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ELECTROKINETIC DEWATERING OF CLAY USING GEOSYNTHETICS

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ABSTRACT: Marine clay is found along the coastal regions of the world. Marine clay having unusual properties like low shear strength and high compressibility. It was found that electrokinetic treatment is effective tool in increasing the strength and removing the pore water from clay. Electro kinetic geosynthetics (EKG) are newly developed material which act as electrodes that prepared by combining the electrokinetic phenomena with functions of geosynthetics.The objective of the work is to study the dewatering efficiency of EKG as cathode in marine clay and the undrained shear strength. The` various parameters studied are depth of anode that contact with clay (25cm,10 cm) , voltage(6V ,12V) and different number of electrodes (1 anode and 2 anode with 10 cm spacing).The undrained shear strength of soil samples were studied before and after the treatment. The variation of current and resistance is also studied.

INTRODUCTION

Soft soil like marine clay having high water content results in loosening of soil particles bonding, low bearing capacity, low shear strength and high compressibility. Engineering construction is difficult in soft soils without altering the characteristics. Dewatering by electrokinetic process is found effective in reducing the high water content.

In geotechnical application electrokinetic treatment is applied in soil with low permeability, high pore water and fine grained soils. Electrokinetic treatment is done by applying electric current through electrodes.

ELECTRO-OSMOSIS THEORY

Electro-osmosis is a process where flow of water between the soil particles is induced under an applied direct current electric field. Electro-osmosis based soil improvement is suitable for clay which having net surface negative charge under an applied electric field anions are attracted towards the anode while cations are attracted towards cathode.

Traditional geosynthetics are used in engineering fields to carry out functions like drainage, reinforcement, filtration, separation, encapsulation and sorption. Elecrokinetic geosynthetics(EKG) perform function like dewatering, strengthening, conditioning in materials like soil, sludges, slurries, tailings compost. Elecrokinetic geosynthetics have the capacity to effect the movement of water in soil by electrokinetic means.

Geosynthetics are primarily polymer based material. It can be made single or form combinations of woven, non-woven, needle punched, knitted, extruded, or laminated materials. Elecrokinetic geosynthetics are formed by inclusion of conducting elements within or associated with standard geosynthetic material.

In this study, Elecrokinetic geosynthetics is used as cathode, by forming the geosynthetics as electrodes . Elecrokinetic geosynthetics overcome the problem of removing water by utilizing the drainage functions of geosynthetics with the additional advantage of exploiting geosynthetics in

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electrokinetic means. Most of Elecrokinetic geosynthetics having dual functions initially in active mode which may be of short duration and which is followed by long term passive role. In this paper, a study of dewatering of marine clay using Galvanized iron (GI) and electrokinetic geosynthetics (EKG) as electrodes.

MATERIALS AND METHDOLOGY

Soil

Soil is collected from Cochin area whose relative properties are shown in Table 1

Table 1: properties of soil

Properties	Values
Specific gravity	2.4
Organic matter content (%)	2.7
Liquid limit (%)	82
Plastic limit (%)	28.5
Plasticity index (%)	53.5
Shrinkage limit (%)	9
Percentage of clay (%)	39.5
Percentage of silt (%)	40.5
Percentage of sand (%)	20
Optimum moisture content OMC (%)	31
Maximum dry density(g/cc)	1.3
IS soil classification	MH
Undrained shear strength(kN/m^2)	3.3
Natural moisture content (%)	79

Test Tanks

The test tank having dimension 40 cm x 40 cm x 50 cm height made of glass of 10 mm thickness. Holes are provided at the bottom of tank at a spacing of 5cm.

Electrodes

In this study anode is made using hollow Galvanized Iron (GI) pipe of diameter 10 mm and thickness of 2 mm and height of 55 cm for connection purpose.EKG are used as cathode, so that stainless steel mesh make the geosynthetics conductive. Steel meshes are tied to non woven geotextile using polyester yarns, which act as a geocomposite.

Methods

Water collector tray is provided at a distance of 10 cm below the tank during the process. Conductive geosynthetics was placed on bottom of tank. GI electrode is placed at a distance of 5 cm(ie,25 cm depth in clay) and 20 cm (ie,10 cm depth in clay) from the bottom of tank to act as anode, after filling the tank with soil at a height of 30 cm with its natural water content .The electrodes were then connected using standard flexible copper wire to a DC unit. Two voltages 6 V and 12 V are applied for the experiment for duration of 3 hours.Figure.1 shows the schematic diagram of dewatering set up. After the treatment the undrained shear strength from 5 cm and 15 cm from anode is determined.

