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P 1104

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Fourth Semester

Civil Engineering

CE 240 — SOIL MECHANICS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Name any four method of determination of field density of soil.

2. Differentiate (a) Bulk density and dry density (b) Saturated density and submerged density.

3. State any four assumptions made in the construction of flownet.

4. List different state of presence of water in soils.

5. State the components of settlement and its predominance soil type.

6. State the limitations of Terzaghi's one-dimensional consolidation theory.

7. State the use of pore pressure parameters in the tri-axial compression testing.

8. When the field and laboratory vane shear tests are preferred?

9. State the mechanism of slope failure.

10. State the advantage of total stress slope stability analysis of sandy soil.

PART B — (5 × 16 = 80 marks)

11. (a) The following index properties were determined for two soils X and Y.

Property	X	Y
Liquid limit	62%	34%
Plastic limit	26%	19%
Natural Water content	38%	25%
Specific gravity of solids	2.72	2.67
Degree of saturation	100%	100%

Which of these soils

(i) contains more clay particles

(ii) has a greater wet density

(iii) has a greater dry density

(iv) has a greater void ratio?

Give reasons for your answers. (16)

Or

(b) (i) Explain the purpose of classifying a soil sample. (8)

(ii) Discuss the bases on which soil classification system are devised. (8)

12. (a) (i) State the formula which expresses Darcy's law, explaining the symbols used. (4)

(ii) A pumping test was carried out at a level site, where 9 m of clay overlies a stratum of fine sand 1.5 m thick; immediately under the sand lies impermeable bedrock. After the pumping rate became steady at 12.75 litre/s, the average water levels in the observation wells were respectively.

at 6 m radius, 4.8 m below ground level, and

at 15 m radius, 4.2 m below ground level.

Determine :

The coefficient of permeability of the sand, proving any formula used; the effective pressure, during pumping at the bottom of the sand stratum, at 6 m radius, if the total pressure at the bottom of the clay was 150 kN/m^2. Take the bulk density of the sand as 2.05 g/cm^3 (or) 2.05 mg/m^3. (12)

Or

(b) (i) Under what circumstances, might it be justified to carry out determinations of permeability in the field. (6)

(ii) A permeameter of 82 mm diameter contains a sample of soil of length 350 mm. It can be used either for constant-head or falling-head tests. The stand pipe used for the latter has a diameter of 25 mm. In a constant head test the loss of head was 1150 mm, measured on a length of 250 mm. When the rate of flow was $2.73 \times 10^3 mm^3/s$. Find the co-efficient of permeability of the soil in cm/s.

If the falling-head test were made on the same soil, find what time would be taken for the head to fall from 1500 mm to 1000 mm. Assume Darcy's law is valid. (10)

13. (a) (i) Explain the meaning of the terms consolidation and settlement and the soil properties that affect them. Explain what is meant by a normally consolidated and an over consolidated clay stratum. Sketch curves showing the variation of void ratio with effective stress increase in each case. (8)

(ii) Three point loads of 640, 160 and 320 kN, 2 m apart in a straightline, act at the surface of a soil mass. Calculate the resultant stresses produced by these loads on a horizontal plane 1.25 m below the surface at points vertically below the loads. Use Boussinesq's formula. (8)

Or

(b) Two column loads of P and $2P$ respectively are to be applied to the surface of a 6 m thick layer of dense sand which overlies a layer of clay. Determine the maximum spacing of the columns if the settlement of the heavier column is not to be greater than 1.5 times that of the other column. Assume the settlement is due to the clay alone and that its compressibility characteristics are the same for each load. (16)

14. (a) (i) The table gives the data at failure obtained from consolidated undrained tri-axial tests on three identical cylindrical specimens of a saturated clay.

