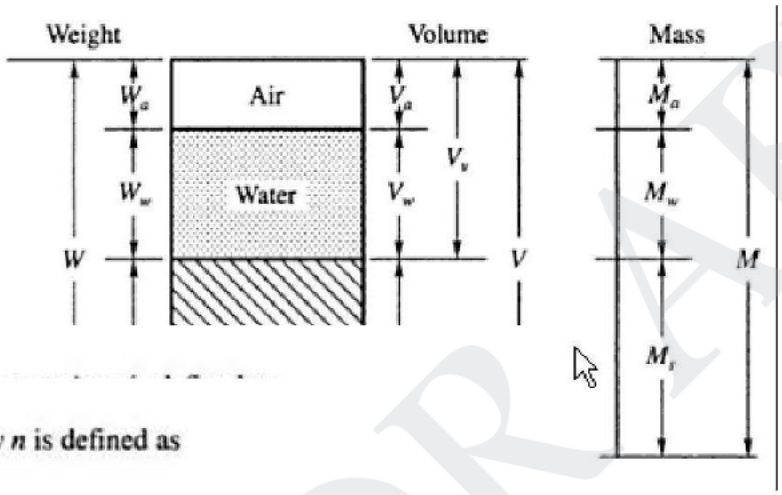
UNIT - I

1.Define Soil mechanics.

Soil mechanics is defined as the application of the laws and principles of mechanics and hydraulics to engineering problems dealing with soil as an engineering material

2) Draw the soil phase diagram.



The *porosity n* is defined as

$$n = \frac{V_v}{V} \times 100\%$$

I element

where, V = total volume of the soil sample. ·entage.

The *porosity n* is always expressed a *percentage*.

The porosity n is defined as

$$N = \frac{V_V}{V}$$

4) Define Voids Ratio.

The *void ratio, e*, is defined as

$$e = \frac{V_v}{}$$

The *void ratio, e*, is defined as

$$e = \frac{V_v}{V_s}$$

where, V_v = volume of voids, and V_s = volume of the solids.

The void ratio e is always expressed as a *decimal*.

5) Define degree of saturation.

The *degree of saturation* S is defined as

$$S = \frac{V_w}{V_v} \times 100\%$$

where, V_w = volume of water

It is always expressed as a *percentage*. When $S = 0\%$, the soil is completely dry, and when $S = 100\%$, the soil is fully saturated.

6) Define Percentage air voids.

Percent Air Voids

'Percent air voids' of a soil mass is defined as the ratio of the volume of air voids to the total volume of the soil mass. It is denoted by the letter symbol n_a and is commonly expressed as a percentage :

7) What is the relationship between unit weight & density

Unit weight or weight per unit volume is still the common measurement in geotechnical engineering practice. The density ρ, may be converted to unit weight, γ by using the relationship

$$\gamma = \rho g$$

The 'standard' value of g is 9.807 m/s^2 (= 9.81 m/s^2 for all practical purposes).

UNIT - II

1) Define water content.

The water content, w, of a soil mass is defined as the ratio of the mass of water, M_w, in the voids to the mass of solids, M_s, as

$$w = \frac{M_w}{M_s} \times 100$$

The water content, which is usually expressed as a percentage, can range from zero (dry soil) to several hundred percent. The natural water content for most soils is well under 100%, but for the soils of volcanic origin (for example bentonite) it can range up to 500% or more.

2) What are the factors affecting soil suction?

(a) The moisture held at fixed suction clearly increases with clay content. This is because both the number of small channels in which water is retained and also the total surface area of the particles increase as the proportion of finer constituents increases.

(b) The structure and bulk density of the soil also appear to affect the soil suction/moisture content relationship.

(c) Since the surface tension at an air/water interface decreases slightly with increase in temperature, the suction of soil water decrease in a similar manner.

3) Define capillarity?

