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Internal Assessment Test 1 – November. 2022

Sub:	Basic Geotechnical Engineering					Sub Code:	18CV54	Branch:	Civil Engg	
Date:	07.11.2022	Duration:	90 min's	Max Marks:	50	Sem / Sec:	5 A		OBE	

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1 (a)	Discuss about history of soil engineering. And Describe soil formation in geological cycle.	[10]	CO1	L2
2 (a)	Explain in detail with neat sketches: Three phase diagram of soil.	[10]	CO1	L2
3 (a)	With the help of Phase diagram of soil, define 1. Void ratio 2. Porosity 3. Degree of Saturation 4. Water content. 5. Specific gravity	[10]	CO1	L1
4 (a)	Define 1. Liquid limit 2. Plastic limit 3. Shrinkage limit. 4. Plasticity 5. Plasticity index	[10]	CO1	L1
5 (a)	Derive the relationship between G, e, S & w? Or Derive Se=wG	[10]	CO2	L2
6 (a)	A soil sample has a porosity of 40%. The specific gravity of solids is 2.70. Calculate 1. Voids ration 2. Dry density 3. Unit weight if the soil is 50% saturated and 4. Unit weight if the soil is completely saturated.	[10]	CO2	L3
7 (a)	Explain the Indian Soil classification system.	[10]	CO2	L2

IAT 1 scheme &solution
Subject: Basic Geotechnical Engineering (18CV54)

1. Describe in detail: Soil Formation in Geological cycle.

Answer: Soil mechanics is a branch of soil physics and applied mechanics that describes the behavior of soils. It differs from fluid mechanics and solid mechanics in the sense that soils consist of a heterogeneous mixture of fluids (usually air and water) and particles (usually clay, silt, sand, and gravel) but soil may also contain organic solids and other matter. 1M

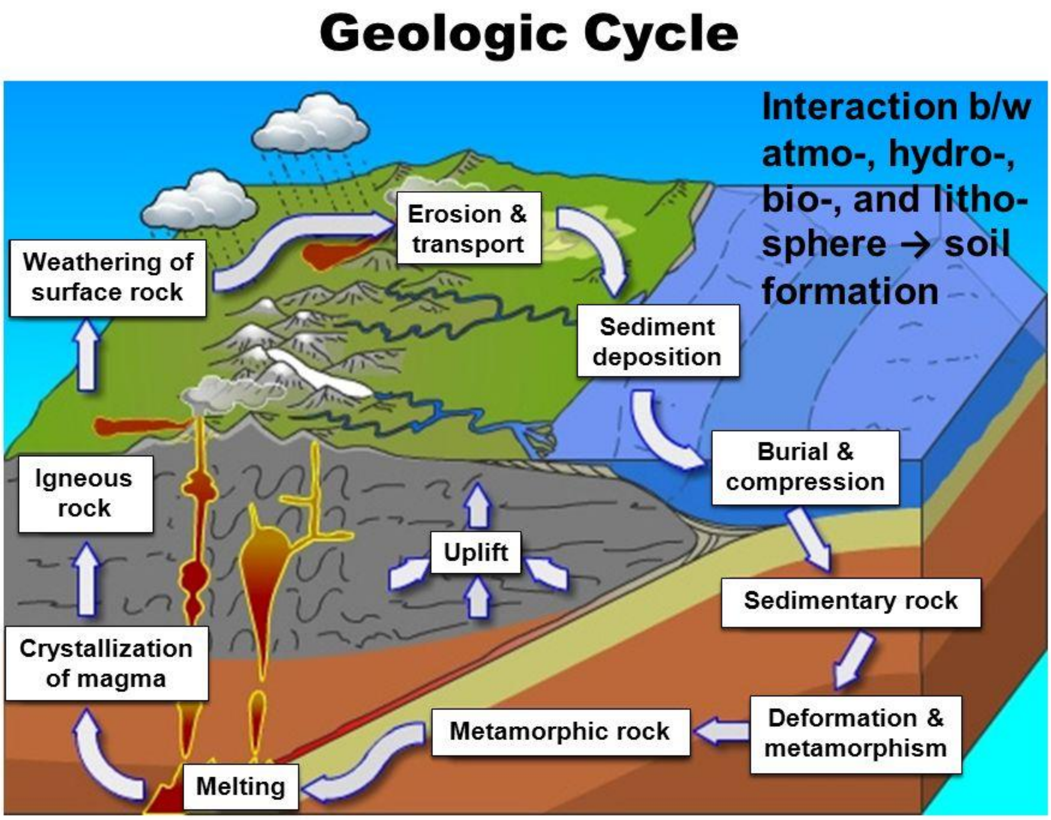
Soil Mechanics is one of the subjects of Civil Engineering involving the study of soil, its behavior and application as an engineering material. According to Terzaghi : "Soil Mechanics is the application of laws of mechanics and hydraulics to engineering problems dealing with sediments and other unconsolidated accumulations of solid particles produced by the mechanical and chemical deformation and transformation of rocks regardless of whether or not they contain an admixture of an organic constituent." 2M

