GEOTECHNICAL ENGINEERING QUESTION BANK

PREPARED

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CHAPTER-1
INTRODUCTION OF GEOTECHNICAL ENGG.

1) Differentiate between 'residual' and 'transported' soils. In what way does this knowledge help in soil engineering practice?

2) Write brief but critical notes on 'texture' and 'structure' of soils.

3) Explain the following materials:

(i) Peat, (ii) Hard pan, (iii) Loess,

(iv) Shale, (v) Fill, (vi) Bentonite,

(vii) Kaolinite, (viii) Marl, (ix) Caliche.

4) Distinguish between 'Black Cotton Soil' and Laterite' from an engineering point of view.

5) Briefly descibe the processes of soil formation.

6) Explain the meanings of 'texture' and 'structure' of a soil. (b) What is meant by 'black cotton soil'? Indicate the geological and climatic conditions that tend to produce this type of soil.

7) (a) Relate different formations of soils to the geological aspects.

8) Descibe different types of texture and structure of soils.

9) Bring out the typical characteristics of the following materials:

(i) Peat, (ii) Organic soil, (iii) Loess,

(iv) Kaolinite, (v) Bentonite, (vi) Shale,

(vii) Black cotton soil.

10) Distinguish between

(i) Texture and Structure of soil.

(ii) Silt and Clay.

(iii) Aeoline and Sedimentary deposits.

CHAPTER-2
Preliminary Definitions and Relationship

1) Define :
   (i) Void ratio, (ii) Porosity, (iii) Degree of saturation,
   (iv) Water content, (v) Dry density, (vi) Bulk density,
   (vii) Submerged density.
2) Derive from fundamentals : (i) S.e = w.G, where S represents degree of saturation, e represents void ratio, w represents water content, and G represents grain specific gravity.
3) Derive the relationship between dry density and bulk density in terms of water content.
4) Sketch the phase diagram for a soil and indicate the volumes and weights of the phases on it. Define ‘Void ratio’, ‘Degree of saturation’, and ‘Water content’. What is a unit phase diagram ?
5) Establish the relationship between degree of saturation, soil moisture content, specific gravity of soil particles, and void ratio. The volume of an undisturbed clay sample having a natural water content of 40% is 25.6 cm3 and its wet weight is 0.435 N. Calculate the degree of saturation of the sample if the grain specific gravity is 2.75.
6) Distinguish between Black cotton soil and Laterite from an engineering point of view.
7) Defining the terms ‘Void ratio’, ‘Degree of saturation’ and ‘Water content’, explain the engineering significance of determining these properties.
8) A piece of clay taken from a sampling tube has a wet weight of 1.553 N and volume of 95.3 cm3. After drying in an oven for 24 hours at 105°C, its weight 1.087 N. Assuming the specific gravity of the soil particles as

2.75, determine the void ratio and degree of saturation of the clay sample.

9) Derive the formula between soil moisture content (w), degree of saturation (S), specific gravity (G), and void ratio (e). A saturated clay has a water content of 40% and bulk specific gravity of 1.90. Determine the void ratio and specific gravity of particles.

10) Derive the relation between void ratio (e), specific gravity of particles (G) and moisture content at full saturation (w). A certain sample of saturated soil in a container weighs 0.65 N. On drying in an oven in the container it weighs 0.60 N. The weight of container is 0.35 N. The grain specific gravity is 2.65. Determine the void ratio, water content, and bulk unit weight

11) Define ‘Soil Texture’ and ‘Soil structure’. What are the various terms used to describe the above properties of the soil ?

12) A clay sample containing natural moisture content weighs 3.462 N. The specific gravity of soil particles is 2.70. After oven drying, the soil weighs 2.036 N. If the displaced volume of the wet soil sample is 24.26 cm3 calculate : (i) the moisture content of the sample, (ii) its void ratio, and (iii) degree of saturation.

13) The porosity and the specific gravity of solids of 100% saturated soil are known. In terms of these quantities and with the aid of a properly drawn sketch, derive a formula for the moisture content of the soil.

14) A highly sensitive volcanic clay was investigated in the laboratory and found to have the following properties : (i) $\gamma wet = 12.56$ kN/m3 (ii) G = 2.75 (iii) e = 9.0 (iv) w = 311%. In rechecking the above values, one was found to be inconsistent with the rest. Find the inconsistent value and report it correctly.

15) A partially saturated soil from an earth fill has a natural water content

of 19% and a bulk unit weight of 19.33 kN/m3. Assuming the specific gravity of soil solids as 2.7, compute the degree of saturation and void ratio. If subsequently the soil gets saturated, determine the dry density, buoyant unit weight and saturated unit weight.