The permeability of a soil is a measure of its capacity to allow the flow of a fluid through it. The fluid may be either liquid or a gas. In soil engineering we are concerned with liquid and that, too, water. Soil mass consists of solid particles with voids between them. In general, the voids are interconnected, which enables water to pass through them, that is, soil is 'permeable' to water.

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Q = the total quantity of water that flowed through the soil in elapsed time t
h = the total head lost

4) What is seepage pressure?

Seepage Pressures: Water percolating through any porous material exerts a pressure known as seepage pressure, which can be very high even when the rate of percolation is extremely small. To estimate seepage pressure, permeability of the material must be known. Seepage pressure affects the stability of earth structures, earth and concrete dams, retaining walls and subsurface structures.

5) State Darcy's law.

The flow of gravitational water through soil is called percolation of seepage and the property which permits such percolation is called permeability. As already mentioned, Darcy (1856) defined the law of rate of fluid flow through a permeable substance, suggesting that for a laminar flow condition in a saturated homogeneous soil, the rate of flow q across a sectional area A is proportional to the hydraulic gradient i. It is expressed as,

$$q \propto i$$
$$q = A\,k \cdot i$$

or

$$v = q/A = k \cdot i$$

where, v is velocity of flow; k the constant of proportionality.

6) Give the fomula for finding the value of k(variable head) in the laboratory.

$$k = 2.3\,\frac{aL}{A(t_1 - t_0)}\log_{10}\left(\frac{h_0}{h_1}\right)$$

a = the cross-sectional area of the standpipe
L = the length of soil sample in the permeameter
A = the cross-sectional area of the permeameter
t_0 = the time when the water level in the standpipe is at h_0
t_1 = the time when the water level in the standpipe is at h_1
h_0, h_1 = the heads between which the permeability is determined

7) Give the fomula for finding the value of k(constant head) in the laboratory.

$$k = \frac{QL}{tHA}$$

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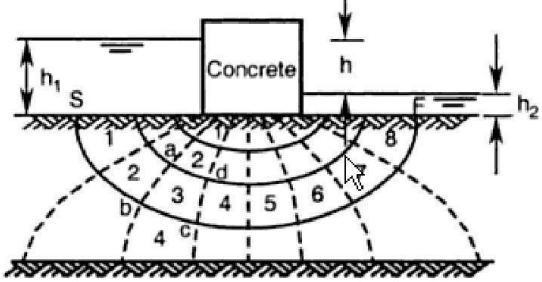
8) What is a flownet?

A flow net is a graphical representation of two-dimensional seepage and consists of two groups of curves of *flow lines* and *equipotential lines*



9) What is compaction?

The process by which the porosity of a given form of sediment is decreased as a result of its mineral grains being squeezed together by the weight of overlying sediment or by mechanical means.

10)What is shrinkage limit?

The shrinkage limit (SL) is the water content where further loss of moisture will not result in any more volume reduction.

11) Define Liquid limit.

The plastic limit (PL) is the water content where soil starts to exhibit plastic behavior. A thread of soil is at its plastic limit when it is rolled to a diameter of 3 mm and crumbles. To improve consistency, a 3 mm diameter rod is often used to gauge the thickness of the thread when conducting the test.

12) What is Plasticity Index?

The plasticity index (PI) is a measure of the plasticity of a soil. The plasticity index is the size of the range of water contents where the soil exhibits plastic properties. The PI is the difference between the liquid limit and the plastic limit (PI = LL-PL). Soils with a high PI tend to be clay, those with a lower PI tend to be silt, and those with a PI of 0 tend to have little or no silt or clay

13) Define the term Liquidity Index.

The liquidity index (LI) is used for scaling the natural water content of a soil sample to the limits. It can be calculated as a ratio of difference between natural water content, plastic limit, and plasticity index: LI=(W-PL)/(LL-PL) where W is the natural water content

14) Define effective stress.

Effective stress (σ') acting on a soil is calculated from two parameters, total stress (σ) and pore water pressure (u) according to Typically, for simple examples

15) What is pore pressure?

Pore water pressure refers to the pressure of groundwater held within a soil or rock, in gaps between particles (pores)

16) What is cohesion?

