

Experimental Study on Stabilization of Kuttanad Clayey Soil Using Electro kinetic Method

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ABSTRACT: Problems related to soft soil is characterized by their low bearing capacity, high compressibility and high volume change leading to defective construction. Some of the remedial measures to improve its performance including adding some stabilizing agent, deep mixing method and in-situ stabilization etc. Electro kinetic stabilization is one of the principle of chemical stabilization and has been chosen as the best ecofriendly method to enhance the improvement of soft soil with minimum disturbance to soil and existing structures. Electrokinetic stabilization is most suited for clayey soil ultimately resulting in reduced water content, impurities removal and stabilization. In this project the effect of EKS treatment is studied on Kuttanad clayey soil focusing on two parameters, varying voltage (0V, 10V, 15V, 20V, 25V) and time of application (3 days and 5 days)

KEYWORDS: EKS treatment, Stabilization, Optimum condition, Shear strength, Voltages, Time of application

I. INTRODUCTION

Electro kinetic stabilization is the process of providing an electric current through soil mass in order to migrate charged particles in the soil to change the properties, leading to an overall stabilization of the soil. Electro kinetic treatment is a chemical ground improvement technique which helps in the removal of heavy metal particles, organic as well as inorganic compounds that make the soil less permeable and defective for construction purpose. It not only reduce the water content but also produce certain cementitious compounds enhancing the properties of soil.

Electro kinetic treatment involve 4 types of mechanism such as Electro-osmosis, Electrolysis, Electrophoresis, Electro migration. It is suitable for clayey soil, to improve the engineering properties of the soil surface while having minimum disturbance to the surface. In this method calcium chloride as stabilizing agent and stainless steel is used as the electrode to strengthen the soft clay soil.

II. RELATED WORK

A T S Azhar et al. (2018) made a study on "The Physical Behavior of Stabilised Soft clay by Electro kinetic Stabilization Technology" the aim of the study is to evaluate the physical behaviour of soft soil using EKS technology as an effective method to strength soft clay soils with CaCl_2 as the stabilizing agent. Stainless steel plates were used as the electrode. Soft clay by using CaCl_2 as the electrolyte and stainless steel as the electrode. The treatment was running for 21 days and a constant voltage gradient of 50 v/m was applied to the soil. The introduction of highly alkine CaCl_2 solution from anode compartment into the soil sample has significantly increased the strength of the treated especially in the vicinity of the cathode.

Nima Saberi et al. (2018) investigated the applicability of different enhancement agents and pH control on the simultaneous removal of a mixture of PAH and heavy metals from artificial clayey soils. To obtain three samples with different levels of organic matter OMO, OM1, and OM2. They tested for different contaminants distribution in OMO, OM1, and OM2 for 1.5 v/cm DC voltage and tested for 15 days. Both electrodes in anode and cathode were reticular stainless steel (A316). Cumulative electro osmotic flow increased with elevated humic acid in OM1 and OM2 soils compared with that in OMO.

III. ADDITIONAL MATERIALS USED

Kuttanad clayey soil

Soft soil required for our project was collected from Kuttanadan. The soil in this area is expected to be poor strength.



(1) Kuttanad Clayey Soil

Stainless Steel (Electrode) and Electrolyte (CaCl₂)

After literature review we have chosen Stainless steel as electrode and CaCl₂ as electrolyte due to its better performance compared to other combination of materials.



