KINGS

COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

Question Bank

Sub. Code/Name: CE2251 SOIL MECHANICS **Year/Sem: II / IV**

UNIT-I INTRODUCTION

1 .Define soil?

Uncemented or weakly cemented accumulation of mineral and organic particles and sediments found above the bedrock, or any unconsolidated material consisting of discrete solid particles with fluid or gas in the voids.

2. Define Soil Mechanics ?

Soil mechanics is defined as the study of action of forces on soil and the study of flow of water through soil.

3. List the Main Types of Soils ?

The types of soil are

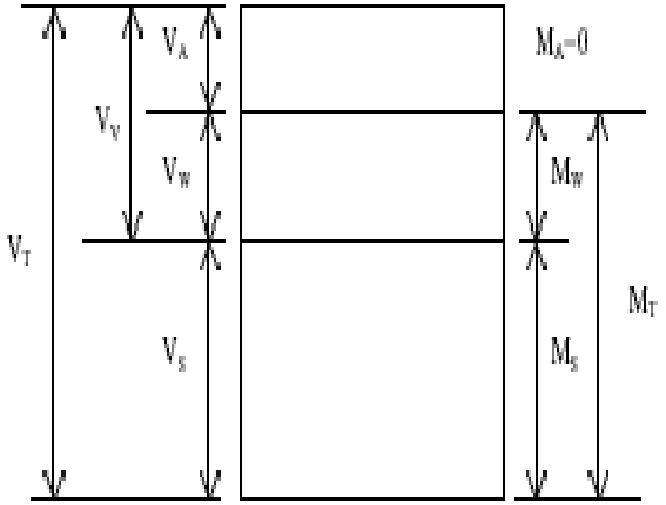
*Granula*r or cohesioless: gravel, sand, (silt)

Cohesive: (silt), clay

Organic: marsh soil, peat, coal, tar sand

Man-Made: mine tailings, landfill waste, ash, and aggregates.

4. Draw the phase diagram ?



5. Define soil Index ?

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100\%$$

Where,
e_{max} = maximum void ratio corresponding to the loosest state,
e_{min} = minimum void ratio corresponding to the densest state, and
e = void ratio of the sample.

6. Give an empirical correlation between PSD and permeability ?

An empirical correlation between PSD and permeability has been developed

$k = c\,(D10)2$ cm/s

Where $100 < c < 150$

Developed by Hazen for uniform, loose, clean sands and gravels.

7. Define degree of saturation ?

The degree of saturation is defined as the ratio of volume of water to the volume of voids

$$S_r = V_w/V_v$$

For fully saturated soil $S_r=100$,
For perfectly dry soil $S_r=0$

8. Define Void Ratio ?

The void ratio of a soil is defined as the ratio of volume of voids to the volume of solids.

$$e = V_v/V_s$$

9. Define specific gravity ?

It is defined as the ratio of the mass of a given volumes of solid gains to the mass of equal volume of water at the same temperature

10. Define Density ?

The density of a substance is the mass per unit volume of that substance. For water this is denoted by w, and its value is about 1000 kg/m3. Small deviations from this value may occur due to temperature differences or variations in salt content. In soil mechanics these are often of minor importance, and it is often considered accurate enough to assume that w = 1000 kg/m3.

11. Define water content ?

By definition the water content w is the ratio of the weight (or mass) of the water to the wt of solids,

$$w = W_w/W_s.$$

PART - B

1. Explain in detail the procedure for determination of grain size distribution of soil by sieve analysis.

2. Explain the procedure for determining the relationship between dry density and moisture content by proctor compaction test.

3. Explain in detail the Indian standards classification system.

4. Describe in detail the procedure for determination of liquid limit of soil

5. Describe in detail the procedure for determination of shrinkage limit of soil

6. Explain in detail the factors affecting compaction.

Unit II SOIL WATER AND WATER FLOW

1. What are the factors that affect hydraulic conductivity?

The hydraulic conductivity is influenced by a number of factors including:

- Effective porosity
- Grain size and grain size distribution
- Shape and orientation of particles
- Degree of saturation
- Clay mineralogy

2. What are assumptions made to derive the equation governing two dimensional steady state seepage?

Several assumptions are required to derive the equation governing two dimensional steady state seepage.