Cohesion is the component of shear strength of a rock or soil that is independent of interparticle friction.

17) What is overburden pressure?

Overburden pressure, lithostatic pressure, and vertical stress are terms that denote the pressure or stress imposed on a layer of soil or rock by the weight of overlying material.

18) Define Bulk Density?

It is defined as the mass of many particles of the material divided by the total volume they occupy

19) What is seepage?

Seepage is the flow of a fluid through soil pores.

20) What is the use of flownet?

The quantity of seepage under dams and sheet piling can be estimated using the graphical construction known as a flownet The Mohr-Coulomb failure criterion is the most common empirical failure criterion used in soil mechanics. In terms of effective stress the Mohr-Coulomb criterion is defined as

$$\tau_f = c' + \sigma'_f \tan \phi'$$

where τ_f is shear strength at failure, c' is effective cohesion, σ'_f is effective stress at failure, and ϕ' is the effective angle of friction, a parametrization of the average coefficient of friction μ on the sliding plane, where

$$\mu = tan\phi'$$

21) What are the various soil classification systems in practice?

Various Soil Classification Systems:

1- Geologic Soil Classification System
2- Agronomic Soil Classification System
3- Textural Soil Classification System (USDA)
4-American Association of State Highway Transportation Officials System (AASHTO)
5- Unified Soil Classification System (USCS)
6- American Society for Testing and Materials System

UNIT – 3

STRESS DISTRIBUTION

2 Mark – Questions

1. What are the assumptions of Boussinesq Equtions?

1. The soil mass is an elastic medium for which the modulus of Elasticity, E is constant.
2. The soil mass in homogeneous, that is all its constituent parts or elements are similar and it has indentical properties at every point in it in indentical directions.
3. The soil mass is isotropic, that is it has identical elastic properties in all directions through any point of it.
4. The soil mass is semi-infinite, that is it extends infinitely in all directions below a level surface.

2. Name the vertical stress distribution diagrams drawn using Boussinesq equation?

1. Vertical stress isobar diagram
2. Vertical pressure distribution on a horizontal plane.
3. Vertical pressure distribution on a vertical line.

3. Define isobar?

An isobar is a curved or contour connecting all points below the ground surface of equal vertical pressure.

4. Define pressure bulb?

The zone in a loaded soil mass bounded by an isobar of given vertical pressure intensity is called a pressure bulb.

5. Write equations of vertical pressure due to line load, strip load an d uniformly loaded circular area?

Line load

$$\sigma z = \frac{q}{z}\frac{2}{\pi}\frac{1}{1+\frac{x^2}{z}}$$

Strip load

At, O $\sigma z = \frac{q}{Z}[\alpha + \sin\alpha \cos\beta]$

$$\sigma z = \frac{q}{Z}[\alpha + \sin\alpha]$$

Vertical stress due to load on circular area

3 2

$$\sigma z == q\,1 - \frac{1}{1+\frac{R^2}{z}}$$

6. Write an equation of vertical pressure in uniformly loaded rectangular area?

$$\sigma z = q.\ \frac{1}{4}\ \frac{2mn(m^2+n^2+1)^{1/2}}{m^2+n^2+1+m^2n^2} X \frac{m^2+n^2+2}{m^2+n^2+1} + \tan^{-1}\frac{2mn(m^2+n^2+1)^{1/2}}{m^2+n^2+1-mn^2}$$

where $m = \frac{l}{z}$; $n = \frac{B}{z}$

7. Define Influence Value?

In Newmarks influence value a circle is drawn with radius r_1 equal to 0.270z and the are is divided into 20 area units, each area unit will produce a vertical stress equal to 0.005q at a depth of z cm below the centre. The arbitrarily fixed fraction 0.005 is called influence value.

8. What is the general equation for vertical stress in Newmarks influence chart?

$$\sigma z = NXqXInfluencevalue$$

where

q → intensity of loading

N → No. of area units under the loaded area.

