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Internal Assessment Test 2 – December. 2022

Sub:	Basic Geotechnical Engineering				Sub Code:	18CV54	Branch:	Civil Engg
Date:	03.12.2022	Duration:	90 min's	Max Marks: 50	Sem / Sec:	5 A		OBE

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1 (a)	Explain with neat sketches: the common clay minerals.	[10]	CO2	L3
2 (a)	Explain Electrical Diffuse double layer in detail.	[10]	CO2	L3
3 (a)	Diffentiate between Standard and Modified compaction tests.	[10]	CO2	L2
4 (a)	Explain anyone laboratory permeability test for soil.	[10]	CO3	L3
5 (a)	Briefly explain how water content, compactive effort & type of soil affect compaction	[10]	CO2	L3
6 (a)	The following data was obtained from standard proctor compaction test:	[10]	CO2	L3

Water content (%)	5.90	7.50	9.70	11.65	13.85
Weight of wet sample N	18.20	19.50	20.10	20.00	19.70

G=2.70, Volume of mould = $9.5 \times 10^{-4} m^3$. Plot the compaction curve & zero air voids line. ine OMC and MDD.

7 (a)	Define Permeability. Explain factors affecting permeability of soil in detail.	[10]	CO3	L2

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Subject: Basic Geotechnical Engineering (18CV54)

1. Explain with neat sketches: the common clay minerals.

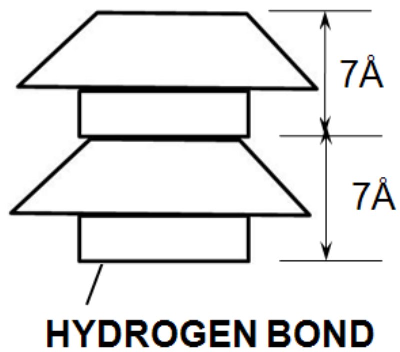
Answer:

CLAY MINERALS:

1. **Kaolinite Mineral:**

Kaolinite is the most common mineral of the kaolinite group of minerals. Its basic structural unit consists of alumina sheet (G) combined with a silica sheet (S) . Tips of the silica sheet and one base of the alumina sheet form a common interface. The total thickness of the structural unit is about 7 Angstrom (Å), here one Å = 10 $^{-10}$ m or 10 $^{-7}$

mm. The kaolinite mineral is formed by stacking, one over the other, several such basic structural units.



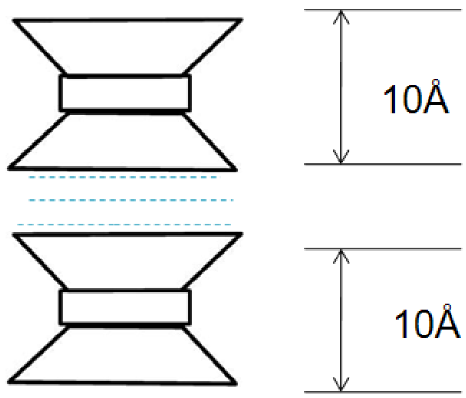
The Structural units join together by hydrogen bond, which develops between the oxygen of silica sheet and the hydroxyles of alumina sheet. As the bond is fairly strong, the mineral is stable. Moreover, water cannot easily enter between the structural units. So, expansion or swelling will not take place. 3.5M

2. <u>Montmorillonite:</u>

Montmorillonite is the most common mineral of the Montmorillonite group of minerals. The basic structural unit consists of an alumina sheet sandwiched between two silica sheets; Successive structural units are stacked one over another, like leaves of a book. Fig shows two such structural units. The thickness of each structural unit is about 10Å.

The two successive structural units are joined together by a link between oxygen ions of the two silica sheets. The link is due to natural attraction for the cations in the intervening space and due to Vander Waal force. The negatively charged surfaces of the silica sheet attract water in the space between structural units. This results in expansion of the mineral. It may also cause dissociation of the mineral into individual structural units of thickness 10Å. The soil containing a large amount of mineral

Montmorillonite exhibits high shrinkage and high swelling characteristics. The water in the intervening space can be removed by heating to 200^0 - 300^0C.



Montmorillonite

3.5M

. <u>Illite Mineral:</u>

Illite is the main mineral of the illite group. The basic structural unit is similar to that of the mineral montmorillonite. However, the mineral has properties different from montmorillonite due to following reasons.

