EXPERIMENTAL INVESTIGATION ON ELECTRO OSMOTIC CONSOLIDATION OF DREDGED SOIL

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Abstract— ***Dredged soils are soils with different parts of mineral and organic properties, which accumulate in or on the water bodies in the course of time. It contains larger percentage of finer particles and the water content of such soils is also high which causes slower and ineffective consolidation process. A model is developed with glass tank. Copper and Mild Steel electrodes are used. Regulated Power Supply (RPS) device is used to apply 6V, 12V and 24V across electrodes. Surcharges by means of steel plates are also applied. Settlement is measured with the help of scales associated with the model. Comparing electrode material, voltage configurations and surcharges, Copper electrode with 24V and surcharge performs better than other configurations.***

I. INTRODUCTION

1.1 GENERAL

Consolidation is a process by which soils decrease in volume. According to the "Father of Soil Mechanics", Karl von Terzaghi, consolidation is "Any process which involves a decrease in water content of saturated soil without replacement of water by air". In general it is the process in which reduction in volume takes place by expulsion of water under long-term static loads.

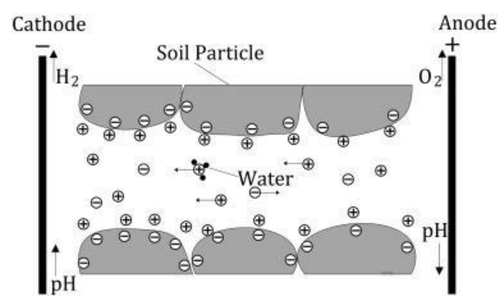

Fig 1.1 Electro osmotic consolidation

Electro osmotic consolidation means the consolidation of soft clays by the application of electric current. It was studied and applied for the first time by Casagrande. It is inherent that fine grained clay particles with large interfacial surface will consolidate and generate significant settlement when loaded. The settlement creates problem in the foundation engineering. Electro osmosis was originally developed as a means of dewatering fine grained soils for the consolidation and strengthening of soft saturated clayey soils. Electro osmotic dewatering essentially involves applying a small electric potential across the sediment layer. It is the process where in positively charged ions move from anode to cathode. i.e Water moves from anode to cathode where it can be collected and pumped out of soil. Electro osmotic flow depends on soil nature, water content, pH and on ionic type concentration in the pore water.

1.2 PROBLEMS IN DREDGED SOIL

Dredged soils are most commonly the sedimentations of some matters. These kind of soils are very less in size. It has more amount of finer particle. As they have very low permeability, the consolidation process is very slow in that medium. In some areas large amount of dredged soil is taken from the water body and dumped in some other places. Those places have more problems in bearing capacity and shear strength. The construction activity can't be done in that places.

II. MATERIALS

A. Collection of soil

The sample is collected from the Aliyar dam area in the depth of 0.5 m. The sample collection area is about 500 m from the upstream side of the dam. The sample have high water content because that was dredged soil from the dam side.

B. Electrodes

Mild steel and copper electrodes were used for testing. The anode was solid rod and the cathodes were hollow pipes. One anode and two cathode configuration is used for electro osmotic consolidation process.

C. Regulated Power Supply

A regulated power supply is an embedded circuit. It converts unregulated AC into a constant DC. With the help of a rectifier it converts AC supply into DC. Its function is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC.

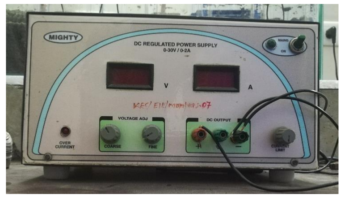

Fig 1.2 Regulated power supply

III. EXPERIMENTAL ANALYSIS AND MODEL DEVELOPMENT

A. Experiments

This chapter is about the properties of the dredged soil sample. Some of the tests were conducted in the laboratory as per relevant Indian standard codes.

B. Model Details

The model is developed based on the study with the help of journals and experiments already done. The length, width and breadth of the modal is 700mm x 350mm x 300mm. It was made by 8 mm thick glass. Two holes were drilled at the bottom of the plate for drainage purpose. On that holes two cathodes were fixed and at the center of the setup one anode was fixed.