Formation of soils

Soil formation, or pedogenesis, is the combined effect of physical, chemical, biological and anthropogenic processes working on soil parent material. Soil is said to be formed when organic matter has accumulated and colloids are washed downward, leaving deposits of clay, humus, iron oxide, carbonate, and gypsum, producing a distinct layer called the B horizon. This is a somewhat arbitrary definition as mixtures of sand, silt, clay and humus will support biological and agricultural activity before that time. These constituents are moved from one level to another by water and animal activity. As a result, layers (horizons) form in the soil profile. The alteration and movement of materials within a soil causes the formation of distinctive soil horizons. 2M

The weathering of parent material takes the form of physical weathering (disintegration), chemical weathering (decomposition) and chemical transformation. Generally, minerals that are formed under high temperatures and pressures at great depths within the Earth's mantle are less resistant to weathering, while minerals formed at low temperature and pressure environment of the surface are more resistant to weathering.[citation needed] Weathering is usually confined to the top few meters of

geologic material, because physical, chemical, and biological stresses and fluctuations generally decrease with depth. 2M

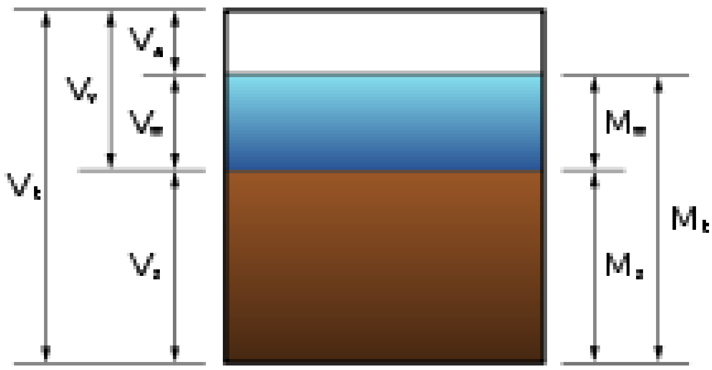


3M

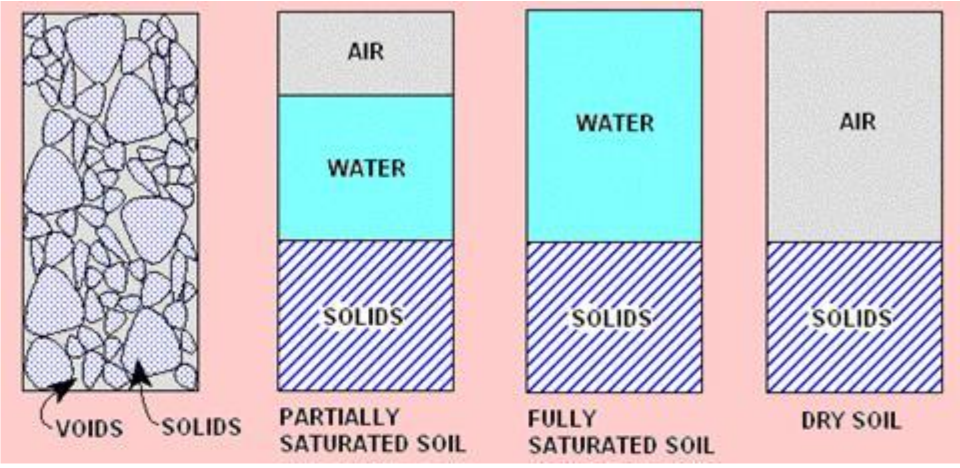
2. Explain in detail with neat sketches: Three phase diagram of soil

Answer:

Soil structure & Three phase system



2M



2M

For the purpose of engineering analysis and design, it is necessary to express relations between the weights and the volumes of the three phases.
The various relations can be grouped into:

1. **Volume relations**
2. **Weight relations**
3. **Inter-relations** **1M**

As the amounts of both water and air are variable, the volume of solids is taken as the reference quantity. Thus, several relational volumetric quantities may be defined. The following are the basic volume relations:

$$e = \frac{V_V}{V_S}$$

1. **Void ratio (e) is the ratio of the volume of voids (Vv) to the volume of soil solids (Vs), and 2.5M**
2. **Porosity (n) is the ratio of the volume of voids to the total volume of soil (V), and is expressed as a percentage.**

