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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

October 2023 Semester End Main Examinations

Programme: B.E **Semester: IV**
Branch: Civil Engineering **Duration: 3 hrs.**
Course Code: 19CV4PCGTE **Max Marks: 100**
Course: Geotechnical Engineering - I

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) For a partly saturated soil using phase diagram from first principles derive a phase interrelationship relating total unit weight of soil, specific gravity, degree of saturation, void ratio and unit weight of water. **06**

b) In its natural condition, a soil sample has a mass of 2280 g and a volume of 1.14 $\times 10^{-3}$ m^3. After being completely dried in an oven, the mass of the sample is 2029 g. The value of Gs for the soil is 2.67. Determine the bulk density, bulk unit weight, water content, void ratio, porosity, degree of saturation and air content. **08**

c) List the different types of transported soils and the agency which transports them. Explain the characteristic feature of glacial deposits. **4+2**

UNIT - II

2 a) Table 1 presents the data obtained from a percussion cup apparatus done to determine liquid limit of a soil having a natural water content of 41.5%. The plastic limit of the soil was ascertained independently and was found to be 28.4 %. **08**

Table 1: Percussion cup test data (Q. 2a)

Number of drops	15	19	24	29	34	42
Water content (%)	45.3	43.6	42.2	41.1	40.2	38.8

Using the data given in Table 1, determine the following:

i) Liquidity index ii) Flow index

b) The physical properties of three soils have been summarized in Table 2. It is required to select a suitable soil for constructing a highway embankment. The maximum natural water content during rainy season will not increase 43 %. Considering that the embankment should be volumetrically stable during its service period, suggest the suitable soil for the construction of embankment giving proper justification. **06**

Table 2: Physical properties of soils obtained from three borrow pits (Q. 2b)

Properties	Soils		
	A	B	C
Liquid limit (%)	92.5	58.6	132.0
Plastic limit (%)	42.0	27.3	69.9
Shrinkage limit (%)	11.1	24.8	53.5

c) A soil has the following physical properties obtained from a routine laboratory test. Classify the soil as per Indian Standard Soil Classification System **06**

Table 3: Physical properties of soil (Q. 2c)

Liquid limit (%)	Plasticity Index (%)	Gravel (%)	Silt (size) (%)	Clay (size) (%)
32.5	9.5	2	8	2

OR

3 a) Data obtained by GSD curves of two soil samples A and B is presented in Table 4 **06**

Table 4: Grain size distribution properties of soils A and B (Q. 3a)

Characteristic	Soil A	Soil B
Gravel (%)	55	35
Sand (%)	45	65
D_{60}	0.4	0.4
D_{10}	0.25	0.04
D_{30}	0.35	0.2

i) Find C_u and C_c

ii) Comment on the gradation of each soil

Which sample do you prefer for the construction of an embankment? Give reasons.

b) An undisturbed clay soil was brought to laboratory and its shear strength was 48 kPa. The shear strength of the same sample after remoulding was observed to be 10 kPa. What property of the clay explains this loss of strength on remoulding. Give the classification of the clays based on that property and indicate the classification of this soil. If driving of piles was planned for supporting the super structure on such a natural soil deposit, what is precaution to be taken before loading the structure? **06**

c) 50 g of oven dried soil sample is taken for sedimentation analysis the hydrometer reading in 1000 ml suspension of soil 30 minutes after commencement of sedimentation test is 24.0. The effective depth for R_h = 24.5, found from the calibration curve is 10.5 cm. Meniscus correction is found to be + 0.5 and the composite correction is -2.5 at the test temperature of 30° C. Taking the specific gravity of particles as 2.70 and viscosity of water as 0.008 poise, calculate smallest particle size which would have settled during this interval of 30 minutes and percentage of particles finer than the size. **08**

