Liquidity index. Comment on the nature of the soil on the basic of these indexes.

3. (a) Differentiate between seepage velocity and discharge velocity. Derive the relation between them.
   (b) Determine the average coefficient of permeability in the horizontal and vertical directions for a stratified soil deposit. It consists of 3 layers of thickness 6m, 3m and 12m and having horizontal coefficients of permeability of $3*10^{-4}$cm/s, $6*10^{-5}$ cm/s and $7*10^{-4}$ cm/s and vertical coefficient of permeability of $4*10^{-5}$ cm/s, $7*10^{-6}$ cm/s and $9*10^{-5}$ cm/s respectively.

4. (a) What is quick sand condition and derive an expression for it with usual notations.
   (b) Differentiate between seepage pressure and pore water pressure
   (c) A soil profile at a site comprises of (i) top layer of sand of 3 m thickness and saturated unit weight of 20 kN/m^3 (ii) a second layer of saturated clay 4 m thick with saturated unit weight of 19 kN/m^3. The water table is at ground level. Compute and sketch the variation in total pressure, neutral pressure and effective pressure over a depth of 6 m.

5. (a) What are the basic assumptions in Boussinesq's theory of stress distribution in soils? Also describe the concept of pressure bulb and its use.
   (b) A line load of 90 kN/m run extends to a long distance. Determine the intensity of vertical stress at a point 1.5m below the surface: (i) Directly under the line load, and (ii) At a distance 1m perpendicular to the line load. Use Boussinesq's theory.

6. (a) How does compaction improve the engineering properties of soils?
   (b) The following results were obtained in a compaction test:-

Bulk unit weight(kN/m^3)	18.8	20.0	20.5	21.0	21.0	20.0
Water content(%)	17.5	19.0	20.0	20.8	21.8	22.4

   Determine the optimum moisture content and maximum dry density. Also draw 5% air voids line and 90% saturation line if G=2.67.

7. (a) Define the terms compression index, coefficient of consolidation and coefficient of compressibility and indicate their units and symbols.
   (b) A normally consolidated clay layer of 10 m thickness has a unit weight of 20 kN/m^3 and specific gravity 2.72. The liquid limit of the clay is 58%. A structure constructed on this clay increase the overburden by 10%. Estimate the ultimate consolidation settlement. Assume there is no secondary compression.

8. (a) Explain the following terms:
      i. Critical void ratio
      ii. Pore pressure coefficients
   (b) Describe a triaxial shear test with a neat sketch.

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