16) In a field density test, the volume and wet weight of soil obtained are 785 cm3 and 15.80 N respectively. If the water content is found to be 36%, determine the wet and dry unit weights of the soil. If the specific gravity of the soil grains is 2.6, compute the void ratio.

17) A clay sample, containing its natural moisture content, weighs 0.333 N. The specific gravity of solids of this soil is 2.70. After oven-drying, the soil sample weighs 0.2025 N. The volume of the moist sample, before oven-drying, found by displacement of mercury is 24.30 cm3. Determine the moisture content, void ratio and degree of saturation of the soil.

CHAPTER-3
Index Properties of soil

1) Distinguish Between: (i) Silt size and clay size (ii) Degree of sensitivity and degree of saturation.

2) Sketch typical complete grain-size distribution curves for (i) well graded soil and (ii) uniform silty sand. Form the curves, determine the uniformity coefficient and effective size in each case. What qualitative inferences can you draw regarding the engineering properties of each soil ?

3) Define the following:
(i) flow index, (ii) Toughness index, (iii) Liquidity index,
(iv) Shrinkage index, (v) Plasticity index, (vi) Uniformity coefficient
(vii) Relative density (Density index), (viii) Sensitivity, (ix) Activity.

4) Write short notes on the "Methods of determination of Atterberg limits".

5) Write a short note on 'Relative density'.

6) Define and explain the following:
(i) Uniformity coefficient, (ii) Relative density,
(iii) Stokes' law, (iv) Flow index.

7) Write short note on 'consistency of clayey soils'.

8) Define and explain: Liquid limit; Plastic limit; shrinkage limit; and Plasticity index. Briefly describe the procedure to determine the Liquid Limit of a soil.

9) Distinguish between: (i) Liquid limit and liquidity index, (ii) Density and relative density.

10) An oven-dried soil weighing 1.89 N is placed in a pyknometer which is then filled with water. The total weight of the pyknometer with water and soil is 15.81 N. The pyknometer filled with water alone weighs 14.62 N. What is the specific gravity of the soil, if the pyknometer is calibrated at the temperature of the test ?

11) In a specific gravity test, 1.17 N of oven-dired soil was taken. The weight of pyknometer, soil and water was obtained as 6.51 N. The weight of pyknometer full of water alone was 5.80 N. What is the value of the specific gravity of solids at the temperature of the test ? If, while determining the weight of pyknometer, soil, and water, 2 cm3 of air got entrapped, what is the correct value of the specific gravity and what is the percentage of error ?

12) In order to determine the water content of a wet sand, a sample weighing 4 N was put in a pyknometer. Water was then poured to fill it and the weight of the pyknometer and its contents was found to be 22.5 N. The weight of pyknometer with water alone was 20.3 N. The grain specific gravity of the sand was known to be 2.67. Determine the water content of the sand sample.

13) An undisturbed sample of sand has a dry weight of 18.9 N and a volume of 1143 cm3. The solids have a specific gravity of 2.72. Laboratory tests indicate void ratios of 0.40 and 0.90 at the maximum and minimum unit weights, respectively. Determine the density index of the sand sample.

14) A sand at a borrow pit is determined to have an in-situ dry unit weight of 18.4 kN/m3. Laboratory tests indicate the maximum and minimum unit weight values of 19.6 kN/m3 and 16.32 kN/m3, respectively. What is the density index of the natural soil ?

15) A core-cutter 12.6 cm in height and 10.2 cm in diameter weighs 10.71 N when empty. It is used to determine the in-situ unit weight of an embankment. The weight of core-cutter full of soil is 29.7 N. If the water content is 6%, what are in-situ dry unit weight and porosity ? If the embankment gets fully saturated due to heavy rains, what will be the increase in water content and bulk unit weight, if no volume change occurs ? The specific gravity of the soil solids is 2.69.

16) Using Stokes’ law, determine the time of settlement of a sand particle of 0.2 mm size (specific gravity 2.67) through a depth of water of 30 cm. The viscosity of water is 0.001 N-sec/m2 and unit weight is 9.80 kN/m3.

17) In a pipette analysis, 0.5 N of dry soil of the fine fraction was mixed in water to form one litre of uniform suspension. A pipette of 10 ml capacity was used to obtain a sample from a depth of 10 cm, 40 min. from the start of sedimentation. The weight of solids in the pipette sample was 0.002 N. Determine the co-ordinates of the corresponding point on the grain-size distribution curve. Assume the grain-specific gravity as 2.70, the viscosity of water as 0.001 N-sec/m2, and the unit weight of water as 9.8 kN/m3.