(2) Electrode – stainless steel

Acrylic Plate

Acrylic plate was used for the lab setup because of its rigid nature and transparency so we could get good visibility



(3) Acrylic Plate

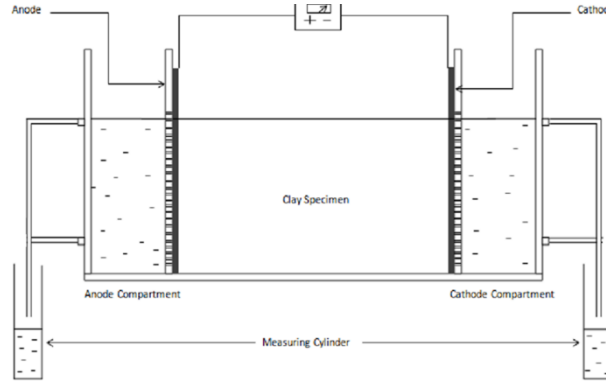
Calcium Chloride (Electrolyte)



(4) Calcium Chloride (CaCl₂)



IV. LAB SETUP ARRANGEMENT



V. EXPERIMENTAL INVESTIGATION

Moisture Content

The water content in soil at different stages of treatment was measured

Specific gravity

Specific gravity of the material was found out

Atterberg Limit

Plastic limit or the water content of the soil which crumbled when 3mm threads were rolled is found.

Unconfined Compression Test

Compressive strength of cohesive soil was found, Since bearing capacity is one of important test conducted on soil before construction.

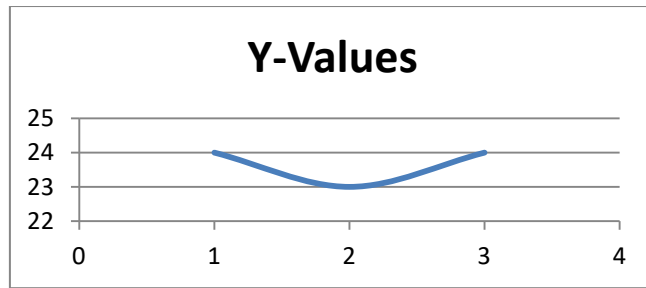
Compaction Test

The optimum moisture content and maximum dry density was determined using Standard Proctor Test Apparatus.

VI. EXPERIMENTAL RESULTS

Preliminary Test Result on Clayey Soil

PROPERTY	RESULT
Water Content	60%
Plastic Limit	48.5%
UCC	94.26 kN/m ²
Dry Density	1.089g/cc

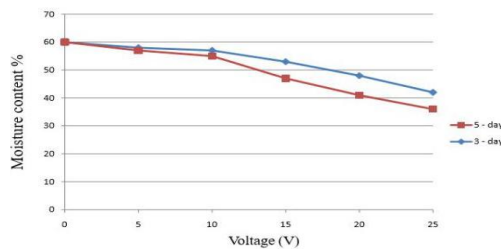


(1)Table showing preliminary test results

1. Moisture Content

Sl.No	Voltage(V)	Moisture content(%)	
		3 days	5 days
1	0	60	60
2	10	57	55
3	15	53	47
4	20	48	41
5	25	42	36

(2) Table showing Moisture content of clay at different voltage in 3 day and 5 day



(1)Graph showing moisture content of clay at different voltage in 3 day and 5 day

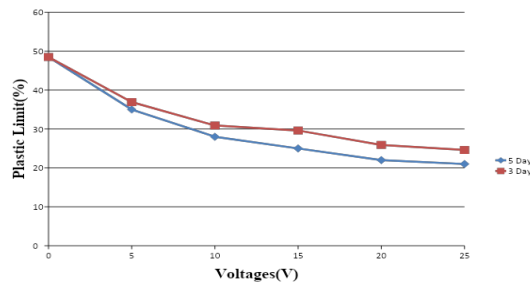
2. Atterberg Limits

SL.NO	VOLTAGE (V)	PLASTIC LIMIT (%)	
		3days	5days
1	0	48.5	48.5
2	10	30.9	28
3	15	29.6	25
4	20	25.9	22
5	25	24.2	21

