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EFFECT OF NONWOVEN CONDUCTIVE GEOTEXTILE ON ELECTROKINETIC DEWATERING USING VERTICAL GEO-DRAINS

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Abstract — *Civil engineers are mainly indulged in the construction sector for improving infrastructure of our country. This in turn alarms geotechnical engineer to go for building structure even in weaker soils leading to the need of improvement of such soils. Electrokinetic process is one of the best methods of soil improvement by dewatering, decontaminating and enhancing soil-chemical interactions. The present research work envisaged to study various factors affecting dewatering using nonwoven conductive geotextiles with help of different nonwoven material and steel mesh. The objective of paper is to evaluate the current parameter and to study the effect of various factors during the process of dewatering. The present study, for vertical dewatering four laboratory scale cylindrical models were prepared for the experimental work. With the help of carbon rods acting as an anode and nonwoven conductive geotextile which acts as a cathode current is applied to the soil for obtaining the required outcome. The different parameters studied include effect of using different nonwoven geotextile. The average current was observed for the 3 days using EKG on daily basis at fixed time.*

Keywords- *Electrokinetics, Electrokinetic Geosynthetics (eKG), Electrokinetic dewatering, Vertical Geo-drains, Electrically conductive vertical drains.*

I. INTRODUCTION

Electrokinetic is a process that has shown a great potential for remediating soil with low shear strengths and strengthening of deep seated soil layers under the existing structure. It is the term applied to a group of physicochemical phenomena involving the transport of charges, action of charged particles, effects of applied electric potentials, and fluid transport in various media. It is an emerging technique, which uses direct current (DC), or a low electric potential difference to an array of electrodes placed in the soil, for removing organic, inorganic and heavy metal particles from low permeable soils, mud, sludge, slurries, sediments and groundwater by electric potential.

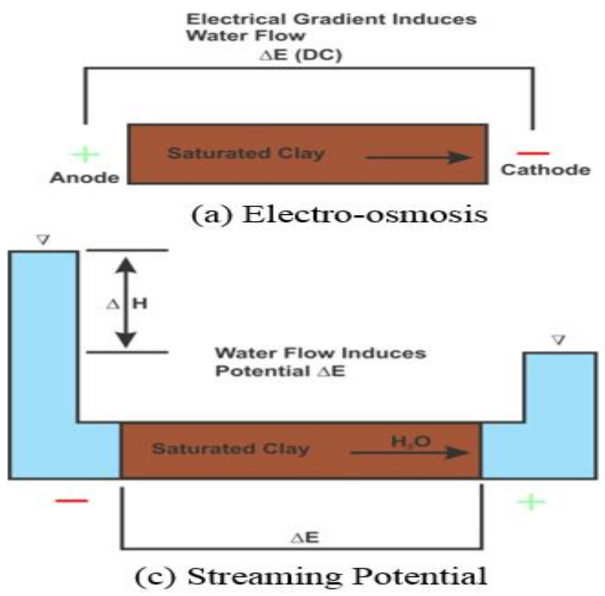


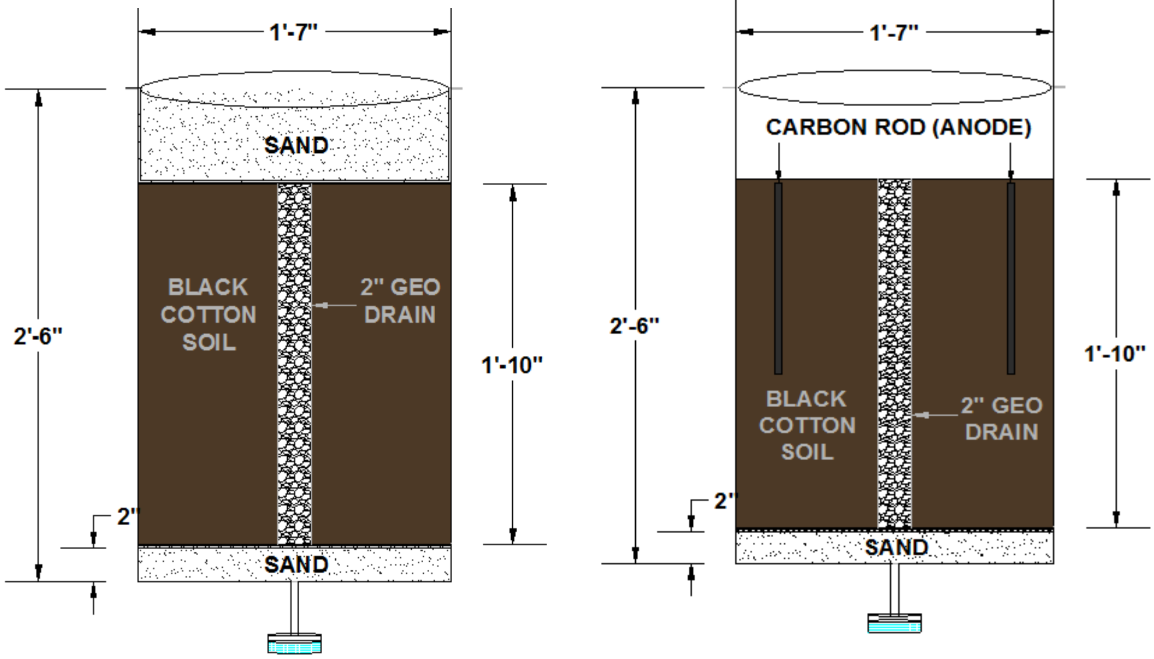
Fig.1 Electrokinetic Phenomena in Clay (After Mitchell, 1993)