UNIT - III

4 a) What are the three most common clay minerals of engineering significance? With a neat sketch describe one clay mineral which if present in the red tropical soils. Also give reason for the soil to have the least swelling due to the presence of that mineral and give the common values of specific surface area, cation Exchange capacity of the clay mineral. **08**

b) The soil profile at a certain site is as follows: **12**

Table 5: Depth versus unit weight

Depth (m)	Unit weight (kN/m^3)
0-3	18.40
3-6	18.60
6-12	20.10
12-20	20.60

The ground water table is at a depth of 8 m below the ground level. **Develop** plots of pore water pressure, total stress, and effective stress versus depth. Assume saturation by capillary rise for a height of 2 m above the water table.

UNIT - IV

5 a) During a falling head permeability test the sample on a close investigation was found to be in two layers 70 and 30 mm thick. The routine falling head permeameter test on this sample yielded the following results: **08**

Diameter of standpipe = 4 mm
Sample diameter = 80 mm
Length of the sample = 100 mm
Initial head = 1200 mm
Final head = 440 mm
Time for fall in head = 6 min

Determine the average permeability coefficient using the laboratory test data. After the test, independent tests were made on each soil layer, and the values of coefficient of hydraulic conductivity were found to be 5.2×10^{-4} mm/s and 1.64×10^{-2} mm/s. Check the average coefficient of hydraulic conductivity through the sample in the laboratory test with the estimated value considering layer effect. Also estimate the average coefficient of hydraulic conductivity in a direction at right angles to sampling. Comment on the result.

b) In a three-layered stratified soil deposit, each layer being 2.3 m depth, the values of coefficient of hydraulic conductivity in horizontal and vertical are tabulated in Table 6: **06**

Table 6: Values of Coefficient of Hydraulic conductivity in a layered soil system (Q.5b)

Layer	Coefficient of Hydraulic conductivity (m/s)	
	Horizontal	Vertical
I	3.9×10^{-5}	1.85×10^{-6}
II	4.1×10^{-6}	4.1×10^{-7}
III	1.9×10^{-6}	1.9×10^{-7}

Find the equivalent coefficients of hydraulic conductivity in the horizontal and vertical directions.

c) List the factors that affect the compaction characteristics of soils. Explain how soils can be classified based on the shape of compaction curves. **06**

OR

6 a) Explain with neat sketches the effect of following factors on compaction characteristics of soils: **06**

i) Soil Type ii) Amount of compaction energy

b) Table 7 presents the results of a standard compaction test conducted on a soil sample to be used for construction of an embankment for a highway project. **08**

Table 7: Compaction test data (Q. 6b)

Water content (%)	8.5	11.2	14.3	16.4	18.1	20.2	21.6
Bulk unit weight (kN/m^3)	15.8	16.9	18.2	19.0	19.2	19.1	18.9

Plot the dry unit weight versus moisture content and obtain the maximum dry unit weight and optimum moisture content. Show100% saturation line on the plot. Take $G_s = 2.65$.

c) What is seepage velocity and discharge velocity? Derive a relation between coefficient of permeability and coefficient of percolation. **06**

UNIT - V

7 a) What are the different methods of determining the shear strength parameters in the laboratory? **04**

b) A direct shear test was carried out on a cohesive soil sample and the following results were obtained. **06**

Table 8: Direct shear test results (Q.7b)

Normal stress (kN/m^2)	200	300
Shear stress (kN/m^2)	110	120

What would be the deviator stress at failure, if a triaxial test is carried out on the same soil with a cell pressure of 100 kN/m^2.

c) Undrained triaxial tests are carried out on four identical specimens of silty clay and the results obtained are tabulated in Table 9. Graphically determine the value of the effective angle of shearing resistance and the cohesion intercept **10**

Table 9: Results of triaxial shear test (Q.7c)

Cell Pressure (kN/m^2)	50	100	150	200
Deviator stress at failure (kN/m^2)	350	440	530	610
Pore water pressure (kN/m^2)	5	10	12	18

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