9. Note down the westergaards equation for the vertical stress for a point load?

In this μ is assured as zero.

$$\sigma z = \frac{Q}{Z^2}\ \frac{1}{\left(1+2\frac{r^2}{z}\right)^{3/2}}$$

or

$$\sigma z = \frac{Q}{Z^2}\ kw$$

where

$$kw = \frac{1}{\left(1+2\frac{r^2}{z}\right)^{3/2}}$$

10. What are the disadvantages of settlement and the components affecting settlement?

If the settlement is excessive, meaning more than what is permissible for the structure, it may cause structural damage or malfunctioning, especially whent eh rate of such settlement is rapid. The total settlement St, of a loaded soil can be recognized as having three components: the immediate settlement Si, the settlement duet o primary consolidation Sc and the settlement due to secondary consolidation Ss or creep.

St = Si+Sc+Ss

11. Briefly explain about immediate settlement

The immediate settlement or distortion settlement occurs almost immediately after the load is imposed, as a result of disortion of the soil without any volume change. The immediate settlement is usually determined by using the elastic theory even though the deformation itself is not truly elastic.

12. Define consolidation?

According to Terzaghi : "Every process involving a decrease in the water content of a saturated soil without replacement of the water by air is called a process of consolidation.

13. What are the factors which cause the compressibility of clays?

i. The expulsion of double layer water from between the grains.

ii. Slipping of the particles to new positions of greater density.

iii. Bending of particles as elastic sheet.

14. Define hydrodynamic lag?

The delay caused in consolidation by the slow drainage of water out of a saturated soil mass is called hydrodynamic lag.

15. Define hydrodynamic pressure?

The pressure that builds up in pore water due to load increment on the soil is termed excess pore pressure or excess hydrostatic pressure.

16. Define primary consolidation?

The reduction in volume of soil which is due principally to a squeezing out of water from the voids is termed primary consolidation.

17. Define secondary consolidation?

Even after the reduction of all excess hydrostatic pressure to zero, some compression of soil takes place at a very slow rate. This is known as secondary consolidation. During secondary compression, some of the highly viscous water between the points of contact is forced out from between the particles.

18. Write an equation for consolidation settlement of a normally consolidated soil?

$$Sc = \frac{Cc}{1+Co} H \log \frac{\sigma^1 zf}{\sigma^1 zo}$$

where

Cc → compression index

Co → Initial voids ratio

H → Height of the soil

$\sigma^1 zf$ → Final vertical stress

$\sigma^1 zo$ → Initial vertical stress

19. Define coefficient of compressibility, a_v?

The coefficient of compressibility is defined as the decrease in voids ratio per unit increase of pressure.

20. Write any 5 assumptions of Terzaghi's theory of one dimeusional consolidation?

1. Compression and flow are one dimensional
2. Darcy's law is valid
3. The soil is homogeneous
4. The soil is completely saturated
5. The soil grains and water are both incompressible.

21. Define isochrone?

The distribution of excess hydrostatic pressure $\bar{u}$ at any time t is indicated by the curve, joining water levels, in the piezometric tubes; this curve is known as isochrone.

22. List down the factors affecting time factor and hence the degree of consolidation?

i. Thickness of clay layer.
ii. No. of drainage faces
iii. Coefficient of permeability, k.
iv. Cv, coefficient of consolidation
v. Magnitude of consolidating pressure
vi. The manner of its distribution across the thickness of the layer.

UNIT IV

SHER STRINGTH

1. What is shear strength?

It is the principle engineering property which controls the stability of a soil mass under loads. The shear stringth of soil is the resistance to deformations by continuous shear displacement of soil particles.

2. What are the factors that influence shear strength?

- resistance due to interlocking of particle
- frictional resistance between the individual soil grains which may be sliding friction, rolling friction.
- Adhesion between soil particle or cohesion.

3. What is principle plane and principle stress?

A principle plane is defined as a plane on which the stress is wholly normal on one. Which does not carry shearing stress.