Description	Specimen		
	1	2	3
All-round cell pressure, σ_3 (kN/m^2)	150	300	450
Principal stress difference, $(\sigma_1 - \sigma_3)$ kN/m^2	192	341	504
Pore water pressure, u (kN/m^2)	80	154	222

Determine the cohesion and angle of shearing resistance for the soil in terms of (1) total stresses and (2) effective stresses. (12)

(ii) An earth works embankment is constructed using this saturated clay. The average bulk density of the fill is 1.9 Mg/m^3. What is the pore water pressure within the embankment at a depth of 20 m beneath the surface? (4)

Or

(b) Write down Skempton's equation for the change in pore pressure which occurs when the soil is subjected to changes in the total principal stresses σ_1 and σ_3, what is the significance of the equation? Specimens of a certain saturated clay soil were consolidated in the tri-axial machine under all-round pressures σ_3 and were then sheared without further drainage, at axial stresses σ_1. The following results were obtained

All-round pressure during consolidation and shear (kN/m^2)	Value of pore pressure parameter 'A' at failure
28	–0.19
360	0.44

The soil is known to have the properties $C' = 28$ kN/m^2 and $\phi' = 23°$. Determine the shear stress parameters interms of total stress would you classify the soil as over consolidated or normally consolidated. (16)

15. (a) (i) Define the term stability number as applied to a uniform slope in a cohesive soil and derive an expression for it in terms of the cohesion of the soil Cu, the unit weight γ, the height of bank H and the factor of safety, F. (8)

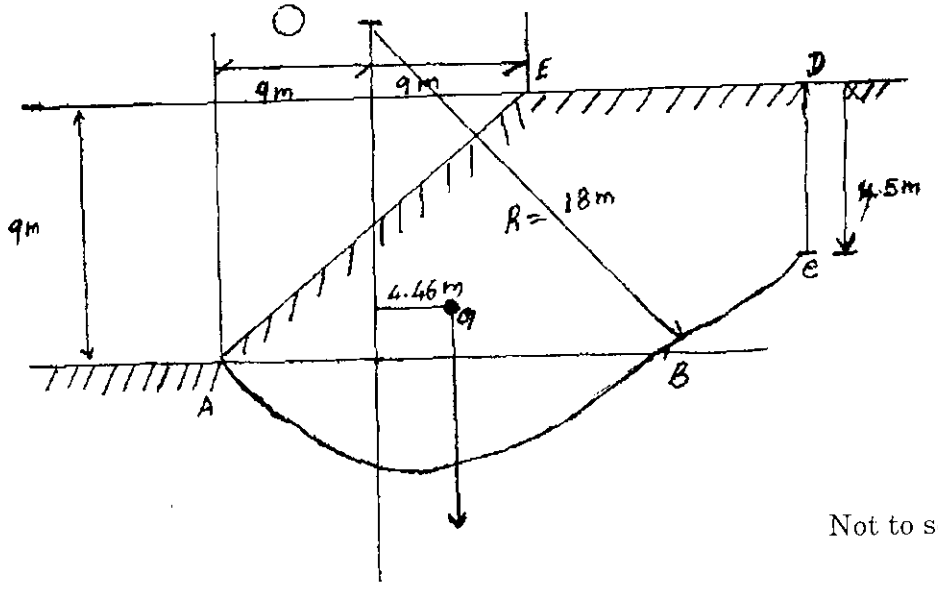
(ii) A cutting 12 m deep is to be made in cohesive soil, the properties of which are : $\gamma = 19.2$ kN/m^3, Cu = 25 kN/m^2 and $\phi_u = 15°$. Find a suitable slope for the side of the cutting if the factor of safety against circular slip is to be 1.5. Assume that the factor of safety applies equally to the cohesive and frictional resistances.

The stability numbers are as follows : (8)

Angle of slope	Stability numbers		
	$\phi = 5°$	$\phi = 10°$	$\phi = 15°$
15°	0.068	0.023	–
30°	0.110	0.075	0.046
45°	0.136	0.108	0.083

Or

(b) Fig. 15(b) shows the section through a cutting in clay. ABC is a trial slip surface and CD is an assumed tension crack, 4.5 m deep. The Area ABCDE is 152 m^2 and its centroid is at G. The density of the soil is 1.92 Mg/m^3 and its cohesion is 43 kN/m^2. Assuming $\phi = 0°$, find the factor of safety against a slip along the surface ABC. Allow for the tension crack being filled with water after heavy rain. (16)



Not to scale

Fig. 15 (b)