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Study on Stabilization of Soil by Electro-Kinetic Method

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ABSTRACT:*Electro-kinetic stabilization (EKS) of soil is a ground improvement technique. The procedure of providing an electrical current through a soil mass that has to be stabilized in order to migrate charged particles in the soil to change the properties, leading to an overall stabilization of the soil is called as electro-kinetic stabilization.*

In this present study EKS process is used to stabilize the Black cotton soil, which is less permeable.These soils under consideration, in any construction site, can me named as expansive soils or dispersive soils, high compressible soil etc.This technique aims to improve the physical properties of Black cotton soil, in turn improves the strength of soil for all construction purposes.

Keywords: Electro Kinetic Stabilization, Black Cotton soil, Stabilization, Strength.

INTRODUCTION:

Black cotton soil is having low permeability, low strength, and low bearing capacity. Because of this it requires stabilization of black cotton soil before going to start any civil Engineering project. For this purpose we may go for machine compaction or removing that existing soft problematic soil. Sometimes it is not possible to go for compaction methods due to complicated area and high water table. In this paper an attempt has been shown based on Electro osmosis process, which is used to improve the properties of Black Cotton Soil. EKS process is one of the best method used to improve the properties of Black cotton soil and also increases the strength of soil. From various study it is proved that, it is one of the economical method and effective method to strengthen Black Cotton soil in a very simple manner without disturbing the further site activities. In this process electric current is passed through the soil mass with the help of certain charged electrodes. Migration of charged particles changes the soil properties and hence helps in stabilization of Black Cotton soil.

ELECTROKINETIC PHENOMENA

This chapter provides details of fundamental study Electro-kinetic process. It includes mechanisms taking place in Electrokinetic process, through presenting the relevant literature which cover physical and chemical behaviors of clays, clay-water electrolytes system, the types of flow, electro-kinetic phenomena and electrochemical effects.

The Following 4 Mechanisms will take place during electro-kinetic process:

- Electrolysis
- Electro-osmosis
- Electrophoresis
- Electro migration

Electrolysis: Itis the process of diffusion of ions into the solution under the action of the applied electric field. Application of direct current through electrodes immersed in water induces electrolysis reactions at the electrodes. Oxidation of water at the anode result in the release of oxygen and hydrogen ions while reduction

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of water at the cathode result in the formation of hydrogen and hydroxide ions as described by the following electrolysis reactions,

$$\text{Anode: } 2H_2O - 4e \rightarrow O_2\uparrow + 4H$$

$$\text{Cathode: } 2H_2O + 2e \rightarrow H_2\uparrow + 2OH$$

Electro- osmosis:It is the movement of water resulting from the application of a direct current through porous medium. When an electric current is applied through saturated fine-grained soil between two electrodes, water contained in the soil migrates from positive charge electrode (anode) to the negative charged electrode (cathode). This results in dewatering and consolidation of the soil mass. The method can reduce the water content of the soil, thereby increasing its strength.

Electrophoresis: It is the process of formation of Double Diffused layer. When the potential difference is applied to the whole system by means of a direct current, there is a possibility that some of the positively charged particles get adsorbed on the clay (negatively charged)

Electron-Migration: It is the process of movement of charged particles towards opposite electrodes.

EXPERIMENTAL WORK

In order to study the Electro-Kinetic phenomena in Black Cotton soil following Preliminary tests are carried out and results are shown in below table1.

Table 1. Properties of BC Soil Sample before treatment.

Sl. No	Property	Results
1	Liquid Limit (%)	62
2	Plastic Limit (%)	20
3	Swelling Index (%)	14
4	MDD (gm/cm)	1.7

Experimental setup

Experimental setup consists of Glass container, Electrodes, RPS/Transformer to convert AC input to DC output.

1. Glass Container

The size of glass container is 290*200*300 mm as shown in Fig 1. The soil sample of varying initial moisture content will be placed in the container up to a height of 10cm by hand remolding. At the both end, provision is given at the bottom of box to collect the drained water during the process of passage of current across the soil sample. The voltmeter is provided to measure the voltage applied. The voltage can be varied as 40 V and 80 V.