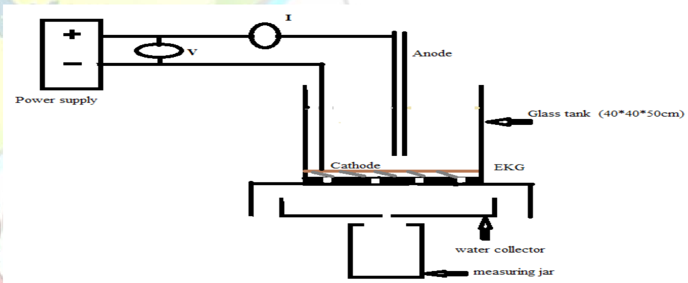
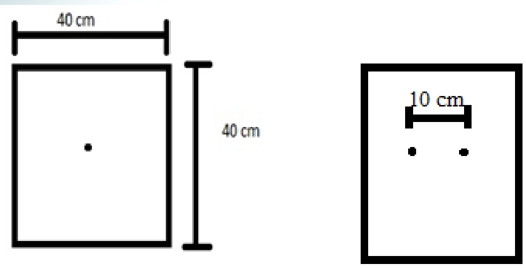


Figure.1.experimental setup

Arrangements of Anode

Figure 2 shows the arrangement of anode during the treatment. (a) 1 Anode at the center of tank and (b) 2 Anode at a spacing of 10cm.



(a) (b)

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Figure.2.Arrangement of anodes

RESULTS AND DISCUSSION

Cumulative Volume of Water Collected At Cathode

Figure 3 and Figure 4 shows the cumulative volume of water collected at cathode. As the voltage increases the cumulative volume of water collected also increases. The graph shows the cumulative volume of water increases with increase in voltage, more number of anodes and increasing the depth of anode in clay (ie 25 cm).

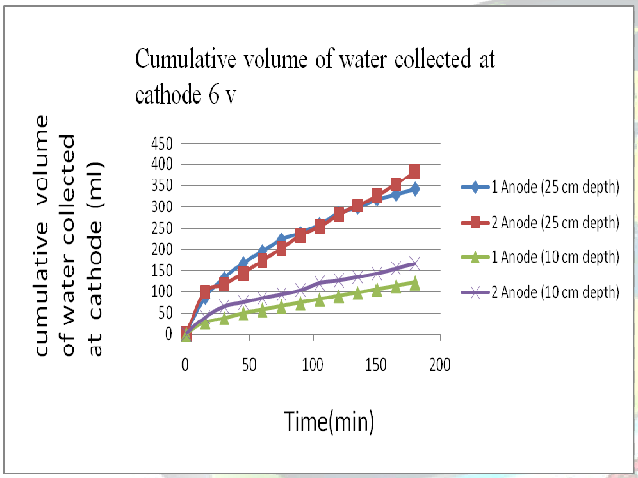

Figure.3.Cumulative volume of water collected at cathode- 6 v

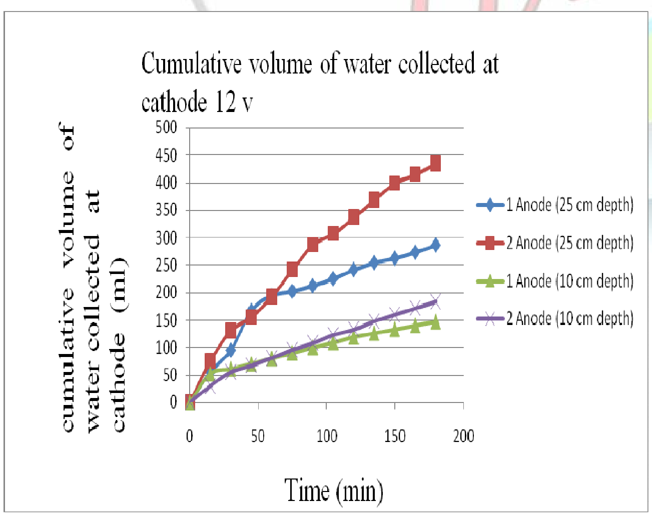

Figure.4.Cumulative volume of water collected at cathode- 12v

Variation of Current with Time

Figure 5 and Figure 6 shows the variation of current with time. Current goes on decreases with time. This is due to the decrease in water content.