This technique is effective for the treatment of low permeable clays and/ or heterogeneous soils. Electrokinetic techniques use the combined effect of electric, chemical land hydraulic potential for remediation of expansive problematic soil. In general, several electrokinetic phenomena can arise when the counter ions in the mobile part of the double layer adjacent to the surface of charged particles are subject to shear by external forces. These phenomena can be classified into two main groups. The first group consists of electro osmosis and electrophoresis, in which the liquid or solid phase moves relative to the other under the influence of an externally applied electric field. The second group consists of streaming potential and migration or sedimentation potential, in which the liquid or solid phase moves relative to the other under the influence of hydraulic or gravity force, thus inducing an electrical potential. These four electrokinetic phenomena are illustrated in Fig. 1.

II. EXPERIMENTAL PROGRAMME

2.1 Laboratory Model

Four laboratory scale drum model were prepared or the experimental work. Two models were having size of 19’’ diameter and 3’ height and another two models were having size of 19’’ diameter and 2’6’’ height. (Fig. 2).



(A) By Preloading *(B) By Nonwoven Conductive Geodrain*

Fig. 2 Setup diagram of Vertical Geodrain

2.2 Development of Conductive Textiles

In the experimental work, for the vertical model 1 types of sample with a different combination were developed. In the vertical model total 4 samples have been prepared, two samples for preloading and two samples for conductive geodrain. This different combination is as shown in the Table 2. To develop this vertical geodrain, the samples were prepared by stitching a steel mesh in between two identically cut nonwoven geotextiles and rounded up so that the inner diameter remains of 2’’ for experimental study. (Fig. 3)

Table 1 Different types of Conductive geotextile (CG) for Vertical model

Geotextile	Top	Middle	Bottom	Thickness
CG 1	*PE	SM	PE	3
CG 2	*PP	SM	PP	2.5

*PE- Polyester, PP- Polypropylene

2.3 Soil Sample

The index properties of the black cotton soil are listed in table 2. The soil sample for the work has been collected from Parekha village, Kayavarohan, Vadodara, Gujarat.

Table 2 Index Properties of Soil

Type of Soil	LL*	PL*	SL*	FSI*	Specific Gravity	MDD (g/cc)	OMC (%)
Black Cotton Soil	62%	31%	7%	90.5 %	2.45	1.51	24.92

*LL = liquid limit, PL = Plastic Limit, SL = Shrinkage Limit, FSI = Free Swell Index