18) A litre of suspension containing 0.5 N of soil with a specific gravity of 2.70 is prepared for a hydrometer test. When no temperature correction is considered necessary, what should be the hydrometer reading if the hydrometer could be immersed and read at the instant sedimentation begins?

19) In a hydrometer analysis, 0.5 N of soil was mixed in water to form one litre of uniform suspension. The corrected hydrometer reading after a lapse of 60 min. from the start of sedimentation was 1.010, and the corresponding effective depth was 10.8 cm. The grain specific gravity was 2.72. Assuming the viscosity of water as 0.001 N-sec/m2 and the unit weight of water as 9.8 kN/m3, determine the co-ordinates of the corresponding point on the grain-size distribution curve.

20) The liquid limit and plastic limit of a soil are 75% and 33% respectively. What is the plasticity index ? The void ratio of the soil on oven-drying was found to be 0.63. What is the shrinkage limit ? Assume grain specific gravity as 2.7.

21) A piece of clay taken from a sampling tube has a wet weight of 1.553 N and volume of 95.3 cm3. After drying in an oven for 24 hours at 105°C, its weight is 1.087 N. The liquid and plastic limits of the clay are respectively 56.3% and 22.5%. Determine the liquidity index and void ratio of the sample. Assume the specific gravity of soil particles as 2.75.

22) A completely saturated sample of clay has a volume of 31.25 cm3 and a weight of 0.5866 N. The same sample after drying has a volume of 23.92 cm3 and a weight of 0.4281 N. Compute the porosity of the initial soil sample, specific gravity of the soil grains and shrinkage limit of the sample.

23) The Atterberg limits of a clay soil are: Liquid limit = 63%, Plastic limit = 40%, and shrinkage limit = 27%. If a sample of this soil has a volume of 10 cm3 at the liquid limit and a volume of 6.4 cm3 at the shrinkage limit, determine the specific gravity of solids, shrinkage ratio, and volumetric shrinkage.

24) A 100 cm3-clay sample has a natural water content of 30%. Its shrinkage limit is 18%. If the specific gravity of solids is 2.72, what will be the volume of the sample at a water content of 15%?

25) The oven-dry weight of a pat of clay is 1.17 N and the weight of mercury displaced by it is 0.855 N. Assuming the specific gravity of solids as 2.71, determine the shrinkage limit and shrinkage ratio. What will be the water content, at which the volume increase is 10% of the dry volume ?

CHAPTER-4
Classification of Soil

1) Describe in detail the Indian System of soil classification. When would you use dual symbols for soils ?

2) Draw neatly the IS plasticity chart and label the symbol of various soils. (b) What are the limitations of any soil classification system ? (c) Explain the following tests with their significance. (i) Dilatancy, (ii) Thread Test, (iii) Dry Strength Test.

3) Why is classification of soils required ? (b) What are common classification tests ? (c) How do you classify a soil by the I.S. Classification system ? (d) How would you differentiate between SC and SF soils.

4) What physical properties of soil distinguish between cohesive and cohesionless soils ? Also explain the principle of sub-dividing cohesive and cohesionless deposits for the purpose of soil classification.

5) (a) Describe the U.S. Bureau of Soils Textural classification. (b) Describe field identification tests to distinguish between clay and silt.

6) (a) Explain why soils are classified and outline the salient features of Casagrande's airfield classification.

7) (a) State the various classification systems of soils for general engineering purposes.

(b) Briefly describe the ''Unified Soil Classification'',

8) (a) Describe the method of field identification of soils.

(b) How do you use the A-line to distinguish between various types of clays ?

9) How do you distinguish between clay and silt in the field ? State the purpose of identification and classification of soils. List any three important engineering classification systems and describe one in detail, clearly bringing out its limitations.

10) State the various classification systems of soils for general engineering purposes.

11) Briefly describe the ''Unified Soil Classification''

12) Describe the method of field identification of soils.

13) How do you use the A-line to distinguish between various types of clays ?

CHAPTER-5
Permeability and Seepage

1. Define 'neutral' and 'effective' pressure in soils.

2. Write short notes on 'neutral' and 'effective' pressure. What is the role of effective stress in soil mechanics ?

3. A uniform homogeneous sand deposit of specific gravity 2.60 and void ratio 0.65 extends to a large depth. The ground water table is 2 m from G.L. Determine the effective, neutral, and total stress at depths of 2 m and 6 m. Assume that the soil from 1 m to 2 m has capillary moisture leading to degree of saturation of 60%.

4. Describe clearly with a neat sketch how you will determine the coefficient of permeability of a clay sample in the laboratory and derive the expression used to compute the permeability coefficient. Mention the various precautions, you suggest, to improve the reliability of the test results.