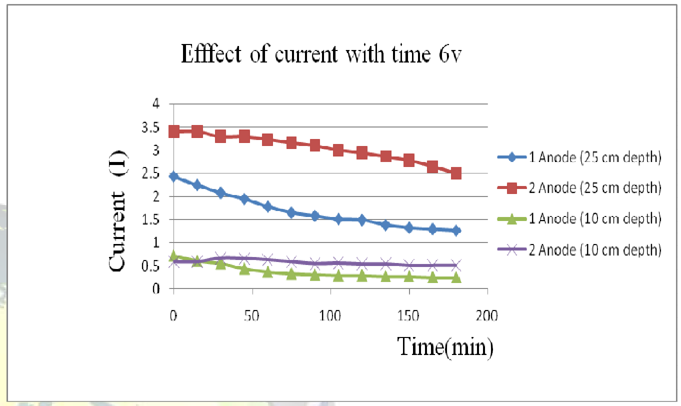

Figure.5.Effect of current with time - 6 v

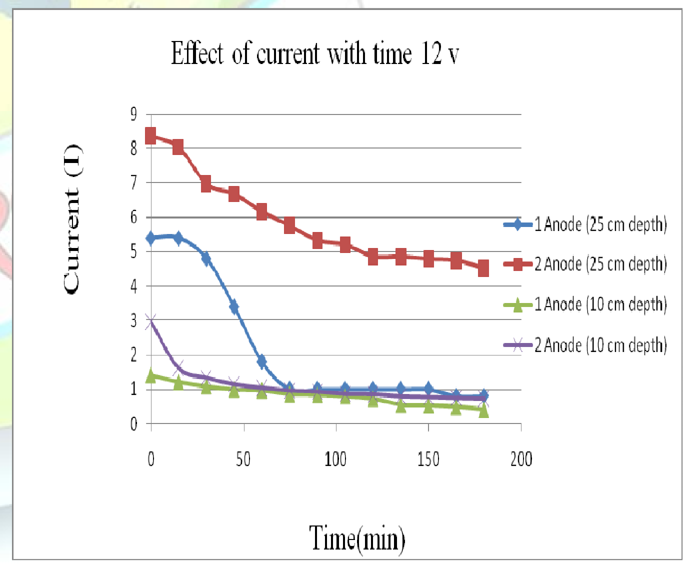

Figure.6.Effect of current with time - 12 v

Variation of Resistance with Time

Figure 7 and Figure 8 shows the effect of resistance with time. The resistance of soil goes on increases with time

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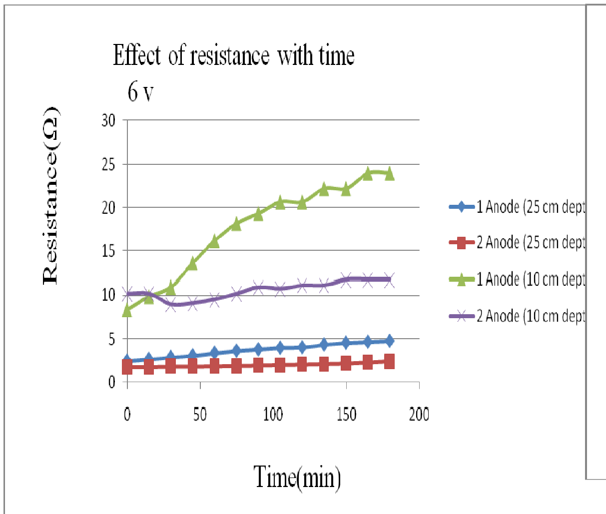

