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CE 181505

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BINA CHOWDHURY CEN
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B.Tech. 5th Semester End-Term Examination

CE

GEOTECHNICAL ENGINEERING — I

(New Regulation & New Syllabus)

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question *one* and any *six* questions from the Rest.

I. Answer the following questions :

(10 × 1 = 10)

- (i) A soil has a liquid limit of 42% and lies above “the A-line” when plotted on the IS plasticity chart. The group symbol of the soil is :
- (a) CL (b) CI
(c) CH (d) MI
- (ii) The void ratios of a soil in its loosest and densest states are 0.8 and 0.3. If the void ratio in the natural state is 0.6, the relative density (%) is :
- (a) 40 (b) 50
(c) 60 (d) 70
- (iii) A sand deposit has a porosity of 0.25 and its specific gravity is 2.6. The critical hydraulic gradient for the sand deposit is :
- (a) 0.78 (b) 1.2
(c) 1.95 (d) 2.7

[Turn over

- (iv) The change in the vertical stress in the soil mass estimated by Boussinesq's equation when Poisson's ratio of soil changes from 0.2 to 0.4 will be :
- (a) no change
 - (b) reduction by 10%
 - (c) reduction by 20%
 - (d) reduction by 40%
- (v) What is the silt size range?
- (a) 0.01 – 0.075 mm
 - (b) 0.002 – 0.001 mm
 - (c) 0.002 – 0.075 mm
 - (d) 0.01 – 0.100 mm
- (vi) If soil is dried beyond its shrinkage limit, it will show :
- (a) Low volume change
 - (b) Moderate volume change
 - (c) Large volume change
 - (d) No volume change
- (vii) At water content greater than the OMC, the dry density decreases because :
- (a) Repulsion between soil and water particles
 - (b) Water replaces soil solids
 - (c) Soil reacts with water to give porous material
 - (d) Water has hydrophilic character
- (viii) The biggest size of clay particle is :
- (a) 0.0002 mm
 - (b) 0.002 mm
 - (c) 0.02 mm
 - (d) 0.075 mm

(ix) During seepage through a soil, the direction of seepage is always :

- (a) Parallel to equipotential lines
- (b) Perpendicular to stream lines
- (c) Perpendicular to equipotential lines
- (d) None of the above

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(x) Which of the following mechanisms are predominant in the cohesionless soils?

- (a) Cohesion
- (b) Friction
- (c) Both (a) and (b)
- (d) Adhesion

2. (a) For a given sandy soil, $e_{max} = 0.75$ and $e_{min} = 0.4$. Let $G_s = 2.68$. In the field, the soil is compacted to a moist unit weight of 17.6 kN/m^3 at a moisture content of 12%. Determine the relative density of compaction. (5)

(b) What is the characteristic engineering behavior of clay containing the minerals kaolinite, illite and montmorillonite? Explain with reference to the crystal structure of these minerals. (5)

3. (a) The moisture content of a soil sample is 18.4%, and its dry unit weight is 15.7 kN/m^3 . Assuming that the specific gravity of solids is 2.65. (2 + 3)

(i) Calculate the degree of saturation.

(ii) What is the maximum dry unit weight to which the soil can be compacted without change in its moisture content?

(b) The coefficient of uniformity and curvature of a soil are 9 and 1 respectively. Determine the ratio D_{30}/D_{10} . (3)

(c) In a liquid limit test using Casagrande apparatus, the water content at 15 blows was 150% and that at 35 blows was 60%. What is the liquid limit of the soil? (2)

4. The results of a standard Proctor test are given in the following table : (5 + 3 + 2)

(a) Find the compaction curve showing the Maximum Dry Density (MDD) and the optimum moisture content of compaction.

(b) Plot the zero-air void line.

(c) Determine the degree of saturation at the MDD.

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Volume of Proctor mold (cm ³)	Mass of wet soil in the mold (kg)	Moisture content (%)
1000	1.68	9.9
1000	1.71	10.6
1000	1.77	12.1
1000	1.83	13.8
1000	1.86	15.1
1000	1.88	17.4
1000	1.87	19.4
1000	1.85	21.2

5. (a) A sample of cohesionless soil in a direct shear test fails under a shear stress of 160 kN/m² when the normal stress is 130 kN/m². (3 + 3)

(i) Find the angle of shearing resistance of the soil.

(ii) For a normal stress of 100 kN/m², what shear stress is required to cause failure in the sample?

(b) What is the radius of Mohr circle for unconfined compression test results? (2)

(c) A clay soil sample was tested in the triaxial apparatus in consolidated drained condition at a cell pressure (σ_3) of 100 kN/m². What will be the axial pressure (σ_1) and pore water pressure at deviator stress of 50 kN/m²? (1 + 1)

6. A cylindrical specimen of dry sand was tested in a triaxial test. Failure occurred under a cell pressure of 150 kPa and a deviator stress of 450 kPa. Draw the Mohr's circle and determine : (4 + 2 + 4)
- (a) Angle of shearing resistance.
- (b) Normal and shear stresses on the failure plane.
7. (a) In a Newmark's chart of stress distribution, there are 10 concentric circles and 10 radial lines. What is the influence factor for the chart? (2)
- (b) A rectangular footing, 4 m × 2 m in size, has to carry a uniformly distributed load of 110 kN/m². Determine the vertical stress intensity at a depth 5 m below the base of the footing. (5)
- (c) Differentiate between pore water pressure and effective stress. (3)
8. (a) A constant head permeability test is carried out on a cylindrical sand sample having a diameter of 8 cm and height of 20 cm. The quantity of water discharged through the sample in 15 min, under a constant head of 1.0 m, is 1.2 kg. Determine the coefficient of permeability of the soil. (6)
- (b) What is a flow net? What are the uses of a flow net? (2 + 2)
9. (a) A 5 m thick clay stratum lies between two previous strata. The properties of the clay are :

Liquid limit = 50%

Coefficient of permeability = 2.8×10^{-7} cm/sec

Void ratio = 0.9

The initial effective overburden pressure at the middle of the clay stratum is 25 kPa, which is likely to increase to 50 kPa due to the construction of a new building. Determine the consolidation settlement of the building.

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- (b) Differentiate between the laboratory consolidation curve and field consolidation relationship. (3)
- (c) In a consolidation test, the void ratio of the soil decreased from 0.7 to 0.6 when the load was changed from 10 kN/m^2 to 100 kN/m^2 . What is the compression index of the soil? (2)

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