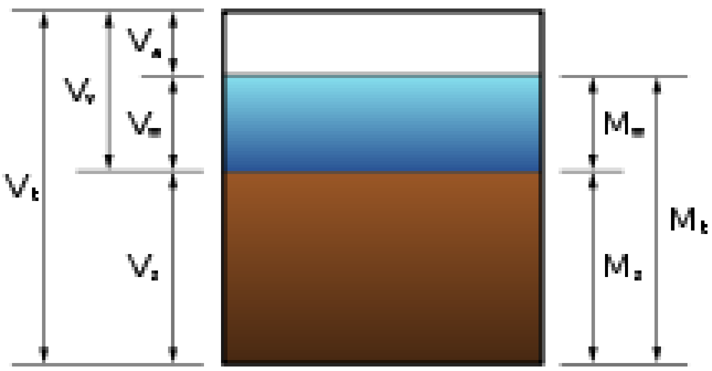
   $$n = \frac{V_V}{V} x\,100$$

   Void ratio and porosity are inter-related to each other as follows:

   $$e = \frac{n}{1-n}$$

   2.5M
3. **With the help of Phase diagram of soil, define 1. Void ratio 2. Porosity 3. Degree of Saturation 4. Water content. 5. Specific gravity.**

Answer:
Soil structure & Three phase system



1. **Void ratio (e) is the ratio of the volume of voids (Vv) to the volume of soil solids (Vs), and** $e = \frac{V_V}{V_S}$

   1M

2. **Porosity (n) is the ratio of the volume of voids to the total volume of soil (V), and is expressed as a percentage.**

   $$n = \frac{V_V}{V} x\,100$$

   1M

   Void ratio and porosity are inter-related to each other as follows:

   $$e = \frac{n}{1-n}$$

   1M

3. **The volume of water (Vw) in a soil can vary between zero (i.e. a dry soil) and the volume of voids. This can be expressed as the degree of saturation (S) in percentage.**

   $$S = \frac{V_W}{V_V} x\,100$$

   1M

4. **The water content (w) of the soil is defined as the ratio of weight of water to the weight of solids present in soil sample.**

   $w = \{W_w / W_s\}*100$ **1M**

5. **Specific gravity is the ratio of the weight in air of a given volume of a material at a standard temperature to the weight in air of an equal volume of distilled water at the same stated temperature. 1M**

4. **Define 1. Liquid limit 2. Plastic limit 3. Shrinkage limit. 4. Plasticity 5. Plasticity index**

Answer:
The liquid limit is the water content at the transition of liquid state to a plastic state, whereby it gains a certain small shearing strength. It is the minimum water content at which the soil is at the liquid state or the maximum water content at which the soil is in a plastic state. 1M
The plastic limit is the minimum moisture content at which the soil can be deformed plastically. As standardized, it can be taken as the smallest water content at which the soil begins to crumble when rolled out into thin threads, approximately 3mm in diameter. That is at the plastic limit the soil must gain some minimum stiffness or strength. 1M
The shrinkage limit is the smallest water content below which a soil sample will not reduce its volume any, that is, it will not shrink any further with further drying. It is the maximum water content below which there is no volume change when the soil is dried. It is the minimum water content at which the soil can be saturated. 1M
Plasticity of soil is defined as the property of cohesive soil which possess the ability to undergo changes of shape without rupture or a change in volume. 1M
Plasticity Index is the range of water content over which a soil behaves plastically. It indicates the degree of plasticity of the soil. PI is the difference between the liquid limit and the plastic limit. Greater the difference, greater is the plasticity of the soil. 1M

5. **Derive the relationship between G, e, S & w? Or Derive Se=wG**

Answer:

Relationships among Unit Weight, Void Ratio, Moisture Content, and Specific Gravity

The unit weight and dry unit weight can be calculated as below:

$$\gamma = \frac{W}{V} = \frac{W_s + W_w}{V} = \frac{G_s\gamma_w + wG_s\gamma_w}{1+e} = \frac{(1+w)G_s\gamma_w}{1+e}$$

$$\gamma_d = \frac{W_s}{V} = \frac{G_s\gamma_w}{1+e} \Rightarrow e = \frac{G_s\gamma_w}{\gamma_d} - 1$$

$$V_w = \frac{W_s}{\gamma_w} = \frac{wG_s\gamma_w}{\gamma_w} = wG_s$$

$$S = \frac{V_w}{V_s} = \frac{wG_s}{e} \Rightarrow S_r e = wG_s$$

10M

6. **A soil sample has a porosity of 40%. The specific gravity of solids is 2.70. Calculate 1. Voids ration 2. Dry density 3. Unit weight if the soil is 50% saturated and 4. Unit weight if the soil is completely saturated.**