- The soil is completely saturated
- There is no change in void ratio of the porous medium
- The hydraulic conductivity is isotropic
- Darcy's law is valid
- The water is incompressible

3. What are the steps in the construction of a flownet?

Steps in Drawing a Flow Net

- Define and clearly mark a datum.
- Identify the boundary conditions (EP, FL, LCP).
- Draw intermediate equipotentials and flow lines.
- draw coarse mesh with a few EPs and FLs
- Verify the coarse mesh is correct.
- Are the boundary conditions satisfied ?
- Are all flow tubes continuous ?
  Are EPs z FLs ?
- Mostly "squares" ?
- Add additional EPs and FLs for suitable refinement of the flow net.
- Calculate desired quantities of flow and heads.

4. Define Seepage velocity ?

The actual velocity of water flowing through the voids is termed as seepage velocity.

PART - B

1. Explain in detail the laboratory determination of permeability using constant head method.

2. Explain in detail the laboratory determination of permeability using falling head method.

3. Derive the Laplace equation for two-dimensional flow.

4. Explain in detail the properties and applications of flow nets.

5. Explain in detail the procedure for drawing the phreatic line for an earthen dam.

Unit III STRESS DISTRIBUTION, COMPRESSIBILITY AND SETTLEMENT

1.What is a principal plane?

At every point in a stressed body, there are three planes on which the shear stresses are zero. These planes are known as principal planes.

2. What are the limitations of coulomb's theory?

The limitations of coloumb theory are

- It neglects the effect of the intermediate principal stress.
- It approximates the curved failure envelope by a straight line which may not give correct results.

3. Give the Coulomb's shear strength equation ?

The Coulomb's shear strength equation is given by,

$$S= c+\sigma \tan \varphi$$

C= cohesion

φ = Angle of internal friction

4. What is Unconsolidated- Undrained condition?

In this type of test no drainage is permitted during the consolidation stage. The drainage is also permitted in the shear stage.

5. What is consolidated- undrained condition?

In a consolidated- undrained test, the specimen is allowed to consolidate in the first stage. The drainage is permitted until the consolidation is complete.

6. What is the main cause of slope failure?

Slope failures occur when the rupturing force exceeds resisting force.

7. What are the factors affecting permeability tests?

The following five physical Characteristics influence the performance and applicability of permeability tests:

- position of the water level,
- type of material - rock or soil,
- depth of the test zone,

- permeability of the test zone, and
- heterogeneity and anisotropy of the test zone.

8. Define effective stress ?

Effective stress equals the total stress minus the pore water pressure, or the total force in the soil grains divided by the gross cross-sectional area over which the force acts.

9. Define critical depth ?

If there is no distinct change in the character of subsurface strata within the critical depth, elastic solutions for layered foundations need not be considered. Critical depth is the depth below the foundation within which soil compression contributes significantly to surface settlements. For fine-grained compressible soils, the critical depth extends to that point where applied stress decreases to 10 percent of effective overburden pressure. In coarse-grained material critical depth extends to that point where applied stress decreases to 20 percent of effective overburden pressure.

10. What are the rules to be followed while construction of flow net?

Rules for flow net construction

- When materials are isotropic with respect to permeability, the pattern of flow lines and equipotentials intersect at right angles. Draw a pattern in which square figures are formed between flow lines and equipotentials
- Usually it is expedient to start with an integer number of equipotential drops, dividing total head by a whole number, and drawing flow lines to conform to these equipotentials. In the general case, the outer flow path will form rectangular rather than square figures. The shape of these rectangles (ratio b/l) must be constant.
- The upper boundary of a flow net that is at atmospheric pressure is a "free water surface". Integer equipotentials intersect the free water surface at points spaced at equal vertical intervals.

11. Write a note on piping ?

Piping and Subsurface Erosion.

Most piping failures are caused by subsurface erosion in or beneath dams. These failures can occur several months or even years after a dam is placed into operation.

In essence, water that comes out of the ground at the toe starts a process of erosion (if the exit gradient is high enough) that culminates in the formation of a tunnel-shaped passage (or "pipe") beneath the structure. When the passage finally works backward to meet the free water, a mixture of soil and water rushes through the passage, undermining the structure and flooding the channel below the dam. It has been shown that the danger of a piping failure due to subsurface erosion increases with decreasing grain size. Similar subsurface erosion problems can occur in relieved dry docks, where water is seeping from a free source to a drainage or filter blanket beneath the floor or behind the walls. If the filter fails or is defective and the hydraulic gradients are critical, serious concentrations of flow can result in large voids and eroded channels.

12. Define stress path.

A convenient way to represent test results, and their correspondence with the stresses in the field, is to use a stress path. In this technique the stresses in a point are represented by two (perhaps three) characteristic parameters and they are plotted in a diagram. This diagram is called a stress path.

