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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fourth Semester

Civil Engineering

CE 6405 — SOIL MECHANICS

(Regulations 2013)

(Also common to : PTCE 6405 – Soil Mechanics for B.E. (Part-Time) –
Third Semester – Civil Engineering – Regulations 2014)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. The results of sieve analysis on three soil samples are given below. Say which soil is gap graded and justify your answer.

Sieve size, mm	Percentage passing		
	Soil A	Soil B	Soil C
4.75	100	99	98
2.0	59	62	55
0.425	28	32	55
0.075	1	0	2

2. Specify the mass of rammer, height of fall, number of layers and number of blows per layer used in the light compaction test

3. What is the influence of temperature on the coefficient of permeability of soils?

4. Flow net is drawn for a weir. The total loss of head is 5 m, the number of potential drops is 10 and the length of the flow line for the last square is 1 m. Calculate the exit gradient.

5. Boussinesq's vertical stress due to a point load at a point which is at a depth of 'z' and at a radial distance of 'r' from the line of action of the load is 'σ_z', when the modulus of elasticity of the medium is 'E'. Find the vertical stress at the same point when the modulus of elasticity of the medium is doubled.

6. A consolidating stratum takes two years for 50 % consolidation. Find the time taken by the stratum for 90 % consolidation for the same drainage condition.

7. A purely cohesive soil sample of cohesion 40 kPa is subjected to a cell pressure of 100 kPa in a triaxial compression test. Will the sample fail by shear? Justify your answer.

8. The diameter of all the Mohr circles drawn at incipient failure condition for the results of a triaxial test performed on a soil is the same and equal to 150 kPa to a scale. Find the shear strength parameters of the soil.

9. Find the factor of safety of an infinite slope having a slope angle of 28°. The slope consists of cohesionless soil with angle of internal friction of 31°.

10. In the case of $c - \phi$ soil, the slope failure of an infinite slope never takes place, if the angle of slope is equal to angle of internal friction of the soil. Why?

PART B — (5 × 13 = 65 marks)

11. (a) (i) The liquid limit, plastic limit and shrinkage limit of a soil are 60%, 40% and 30% respectively. A specimen of the soil has a volume of 100 cm³ at liquid limit.

    Find its volume at shrinkage limit, if the specific gravity of solids is 2.0. When oven-dried sample of the soil is subjected to liquid limit test, the liquid limit reduced to 42%. Classify the soil as per IS, if the fraction of the soil passing 75 micron sieve is 70%. (10)

   (ii) Discuss the influence of size of the particles of soil on optimum moisture content. (3)

Or

   (b) (i) A loose, uncompacted sand fill 1.5 m deep has a relative density of 30%. Laboratory tests on the same sand indicate that the minimum and maximum void ratios are 0.45 and 0.82 respectively. The specific gravity of solids is 2.65. If the sand fill is compacted to a relative density of 70%, what is the decrease in its thickness? Also, find the dry unit weight of the compacted sand. (7)

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(ii) The maximum dry density achieved in a laboratory compaction test on a soil which is being used for building a compacted fill is 1.98 g/cc. Two field density tests have been performed in the recently completed fill, but one of these tests has produced results that are definitely incorrect. Test A indicates a relative compaction of 97% at placement water content of 14.3% whereas Test B indicates a relative compaction of 98% at a placement water content of 14.7%. Which test results are definitely incorrect? Justify your answer. Take specific gravity of solids as 2.7. (6)

12. (a) The ground water table in a deep deposit of sand is located at 4 m from the ground level. Due to capillary action, sand is saturated for a height of 1 m from the water table. The degree of saturation of the sand above the capillary fringe is 40%. If the specific gravity of solids and average void ratio of the sand are 2.68 and 0.72 respectively, obtain the effective stress at 2 m, 3 m, 4 m and 10 m from the ground level.

Or

(b) (i) A permeameter of cross sectional area 100 cm², has a soil sample of length 20 cm. The sample is heterogeneous having coefficient of permeability of 1×10^{-4} cm/s for the first 7 cm and 1×10^{-3} cm/s the last 7 cm thickness. When falling head permeability test is conducted with a stand pipe of cross sectional area 2 cm², the head drops from 40 cm to 20 cm in 18 minutes, Find the coefficient of permeability of the middle part of the sample. (7)

(ii) A 5-m deep vertical cut is made in a stiff saturated clay of thickness 7 m that is underlain by sand. The ground water table is at a depth of 2 m from the ground level. What should be the minimum height of water in the cut so that the stability of bottom of the cut is not lost? Take specific gravity of solids and water content of the clay as 2.65 and 30% respectively. (6)