Answer:

Example 2.1. *A soil sample has a porosity of 40 per cent. The specific gravity of solids is 2.70. Calculate (a) voids ratio, (b) dry density, (c) unit weight if the soil is 50% saturated and (d) unit weight if the soil is completely saturated.*

Solution : Given, $n = 40\ \% = 0.4$; $G = 2.70$

(a) We have $e = \frac{n}{1-n} = \frac{0.4}{1-0.4} = \mathbf{0.667}$

(b) $\gamma_d = \frac{G\gamma_w}{1+e} = \frac{2.7 \times 9.81}{1+0.667} = \mathbf{15.89\ kN/m^3}$ (Taking $\gamma_w = 9.81\ kN/m^3$)

(c) $e = \frac{wG}{S}$ or $w = \frac{eS}{G} = \frac{0.667 \times 0.5}{2.70} = 0.124$

$\gamma_d = 15.89\ kN/m^3$ (as before)

$\therefore$ $\gamma = \gamma_d(1+w) = 15.89 \times 1.124 = \mathbf{17.85\ kN/m^3}$

Check : $\gamma = \frac{\gamma_w(G+eS)}{1+e} = \frac{9.81\ (2.70 + 0.667 \times 0.5)}{1+0.667} = \mathbf{17.85\ kN/m^3}$

(d) When the soil is fully saturated, $e = w_{sat} \cdot G$

$\therefore$ $w_{sat} = \frac{e}{G} = \frac{0.667}{2.70} = 0.247$

$\therefore$ $\gamma_{sat} = \gamma_d(1+w_{sat}) = 15.89 \times 1.247 = \mathbf{19.81\ kN/m^3}$

Alternatively, $\gamma_{sat} = G\gamma_w(1-n) + \gamma_w n = 2.7 \times 9.81\ (1-0.4) + 9.81 \times 0.4$

$= 15.89 + 3.92 = \mathbf{19.81\ kN/m^3}$

10M

7. **Explain the Indian Soil classification system.**

Answer:

Indian Standard Soil Classification System (ISSCS):

The Indian soil classification system is basically the same as that of USCS with the slight modification that the fine grained soil have been subdivided into three sub-groups of low, medium and high compressibility.

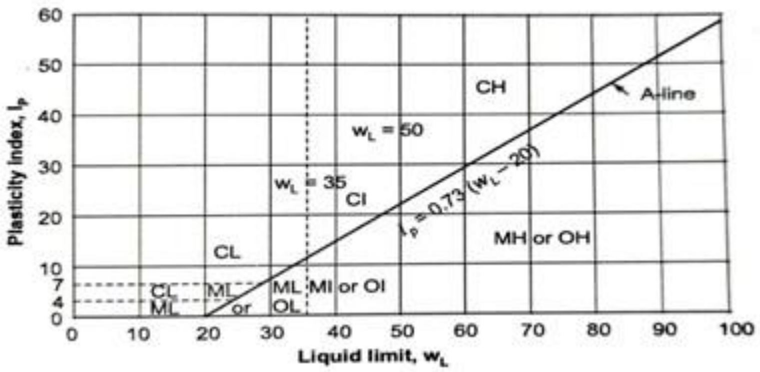
In this system, coarse grain soils are classified on the basis of grain size distribution and fine soils on the basis of plasticity. **1M**

		Soils

Boulder (mm)	Cobble (mm)	Coarse grained soil					Fine Grained soil	
		Gravel		Sand			Silt (mm)	Clay (mm)
		Coarse (mm)	Fine (mm)	Coarse (mm)	Medium (mm)	Fine (mm)		
>300	300-80	20-80	4.75-20	2-4.75	0.425-2.0	0.075-0.425	0.002-0.075	<0.002

I.S. Classification (grain size distribution) 4M

The fine grained soils are classified on the basis of their plasticity characteristics using the I.S. plasticity chart.



2M

Fig: Plasticity chart as per Indian Soil Classification System

Coarse grained soils which contain more than 12% fines (<75 μ) are classified as GM or SM if the fines are silty in character; they are classified as GC or SC if the fines are clayey in character.

Coarse-grained soils having 5% to 12% fines are borderline cases and given a dual symbol. Fine grained soil also can have dual symbols if I_P and W_L values fall close to the A-line.
The above soil classification is based on a line called A-line, which is a boundary representing relationship between plasticity index I_P and liquid limit W_L
If I_P of soil> I_P of A-line
The soil will be above A-line and it will be clay(C)
If I_P of soil< I_P of A-line
The soil will be below A-line and it may be either silt(M) or organic clay(OI)

The I_P of A-line is given by $I_P=0.73(W_L-20)$
Where, W_L is the liquid limit. 3M