Figure.7.Effect of resistance with time - 6 v

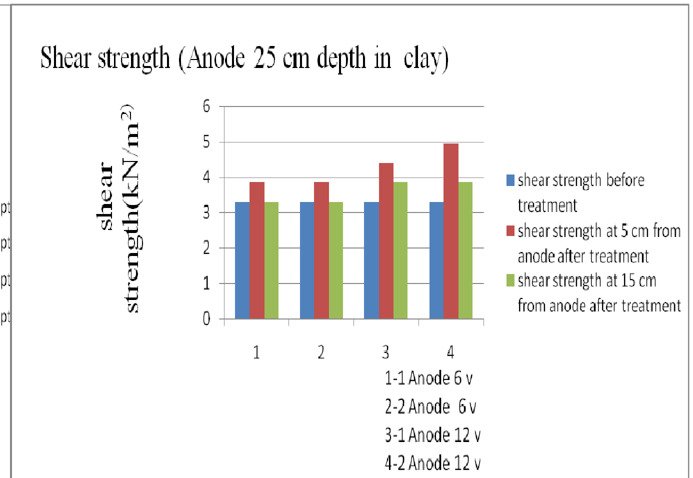

Figure 9. .undrained shear strength-25 cm depth

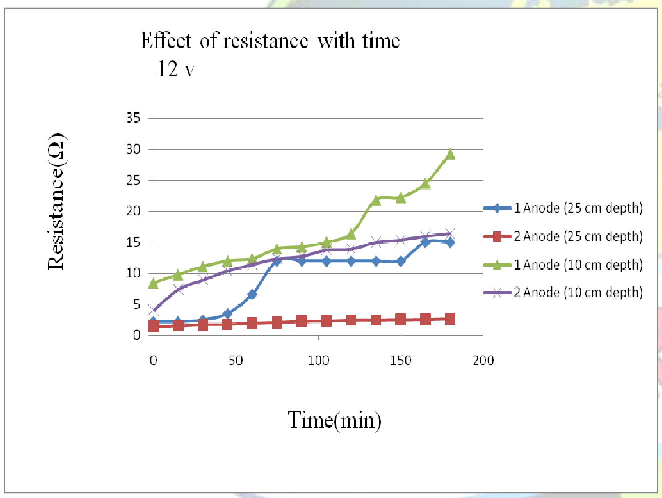

Figure.8.Effect of resistance with time - 12 v

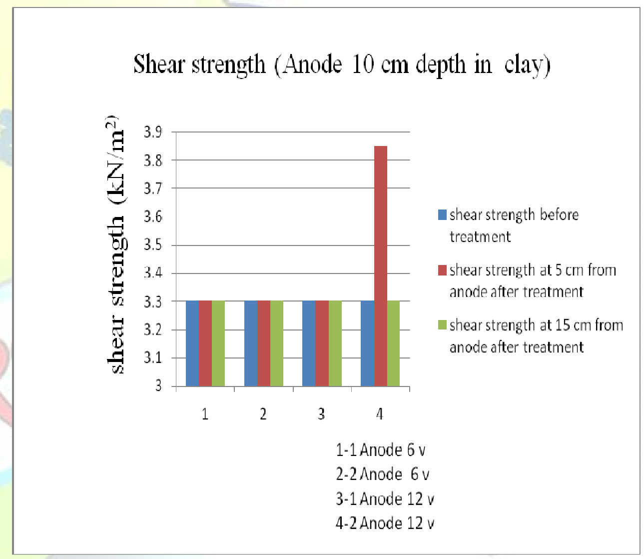

Figure.10.undrained shear strength -10 cm depth

Undrained Shear Strength

Figure 9 and 10 shows the undrained shear strength of clay before and after the treatment. The vane shear strength of soil found to be increased in 5 cm than 15 cm from anode .The strength of soil increases the area near anode. From the results it has found a overall considerable increase in shear strength of soil with 25 cm depth than 10 cm depth of anode.

CONCLUSIONS

From the results presented in this paper electro kinetic geosynthetics are suitable technology for dewatering. In this study conductive non woven geotextile used as cathode using conductors ie, stainless steel mesh.Geotextiles have functions like filtration, separation, drainage etc.Therefore no filtering units like filter paper is used in this study for filtering the water from clay. The strength of clay is noted after end of treatment and there is increase in strength of soil near the anode. The increase in

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voltage and number of anodes increase the dewatering process and undrained shear strength of soil. The dewatering process and shear strength increases when the depth of anode has increased from 10 cm to 25 cm. Electro kinetic process decreases the water content near the anode and it is found to be effective tool to remove water from marine clay. From results it was found that decrease in the distance between anode and cathode increases the cumulative volume of water collected at cathode. The efficiency of the process can increase by increasing parameter like time, voltage, and depth of anode at a certain distance from EKG where it acts as cathode.

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