13. (a) (i) A Newmark's chart is drawn with an interval of 0.1 for σ_z/q. If there are 20 radial lines, find the influence factor. (σ_z and q are additional vertical pressure and applied loading intensity respectively). (3)

(ii) A certain clay layer has a thickness of 2 m. After one year when the clay layer was 50% consolidated a settlement of 20 mm occurred. For a similar clay layer, under similar loading and drainage conditions, how much settlement would occur at the end of one year and four years respectively, if the thickness of the new layer were 4 m? (10)

Or

(b) (i) A point in a clayey layer is subjected to a stress of 80 kPa at present. The consolidation test results conducted on a sample of the clay show a preconsolidation pressure of 120 kPa. Say whether the clay is normally consolidated or overconsolidated. Justify your answer. (3)

(ii) In a normally consolidated clay, the void ratio decreases from 1.02 to 0.92 when the effective pressure is increased from 80 kpa to 160 kPa. The coefficient of permeability of the clay for this pressure range is 1×10^{-10} m/s. How long will it take for a 2-m thick clay layer which is sandwiched between coarse sand and rock in the field to reach 60% consolidation? What is the settlement at that time? (10)

14. (a) (i) In direct shear test, find the angle made by failure plane and major principal plane respectively with respect to horizontal, if the angle of internal friction is 30°. (3)

(ii) Describe the state of soil samples A to D when the Mohr circles describing their state of stresses are as follows : for A, the Mohr circle is a dot on the normal stress axis, for B, the Mohr circle is too small to touch the strength envelope, for C, the Mohr circle is tangential to strength envelope and for D, the Mohr circle is so large that part of the circle is above the strength envelope. Also for the sample C, find the angle made by the failure plane with respect to minor principal plane.. (10)

Or

(b) Following are the results of a triaxial test conducted on two specimens of the same soil. Find the shear strength parameters of the soil. If another specimen of the same soil is subjected to a cell pressure of 400 kPa, find the deviator stress at which it is likely to fail. Also for this specimen, find the normal stress and shear stress on the failure plane and locate the plane of maximum shear stress with respect to major principal plane and find the magnitude of maximum shear stress.

| Cell pressure, kPa | 100 | 200 |
| Deviator stress at failure, kPa | 300 | 585 |

15. (a) An infinite slope with a slope angle of 28° is 4.5 m high. The soil has cohesion of 30 kpa, angle of internal friction of 20° and unit weight of 19 kN/m³. Find the factor of safety with respect to cohesion. Derive the equation used if any.

Or

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(b) (i) Explain with sketches, the different ways by which a finite slope may fail. State the situations where each failure is likely to happen. (6)

(ii) A purely cohesive soil has a unit weight of 18 kN/m³ and an average cohesion of 22 kPa. A hard stratum exists only at infinite depth below the ground level. A 4-m deep cutting is to be made. Find the factor of safety if the slope angle is (1) 90° (2) 53°. (7)

PART C — (1 × 15 = 15 marks)

16. (a) The unit weight of a soil at 50% and 80% saturation is 17.60 kN/m³ and 18.81 kN/m³ respectively. Find

(i) Specific gravity of solids

(ii) Void ratio

(iii) Porosity

(iv) Dry unit weight

(v) Saturated unit weight

(vi) Submerged unit weight

(vii) Water content corresponding to 100% saturation When a disturbed sample of the same soil was subjected to classification tests, the following results were obtained :

Percentage finer than 4.75 mm	: 80
Percentage finer than 0.075 mm	: 9
Liquid limit	: 23%
Plastic limit	: 15%
Size corresponding to 10% finer	: 0.09 mm
Size corresponding to 30% finer	: 1.2 mm
Size corresponding to 60% finer	: 3.4 mm

Classify the soil as per IS 1498.

Or

(b) A soil profile consists of 4-m thick sand underlain by 3-m thick clay. The clay layer overlies hard rock. A square foundation of size 2 m carrying a load of 800 kN is founded at a depth of 1.5 m from the ground level. The ground water table is at the base of the foundation. The specific gravity of solids and void ratio of the sand are 2.7 and 0.7 respectively. The degree of saturation above the water table can be assumed as 30%. The liquid limit, water content and specific gravity of solids of the clay are 40%, 27% and 2.66 respectively. Estimate the probable consolidation settlement of the clay layer, assuming the clay to be normally consolidated. For calculation of additional vertical stress, equivalent point load approach shall be adopted (dividing the total area into four area units)

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