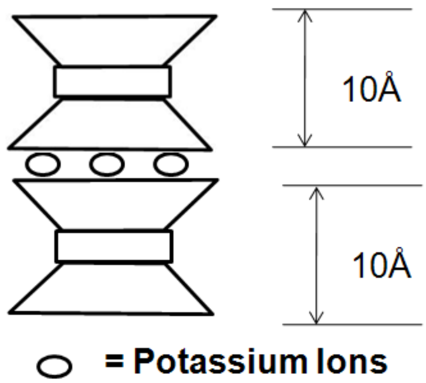
a. There is always a substantial amount of isomorphous substitution of silicon by aluminum in silica sheet. Consequently, the mineral has a larger negative charge than that in montmorillonite.

b. The link between different structural units is through non-exchangeable potassium (K^+) and not through water. This bonds the units more firmly than in montmorillonite.

c. The lattice of illite is stronger than that of montmorillonite and is therefore less susceptible to change.

d. Illite swells less than montmorillonite. However, selling is more than in kaolinite.

e. The space between different structural units is much smaller than in montmorillonite, as the potassium ion just fit between the silica sheet surfaces.



3M

2. Explain Electrical Diffuse double layer in detail.

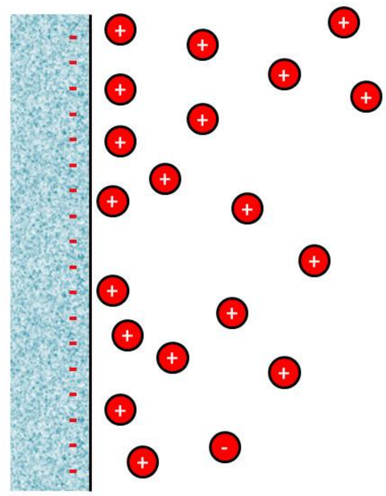
Answer:

Diffuse double layer:

The faces of clay minerals carry a net negative charge because of which the clay particles attract cations in presence of moisture and reach an electrical balanced equilibrium. These cations in turn, attract particles with negative charges and water dipoles. The cations attracted to a clay mineral surface also try to move away from the surface because of their thermal energy. 3.5M

The net effect of the forces due to attraction and that due to repulsion is that the forces of attraction decrease exponentially with an increase in distance from the clay particles surface. It is believed that immediately surrounding the particle, there is a thin, very tightly held layer about 10Å thick. Beyond this thickness there is a second layer, in which water is mobile. This second layer extends to the limit of attraction. The layer the clay particle surface to the limit of attraction is known as diffuse double layer.

3.5M



Diffuse Double Layer

In other words, Base Exchange capacity is the capacity of the clay particles to change the cation adsorbed on the surface. 3M

3. Differentiate between Standard and Modified compaction tests.

Answer:

Standard Proctor Test	**Modified Proctor Test**
305 mm height of drop	450 mm height of drop
25 N hammer	45 N hammer
25 blows/layer	25 blows/layer
3 layers	5 layers
Mould size: 945 ml	Mould size: 945 ml
Energy 605160 N-mm per m^3	Energy 2726000 N-mm per m^3

1M each

4. **Explain anyone laboratory permeability test for soil.**

Answer: Falling or Variable head Permeability test:

- **The falling-head permeability test is more suitable for fine-grained soils.**
- **Figure shows the general laboratory arrangement for the test.**
- **The soil specimen is placed inside a tube, and a standpipe is attached to the top of the specimen. Water from the standpipe is let to flow through the soil specimen.**
- **The initial head difference h_1 at time $t = t_1$ is recorded, and water is allowed to flow through the soil such that the final head difference at time $t = t_2$ is h_2.** **3M**

The rate of flow through soil is

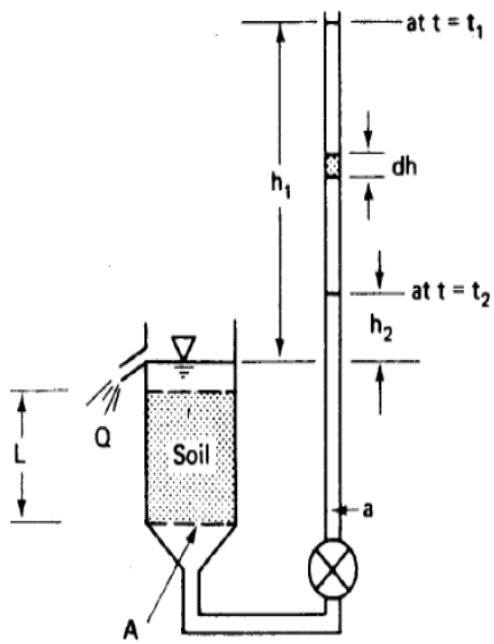
Velocity of fall of water level; $v = -\frac{dh}{dt}$

Flow of water into the sample; $q_{in} = -a\frac{dh}{dt}$

From Darcy's law flow out of the sample; $q_{out} = kiA = k\frac{h}{L}A$

For continuity; $q_{in} = q_{out}$

$$\Rightarrow \; -a\frac{dh}{dt} = k\frac{h}{L}A$$



4M

Seperating the variables and integrating over the limits,

$$\Rightarrow \quad a\int_{h_2}^{h_1} \frac{dh}{h} = k\frac{A}{L}\int_{t_2}^{t_1} dt;$$

$$\Rightarrow \quad a\ln\left(\frac{h_1}{h_2}\right) = k\frac{A}{L}(t_1 - t_2)$$

$$\Rightarrow \quad k = \frac{aL}{At}\ln\left(\frac{h_1}{h_2}\right)$$

where $t = t_1 - t_2$, interms of $(\log_{10})$

$$\Rightarrow k = 2.303\frac{aL}{At}\log_{10}\left(\frac{h_1}{h_2}\right)$$

3M

5. Briefly explain how water content, compactive effort & type of soil affect compaction

Answer:

Water Content

1. With increase in water content, compacted density increases up to a stage, beyond which compacted density decreases.

2. The maximum density achieved is called MDD and the corresponding water content is called OMC.

3. Particles slide over each other easily increasing lubrication, helping in dense packing.

4. After OMC is reached, air voids remain constant. Further increase in water, increases the void space, thereby decreasing dry density. 3M

Compactive effort

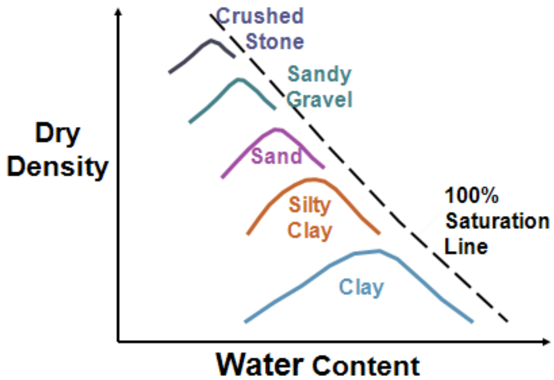
1. Effect of increasing compactive effort is to increase MDD And reduce OMC (Evident from Standard & Modified Proctor's Tests).

2. However, there is no linear relationship between compactive effort and MDD 3M

Effect of type of Soil

1. Maximum density achieved depends on type of soil.

2. Coarse grained soil achieves higher density at lower water content and fine grained soil achieves lesser density, but at higher water content.



4M

6. The following data was obtained from standard proctor compaction test:

Water content (%)	**5.90**	**7.50**	**9.70**	**11.65**	**13.85**
Weight of wet sample N	**18.20**	**19.50**	**20.10**	**20.00**	**19.70**

G=2.70, Volume of mould = $9.5 \times 10^{-4} m^3$. Plot the compaction curve & zero air voids line. Determine OMC and MDD

Answer:

Water content (%)	**5.90**	**7.50**	**9.70**	**11.65**	**13.85**
Weight of wet sample N	**18.20**	**19.50**	**20.10**	**20.00**	**19.70**
Bulk unit weight(kN/m^3) γ	**19.16**	**20.53**	**21.16**	**21.05**	**20.74**
Dry unit weight γd	**18.09**	**19.09**	**19.29**	**18.85**	**18.22**

8M

For each reading γ = M/V and $\gamma d = \gamma 1 + w$

For eg. γd=19.81+0.083=18.09 kN/m3
1M

MDD = 19.40 kN/m3
OMC = 9.5%
1M

7. Define Permeability. Explain factors affecting permeability of soil in detail.
Answer:

The property of a porous medium such as soil by virtue of which water can flow through it is called its permeability. 1M

The different factors affecting permeability are
(a) Particle size
(b) Structure of soil mass
(c) Shape of particles
(d) Void ratio
(e) Properties of water
(f) Degree of saturation
(g) Adsorbed water
(h) Impurities in water 1M

For a laminar flow, coefficient of permeability of soil can be given as k=[$\gamma w \mu$][e31+e]D2
This expression can be used to explain the different factors affecting permeability.

i. Particle size:
Coefficient of permeability varies approximately as the square of the grain size. It depends on the effective diameter of the grain size i.e., D10.
K=CD102
ii. Structure of soil mass:
The coefficient C, takes into account the shape of flow passage. The size of flow passage depends upon the structural arrangement. For the same void ratio, the permeability is more in case of flocculated structure as compared to dispersed structure.
iii. Shape of particles
Angular particles have greater specific surface area as compared to rounded particles. For the same void ratio, angular particles are less permeable than those with rounded particles as the permeability is inversely proportional to specific surface.
iv. Void ratio
k α e31+e
Greater the void ratio, greater is the permeability.

v. Properties of water
k α $\gamma w \mu$
Coefficient of permeability is directly dependent on unit weight of water and inversely proportional to its viscosity. Since viscosity is dependent upon temperature, coefficient of permeability is dependent upon temperature.

vi. Degree of saturation

Presence of air in soil causes blockage to the flow of water. So if the soil is not saturated, coefficient of permeability decreases.

vii. Adsorbed water

Fine grained soils have a layer of adsorbed water around it and this will not mover under gravity. It causes an obstruction to flow passage. Thus coefficient of permeability decreases with presence of adsorbed water. **1M for at least 5 points.**