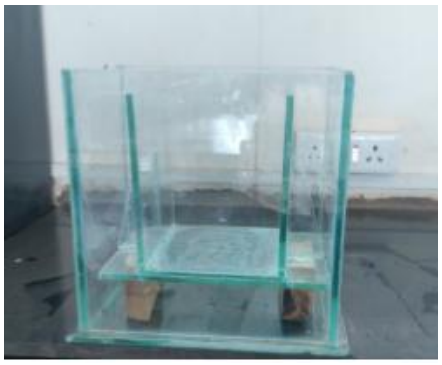

Fig 1:Glass Container

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2. Electrode

Electrodes are used to transmit the electric current into soil sample. 2 Number of Aluminium plates of size 200*100mm are used. The electrodes have good conductivity property, are shown in Figure No. 2.

Fig 2: Aluminium Electrodes

3. Transformer

Transformer is used to convert the AC input to DC output, which is shown in Figure No.3 and has a capacity of varying output from 40V to 100V.

Fig 3: Transformer

Experiment is carried for 2kg of soil sample. Added 50% of water mixed thoroughly and filled in the middle compartment. Electrodes were inserted into the soil sample at distance 5 and10cm apart as shown in Figure No. 4.Voltage supply is varied from 20V to 80V. The heat produced due to Electric current will evaporate the water and dewatering process takes place. Time taken for the evaporation of water is noted down.

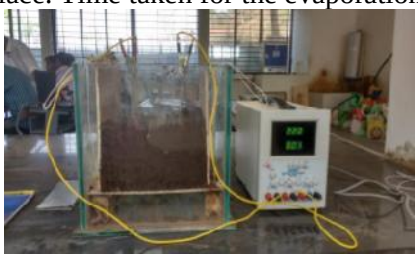

Fig 4: Experimental Set-up

The time taken for the evaporation of complete water is shown in below Table No. 2, at spacing of electrodes 10cm apart with varying voltage.

Table 2. Time Taken for the evaporation of water at 10 cm spacing between Electrodes.

Voltage (V)	Spacing between electrodes	Time Taken for complete Evaporation of water	Moisture Content
20	10 cm	Longer time(More than 8 hours)	50%
30			
40			
50		4 hours 10 min.	
60		2 hours 30 min.	
70		1 hours 55 min.	
80		1 hour 35 min.	

Similarly time taken for the evaporation of complete water is shown in below Table No. 3, at spacing of electrodes 5cm apart with varying voltage with 50% of water content.

Table 3. Time Taken for the evaporation of water at 5 cm spacing between Electrodes.

Voltage (V)	Spacing between electrodes	Time Taken for complete Evaporation of water	Moisture Content
20	5 cm	Longer time(More than 8 hours)	50%
30			
40			
50		3 hours 40 min.	
60		2 hours 10 min.	
70		1 hours 30 min.	
80		1 hour 5 min.	

Again same sample is collected back to study the changes in soil properties and the results are shown in below Table No.4

Table 4. Properties of BC Soil Sample After treatment.

Sl. No	Property	Results
1	Liquid Limit (%)	45
2	Plastic Limit (%)	22
3	Swelling Index (%)	5.5
4	MDD (gm/cm)	2.1

CONCLUSION

From the experimental results it is concluded that, the Electro-Kinetic Process is economical method for stabilizing Black Cotton Soil. This process can be used for water logged areas and wherever Mechanical compaction is not possible. On applying 20, 30, and 40V the time taken for the evaporation of water is too much (more than 8 Hours), but when we use higher voltages evaporation of water is very fast, and also which is dependent on spacing between electrodes inserted into the soil sample. For example at 80V the time taken for the evaporation of water is 1 hour 5 min. and 1 hour 35 min. at 5 and 10cm spacing between the Electrodes respectively.

By this process the maximum dry density of BC soil has been increased from 1.7 to 2.1gm/cc and swelling index is reduced after treatment. Hence this process can be used for the stabilization of BC soil with proper precautions at site.

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