13. What is the significance of soil mechanics?

Soil mechanics has become a distinct and separate branch of engineering mechanics because soils have a number of special properties, which distinguish the material from other materials. Its development has also been stimulated, of course, by the wide range of applications of soil engineering in civil engineering, as all structures require a sound foundation and should transfer its loads to the soil. The most important special properties of soils will be described briefly in this chapter. In further chapters they will be treated in greater detail, concentrating on quantitative methods of analysis.

14. Write a short note on shear ?

In compression soils become gradually sti_er. In shear, however, soils become gradually softer, and if the shear stresses reach a certain level, with respect to the normal stresses, it is even possible that failure of the soil mass occurs. This means that the slope of sand heap, for instance in a depot or in a dam, cannot be larger than about 30 or 40 degrees. The reason for this is that particles would slide over each other at greater slopes.

15. What is creep?

The deformations of a soil often depend upon time, even under a constant load. This is called creep.

16. Define plastic limit ?

The transition from the plastic state to the solid state is called the plastic limit, and denoted as wP . It is defined as the water content at which the clay can just be rolled to threads of 3 mm diameter. Very wet clay can be rolled into very thin threads, but dry clay will break when rolling thick threads. The (arbitrary) limit of 3 mm is supposed to indicate the plastic limit. In the laboratory starting with a rather wet clay sample, from which it is simple to roll threads of 3 mm, performs the test. By continuous rolling the clay will gradually become drier, by evaporation of the water, until the threads start to break.

17. Define liquid limit ?

The transition from the liquid state to the plastic state is denoted as the liquid limit, wL. It represents the lowest water content at which the soil behavior is still mainly liquid.

PART - B

1. Derive the equation for Terzhaghi's one-dimensional consolidation.
2. Explain in detail the laboratory determination of co-efficeint of consolidation.
3. Explain the concept of consolidation using Terzaghi's mechanical model.
4. Explain the principle of Newmark's Chart in detail.
5. Explain in detail with sketches the applications of Boussinesq theory.

Unit IV SHEAR STRENGTH

1.Define shear strength

In engineering, shear strength is the strength of a material or component against the type of yield or structural failure where the material or component fails in shear. A shear load is a force that tends to produce a sliding failure on a material along a plane that is parallel to the direction of the force. When a paper is cut with scissors, the paper fails in shear.

2. What are the shear strength parameters?

The effective shear strength parameters c', □', are important factors of the geotechnical design. Consolidated Drained (CD) triaxial tests or Consolidated Undrained with Pore Pressure Measurements triaxial tests (CU) are common methods for their experimental estimation.

3. What is angle of internal friction?

Angle of internal friction for a given soil is the angle on the graph (Mohr's Circle) of the shear stress and normal effective stresses at which shear failure occurs.Angle of Internal Friction, ϕ, can be determined in the laboratory by the *Direct Shear Test* or the *Triaxial Stress Test*.

4.Write the Mohr-Coulomb equation.

In geotechnical engineering, we write the Mohr-Coulomb equation for these lines as:

$S = N \tan(\Phi) + c$This equation is written for peak, large-displacement, or residual shear strength conditions.

5.Define Failure envelope.