From mechanics it is known that there exist three principle planes at any point in a stressed material. The normal stress acting on the principal plane are known as principal stresses.

4. What are shear stringth parameters?

c and φ

where c is known as apparent cohesion

φ is called angle of internal friction.

5. What are the limitations of rohr coulomb theory?

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

6. What are the difference to measure the shear stringth of soil?

1. Direct shear test
2. Friaxial shear test
3. Unconfined compression test
4. Vane shear test

7. What is rohr coulomb theory?

The rohr coulomb theory of shecuring stringth of a soil, first propounded by coulomb (1976) and later generalized by rohr, is the most commonly used concept. The functional relationship between the normal stress on any plane and the shearing strength available on that plane was assumed to be linear by colomb. Thus the following is usually known as coulomb's law.

$S = C + \sigma \tan d$

C = apparent cohesion

φ = internal friction

9. What is strength envelope?

It the normal and shear stress corresponding to failure are plotted, then a curve is obtained. The plot or the curve is called strength envelope.

10. What do you know about undrained and drained test?

In the underained test, no drainage of water is permitted. Hence there is no dissipation of pore pressure during the entire test. In the drained test, drainage is permitted throughout the test during the application of both normal and shear stress.

11. What are the field test to determine shear strength test?

- Field test
- Penetration test

12. What are the different types of soil based on shear stringth?

Cohesionless soil : These are the soils which do not have cohesion ie c=oo. These soils derive shear stringth from the intergranular friction. These soils are also called frictional soils.

eg : sand, gravel

Purely wherive soil : These are the soils which …… cohesion but the angle of shearing …… $\varphi = 0$.

eg: silts, saturated clay

13. What are the factors that affect shear stringth of cohesionless soils?

Shape of particles, gradation, confining, pressure, deviator stress, vibration and repeated loading, type of minerals.

14. what are the factors that affect shear strength of cohesive soils?

Structure of clay, clay content, drainage condition, rate of strain, repeated loading, confining pressure, plasticity index, disturbance.

15. What are the merits and demerits of direct shear test?

Merits

a. This is the only test where both the shearing stress and the normal stress on the plane of failure are measured directly.
b. Volume changes during the test can be measured easily.

Demerits

a. The shear stress distribution over the plane of failure is non-uniform
b. The drainage cannot be controlled, and so the pore pressure behaviour cannot be obtained from the test.

16. What are the different types of failure of a triaxcal compression test specimen?

Brittle failure

Semi plastic failure

Plastic failure

17. What do you mean by stress-path?

A stress-path is a curve or a straight line which is the locus of a series of stress points depicting the changes in stress in a test specimen or in a soil element in-situ, during loading or unloading.

18. What is peak shear strength? West out the factors it depends on?

Peak shear strength of a soil is the max shear stress that can be rested by the soil. It depends on percent day contact, drainage condition, stress level, anisotropy.

19. What is rohr's circle? What are the characteristics of rohr's circle?

The graphical method for the determination of stresses on a plane inclined to the principal stress is called rohr's wide.

The characteristics are

1. The maximum angle of obliquity β max is obtained by drawing a tangent to the circle from the origin o.
2. Shear stresses plane at right angle to each other are numerically equal but are of opposite signs.

20. Give the expression to find shear strength by vane shear test?

$$S = \frac{T}{\pi D^2 \frac{H}{2} + \frac{D}{12}}$$

T = Torque

D = Diameter of the vane

H = Height of vane

UNIT V

SLOPE STABILITY

1. What are the factors leading to the failure of slopes?

The factors leading to the failure of slope may be classified in to two categories.

a) The factors which cause an increase in the shear stresses loads, seepage pressure.
b) The factors which cause a decrease in the shear stresses. This is due to increase in water content, increase in pore water, weathering. or

The failure of slope occurs due to

i. The action of gravitational forces
ii. Seepage forces within the soil
iii. Excavation or undercutting of its foot, or due to gradual disintegration of the soil.

2. What is a land slide?

Failure involving downward or outward movement of portion of the soil is the case of natural slope is known as land slide.