5. Define 'permeability' and explain how would you determine it in the field.

6. Define coefficient of permeability and list four factors on which the permeability depends. A falling head permeability test is to be performed on a soil sample whose permeability is estimated to be about 3 × 10–5 cm/s.

What diameter of the standpipe should be used if the head is to drop from 27.5 cm to 20.0 cm in 5 minutes and if the cross-sectional area and length of the sample are respectively 15 cm2 and 8.5 cm ? Will it take the same time for the head to drop from 37.7 cm to 30.0 cm ?

7. What are the conditions necessary for Darcy's law to be applicable for flow of water through soil

8. Why is the permeability of a clay soil with flocculated structure greater than that for it in the remoulded state ?

9. State the principle of Darcy's law for laminar flow of water through saturated soil.

10. Demonstrate that the coefficient of permeability has the dimension of velocity.

11. The discharge of water collected from a constant head permeameter in a period of 15 minutes is 400 ml. The internal diameter of the permeameter is 6 cm and the measured difference in heads between the two gauging points 15 cm apart is 40 cm. Calculate the coefficient of permeability and comment on the type of soil.

12. A glass cylinder 5 cm internal diameter with a screen at the bottom is used as a falling head permeameter. The thickness of the sample is 10 cm. The water level in the tube at the start of the test was 40 cm above tail water level and it dropped by 10 cm in one minute while the level of tail water remained unchanged. Determine the value of the coefficient of permeability.

13. The initial head is 300 mm in a falling head permeability test. It drops by 10 mm in 3 minutes. How much longer should the test continue, if the head is to drop to 180 mm ?

14. Determine the average horizontal and vertical permeabilities of a soil mass made up of three horizontal strata, each 1 m thick, if the coefficients of permeability are 1 × 10–1 mm/s, 3 × 10–1 mm/s, and 8 × 10–2 mm/s for the three layers.

15. The coefficient of permeability of a soil sample is found to be 9 × 10–2 mm/s at a void ratio of 0.45. Estimate its permeability at a void ratio of 0.63.

16. In a falling head permeability test the time intervals noted for the head to fall from h1 to h2 and from h2 to h3 have been found to be equal. Show the h2 is the geometric mean of h1 and h3.

17. Write short notes on ‘Flow nets’

18. (a) What are the principles of a flow net ? What are its uses ? (b) Explain the phenomenon of ‘‘Piping’’.

19. What are the salient characteristics of a flow net? Describe a suitable procedure of drawing flow net.

20. Write short notes on: Critical hydraulic gradient, Phreatic line.

21. Write short notes on : Quicksand conditions, Laplace system.

22. Briefly discuss: (i) Properties and utility of the flow net. (ii) Seepage force (iii) Electrical analogy method.

23. (a) Explain the meaning of the term ‘‘ Seepage pressure’’.

(b) Show how the effective pressure is altered when water is flowing through the soil vertically downwards and vertically upwards.

CHAPTER-6
Compaction and Consolidation.

1. Write short notes on the following: (a) Log fitting method for evaluation of Cv from laboratory consolidation test. (b) Precompression in clays.
2. State the assumptions made in Terzaghi's theory of one-dimensional consolidation.
3. Define the terms 'Compression index', coefficient of consolidation', and 'coefficient of compressibility', and indicate their units and symbols.
4. Define 'preconsolidation pressure'. In what ways in its determination important in soil engineering practice ? Describe a suitable procedure for determining the preconsolidation pressure.
5. Explain with neat sketches: (i) The influence of load-increment ratio on time-settlement curve. (ii) Terzaghi's assumptions.
6. Differentiate between 'compaction' and 'consolidation'.
7. Define (i) Compression Index, (ii) Coefficient of volume decrease, (iii) Coefficient of consolidation and (iv) Per cent consolidation.
8. Describe a suitable method of determining the compression index of a soil.
9. Explain what is meant by normally consolidated clay stratum and over-consolidated clay stratum. Sketch typical results of consolidation test data to a suitable plot relating the void ratio and consolidation pressure in each case and show how preconsolidation can be estimated.
10. Distinguish between normally consolidated and over consolidated soils. (b) Explain in detail and one method for determining the coefficient of consolidation of a soil.
11. Obtain the differential equation defining the one-dimensional consolidation as given by Terzaghi, listing the various assumptions.
12. Define and distinguish between coefficient of volume compressibility and

coefficient of consolidation. Describe clearly one method of computing coefficient of consolidation, given oedometer test data.

13. Draw a typical time-consolidation curve for an increment of load and show the process of consolidation. (b) Explain why is it necessary to double the load in a consolidation test.