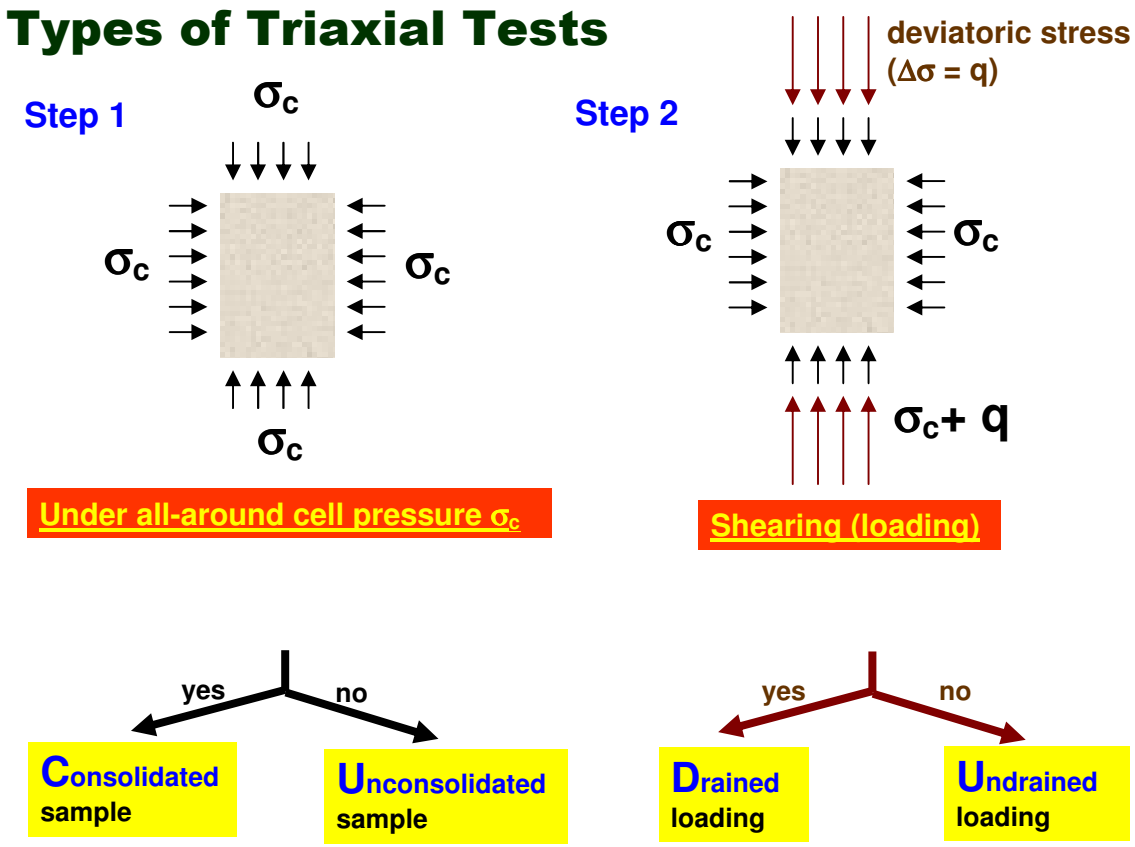
The Mohr failure envelope is the locus of all shear and normal stresses at failure for a given rock material. The Mohr failure envelope delineates stable and unstable states of stress for a given rock material.

6.What are the disadvantages of direct shear test?

Failure occurs along a predetermined failure plane
Area of the sliding surface changes as the test progresses

Non-uniform distribution of shear stress along the failure surface

7.What are the types of triaxial test based on drainage consitions?



8. What is a stress path?

The stress path represents the change in horizontal stress as the pore pressure changes. In a producing reservoir the horizontal stress is reduced as the pore pressure is reduced, leading to an increase in effective stress. The relationship between the initial and present state of these two factors is known as the stress path (Q) and can in its simplest form be described as: $Q = (S_{initial} - S_{present}) / (PP_{initial} - PP_{depleted})$

PART - B

1. Explain in detail the determination of shear strength using direct shear test.

2. Explain in detail the determination of shear strength using unconfined compression test.

3. Explain in detail the determination of shear strength using triaxial shear test.

4. Explain in detail the determination of shear strength using vane shear test.

5. Explain the shear strength behavior of cohesive and cohesionless soils under different drainage condition in a triaxial test.

6. Explain in detail the stress path method of determination of shear strength parameters.

Unit V SLOPE STABILITY

1. Write a note on piping.

Piping and Subsurface Erosion.

Most piping failures are caused by subsurface erosion in or beneath dams. These failures can occur several months or even years after a dam is placed into operation.

In essence, water that comes out of the ground at the toe starts a process of erosion (if the exit gradient is high enough) that culminates in the formation of a tunnel-shaped passage (or "pipe") beneath the structure. When the passage finally works backward to meet the free water, a mixture of soil and water rushes through the passage, undermining the structure and flooding the channel below the dam. It has been shown that the danger of a piping failure due to subsurface erosion increases with decreasing grain size. Similar subsurface erosion problems can occur in relieved dry docks, where water is seeping from a free source to a drainage or filter blanket beneath the floor or behind the walls. If the filter fails or is defective and the hydraulic gradients are critical, serious concentrations of flow can result in large voids and eroded channels.

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7. Define liquid limit.

The transition from the liquid state to the plastic state is denoted as the liquid limit, wL. It represents the lowest water content at which the soil behavior is still mainly liquid.

8. What are methods available for determination of k for a soil sample?

- Constant Head permeability test
- Falling Head Permeability Test
- Horizontal Capillary Test.

9. Define effective stress.

Effective stress equals the total stress minus the pore water pressure, or the total force in the soil grains divided by the gross cross-sectional area over which the force acts.

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PART – B

1. Explain in detail the Swedish circle method of stability analysis.
2. Explain in detail the friction circle method of stability analysis.
3. Explain in detail the Bishop's method of stability analysis.
4. Explain in detail about Taylor's stability number and stability curves.
5. Explain in detail the various methods to protect slopes from failure.