3. What do you know about Infinite slope?

A Infinite slope is very large in extent and is theoretically infinite and the properties of the soil will be same at identical points.

4. What do you mean by Finite Slope?

A Finite slope is limited in extent and the properties of the soil will n't be same at identical depths. So that the slip surface may be curved.

5. What are the two basic types of slope failure – Define.

(1) Slope failure
(2) Base failure

(1) Slope failure:

If the failure occurs along a surface of sliding that intersects the slope at or above its toe, the slide is known as slope failure.

(2) Base failure:

If the failure occurs along a surface that is some distance below the toe of a slope is known as base failure.

6. What are the two types of slope failure?

1) Face failure
2) Toe failure

1) Face failure

If the failure occurs above the toe, then the failure is said to be face failure.

2) Toe failure

If the failure occurs through the toe, then the failure is said to be Toe failure.

7. Define Depth factor.

The ratio of total depth (H+D) to depth H is called depth factor (Df).

(1) For toe failure, Df = 1
(2) For base failure, Df > 1

8. What are the types of slip surface in a Finite slope.

1. Planar failure surface

2. Circular failure surface

3. Non circular failure surface

9. What are the different methods used for analysis of finite slope.

1. Culmann's method of planar failure surface

2. Swedish circle method (slip circle method)
3. Friction circle method

4. Bishop's method

10. What do you mean by planar failure?

Planar failure surface may commonly occur in a soil deposit or embankment with a specific plane of weakness. It is common in stratified deposit and the failure plane is 11el to the strata.

11. Where does a Noncircular (composite) slip surface occur in a homogenous dam?

1. Foundation of infinite depth

2. Rigid boundary planes of maximum or zero shear.

3. Presence of relatively stronger or weaker layes.

1. Presence of a soft layer in foundation

2. Use of different type of soil or rack in the dam section with varying strength and pore pressure condition.

3. Use of drainage blankets to facilitate dissipation of pore pressure.

13. Write down the assumptions made in the analysis of slope?

1. The stress is assumed to be two dimensional.

2. Coulomb equation for shear strength is applicable and parameters and Φ are known.

3. Seepage pressure was estimated from the assumed seepage conditions and water levels.

4. The conditions of plastic failure are assumed to be satisfied along the critical surface.

14. What are the three forces acting in circular failure while analysis through friction circle method?

1. Weight (w) of the sliding wedge
2. Cohesive force (C) developed along the slip surface
3. Reaction (R) on the slip surface

15. What do you mean by slide?

The failure of a mass of soil located beneath a slope a called a slide.

16. Why does a slope be analysed?

The failure of slope is analysed thoroughly since their failure may lead to loss of human life as well as colossal economic loss.

17. Define Stability number?

The force causing instability is the weight of the wedge which I equal to unit weight γ and the area of the wedge which I proportional to the square of the height H. It is a dimensionless quantity.

$$Sn = \frac{C}{FC\,\gamma\,H}$$

Sn =Stability number

Fc – Factor of safety

γ - unit weight

H – Height of the scope

18. What are the Factor of safety used in stability Analysis of slopes?

1. Factor of safety with respect to cohesion assuming to be fully mobilized.
2. Factor of safety with respect to friction assuming to be fully mobilized.
3. Factor of safety with respect to shear strength
4. Factor of safety with respect to height.

19. Write down the formula for calculating factor of safety with respect t cohesion?

$$Fc = \frac{C}{cm}$$ (assuming friction to be fully mobilisede)

Fc – Factpr pf safetu wotj res[ect tp cpjesopm

C – ultimate cohesion

cm – mobilized cohesion

20. Write down the formulae for calculating factor of safety with respect to friction?

$$F\varphi = \frac{\tan\varphi}{\tan\varphi m} = \frac{\varphi}{\varphi m}$$ (assuming cohesion to be fully mobilized)

φ - ultimate angle of shearing resistance

φm – mobilised angle of shearing resistance.