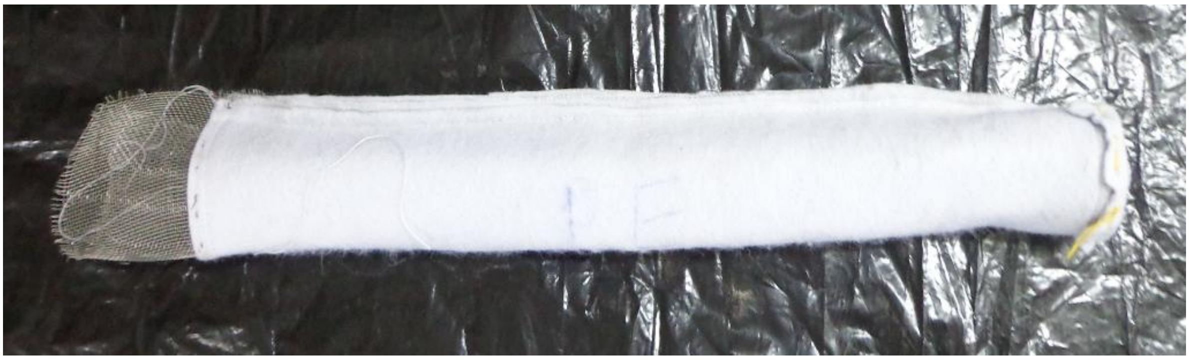


Fig.3 Conductive nonwoven Geodrain

III. SETUP AND EXPERIMENTAL DEVELOPMENT

3.1 Vertical nonwoven conductive Geodrain

Black cotton soil was air dried and kept at 100˚C for 24hrs. Black cotton soil was sieved through a 600μm sieve and then its use. The experiment was performed to study the effect of conductive vertical geodrain using the basic principle of electrokinetics i.e. application of DC supply. The experimental drum model was installed at some elevation from the floor surface with a bottom central hole for collection of water. The opening was fitted with a brass nipple of appropriate size to connect a flexible PVC pipe was collecting the drained water. The bottom of the drum was laid with a 5 cm sand drain layer (passing 10mm retained 4.75mm) overlain with a perforated disc to act as a separator and drain media. The disc made of PVC of 6mm thickness was levelled using a level tube and the sides then sealed using bentonite to have proper water insulation between the filter and soil. The separator disc was overlain with two Whatman filter paper discs before filling up with 600μm sieved black cotton soil at its liquid limit. In the middle of the drum nonwoven conductive geotextile was put, which is surrounded by the black cotton slurry and carbon electrodes. For installing the conductive vertical geodrain a PVC pipe of 5 cm diameter was inserted and the slurry was filled all around its sides. The PVC pipe was so kept so as to fall on the lower drain in the bottom of the drum. The vertical geodrain was stitched in the form of a long sock and filled with coarse aquarium quality stone and then installed inside the pipe. Once the complete length was dropped down to the bottom the pipe was gently removed and the drain came into contact with the slurry. This vertical conductive geodrain was designated to work as cathode, whereas six carbon rods of 10mm diameter with 30cm length were used as anode all around the vertical geodrain (Fig.4).

Fig. 4 Nonwoven Conductive drain (Cathode)

IV. EXPERIMENTAL RESULTS

4.1 Effect of Current

Different combination of nonwoven conductive Geodrain was used at the constant voltage gradient as 12 V for the experimental work. At the different time interval current was measured for the 1st run, 1st rerun and 2nd rerun. The graph was plotted which is shown below.

The average current v/s numbers of day's behaviour for P.E. is graphically represent in Fig.5, with maximum average current was observed as 1.81 amps at day 1 in 1strun. The minimum average current was observed as 0.06 amps at day 3 in 2nd rerun.

In the similar manner, the graph was plotted for average current v/s numbers of day's behaviour for P.P. which is shown in Fig.6. The maximum average current was observed as 2.27 amp at day 1 in 1st rerun. The minimum average current was observed as 1.06 amp at day 3 in 2nd rerun.

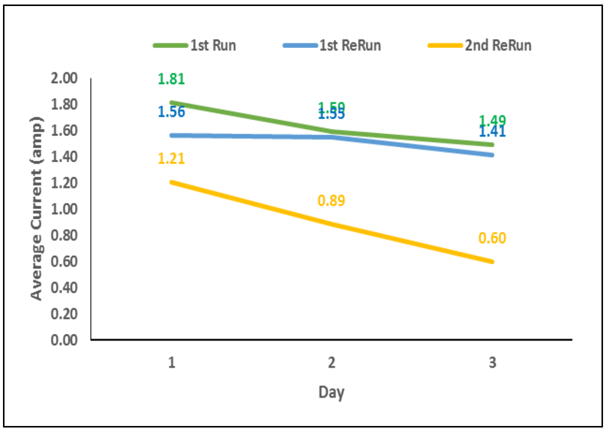


Fig.5 Average Current v/s number of days (with electrokinetic) for P.E.(Polyester)

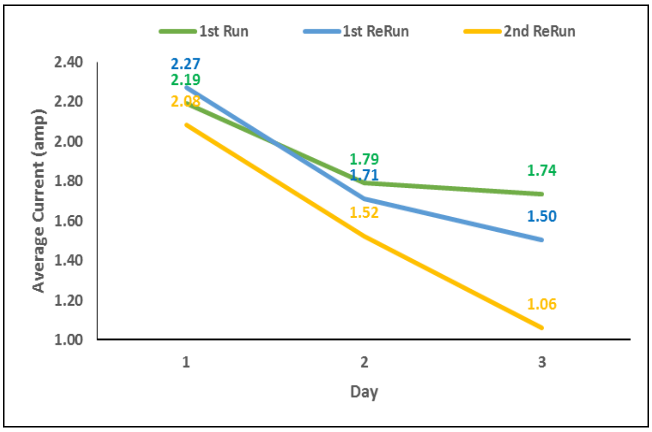


Fig.6 Average Current v/s number of days (with electrokinetic) for P.P.(Polypropylene)

V. CONCLUSIONS

Experiment were performed for P.E. and P.P. nonwoven conductive geotextile at constant voltage at 12 V for 3 days for all runs (1st run, 1st rerun and 2nd rerun). We can conclude that, at initial stage current was maximum after that current starts decreasing with passage of time as the water content of the soil decreases following the attributed trend. The maximum current was observed as 2.27 amp in P.P. at 1st rerun.

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