(3) Table showing plastic limit of clay at different voltage in 3 day and 5 day



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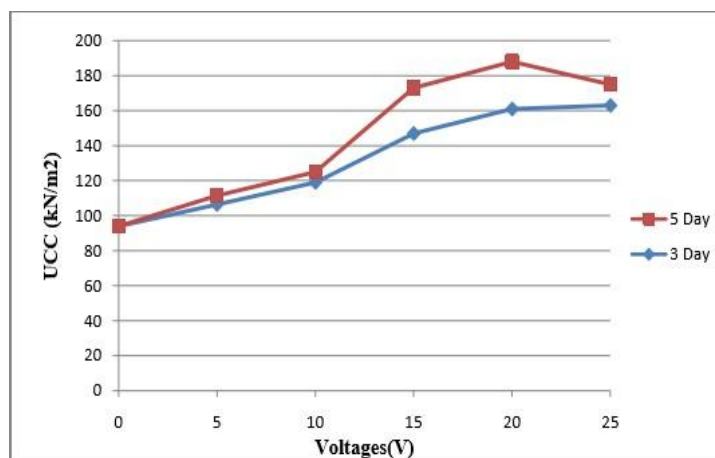


(2) Graph showing Plastic limit of clay at different voltage in 3 day and 5 day

3. Unconfined Compression Test

SL No	Voltage (V)	UCC (KN/m ²)	
		3 days	5 days
1	0	94	94
2	10	113	119
3	15	121	147
4	20	134	161
5	25	144	170

(4) Table showing UCC of clay at different voltage in 3 day and 5 day



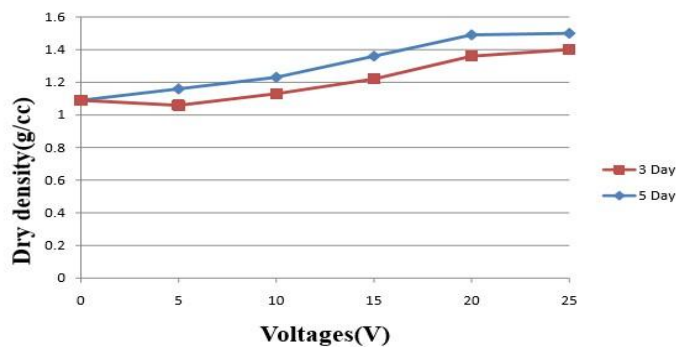
(3) Graph showing UCC of clay at different voltage in 3 day and 5 day



4. Compaction Test

Sl. No	Voltage(V)	Dry Density(g/cc)	
		3days	5days
1	0	1.089	1.089
2	10	1.13	1.13
3	15	1.22	1.24
4	20	1.36	1.48
5	25	1.40	1.50

(5) Table showing Dry Density of clay at different voltage in 3 day and 5 day



(4) Graph showing Dry Density of clay at different voltage in 3 day and 5 day

Results of test performed

	Voltage	Moisture Content (%)	Plastic Limit (%)	UCC (kN/m2)	Dry Density (g/cc)
3 days	0v	60	48.5	94	1.089
	10v	57	30.9	113	1.13
	15v	53	29.6	121	1.22
	20v	48	25.9	134	1.36
	25v	42	24.2	151	1.40
5 days	0v	60	48.5	94	1.089
	10v	55	28	119	1.23
	15v	47	25	147	1.36
	20v	41	22	161	1.48
	25v	36	21	163	1.50

(6) Table showing experimental results

VII. CONCLUSION

Apart from removal of heavy metal particles, organic as well as inorganic compounds that make the soil less permeable and defective for construction purpose. EKS treatment also favours existing structures by its environmentally friendly nature of causing minimum disturbance to site conditions. With varying voltages and time of application, soil properties is found to be improving after EKS treatment. When the moisture content decrease the cohesive force of the clayey particles increases thereby strength also increases. Here with increase in time of application and voltages moisture content was decreasing. Plasticity of the soil decreases the water holding capacity decreases then automatically strength will increases. In UCC Test, Shear Strength was found to be increasing with increasing voltages, showing sign of improvement in soil strength. When voltage increases dry density increases. As moisture content decreases, the dry density increases cause an appreciable reduction in interface shear resistance. The results not only depicted the influence of varying voltages, but also the effect of time of application. Results was found to be improving with change in time of application from 3 days to 5 days.

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