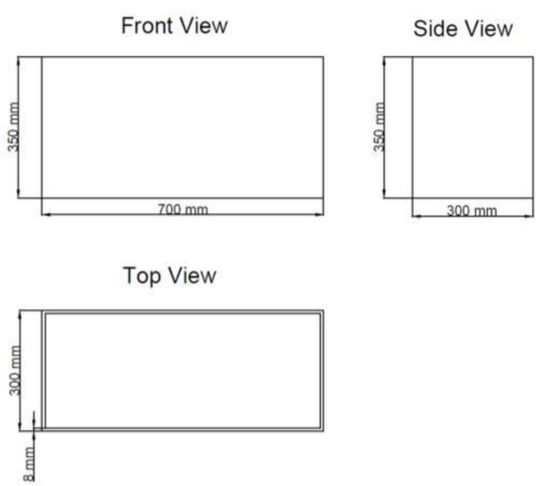

Fig.1.3 - Setup details

Scales are fixed at sides of the setup to measure the settlement of the soil. They were numbered from 1 to 18 for the understanding purpose.

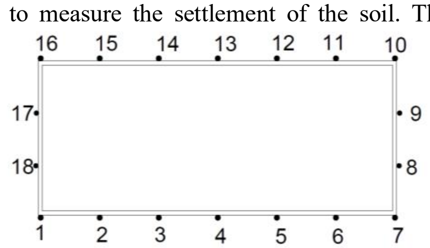

Fig.1.4 – Scale marking

The RPS was connected with the circuit to regulate the voltage and maintain that in a same way. That shows the current flow and voltage variation in the circuit. The electrodes are connected to the opposite poles for the electron circulation which is reason for the electro osmotic consolidation.

Fig 1.5 Setup

Table 1 Properties of Sample

Si. No.	Property	Result
1	Field density	1.02g/cc
2	Moisture content	36.3 %
3	Specific gravity	2.3
4	Liquid limit	40 %
5	Plastic limit	29.4 %
6	Plasticity Index	10.6 %
7	Optimum moisture content	20 %

IV. Consolidation for various configuration

A. General

This results shows the height of filling from the bottom of the tank. All the readings tabulated below are in cm.

B. Mild steel-6V

Scale	0 hours	24 hours	48 hours	72 hours	96 hours
1.	19	18.9	18.8	18.6	18.5
2.	19	19	18.9	18.7	18.5
3.	19	18.9	18.7	18.6	18.4
4.	19	18.9	18.7	18.7	18.4
5.	19	18.8	18.6	18.6	18.4
6.	19	18.7	18.7	18.6	18.5
7.	19	18.8	18.7	18.6	18.5
8.	19	18.9	18.8	18.7	18.6
9.	19	18.9	18.9	18.7	18.6
10.	19	18.8	18.7	18.6	18.5
11.	19	18.8	18.7	18.7	18.5
12.	19	18.7	18.6	18.6	18.4
13.	19	18.8	18.6	18.7	18.3
14.	19	18.8	18.7	18.6	18.4
15.	19	18.8	18.7	18.6	18.4
16.	19	18.7	18.7	18.6	18.5
17.	19	18.9	18.8	18.7	18.6
18.	19	18.8	18.8	18.7	18.6

Table 2 Mild Steel-6V

C. Mild steel -12V

Scale	0 hours	24 hours	48 hours	72 hours	96 hours
1.	19	18.8	18.7	18.6	18.5
2.	19	18.8	18.7	18.6	18.5
3.	19	18.9	18.7	18.7	18.6
4.	19	19	18.8	18.6	18.4
5.	19	18.7	18.7	18.6	18.5
6.	19	18.9	18.7	18.6	18.5
7.	19	18.9	18.8	18.7	18.5
8.	19	18.9	18.7	18.5	18.4
9.	19	18.9	18.8	18.4	18.3
10.	19	18.9	18.7	18.6	18.5
11.	19	18.9	18.8	18.7	18.5
12.	19	19	18.8	18.7	18.6
13.	19	19	18.8	18.6	18.4
14.	19	18.8	18.8	18.7	18.6
15.	19	18.9	18.7	18.6	18.5
16.	19	18.8	18.6	18.6	18.5
17.	19	18.8	18.6	18.4	18.4
18.	19	18.8	18.6	18.4	18.4

Table 3 Mild Steel-12V

D. Copper-6V

Scale	0 hours	24 hours	48 hours	72 hours	96 hours
1.	19	18.9	18.7	18.6	18.5
2.	19	18.9	18.7	18.5	18.5
3.	19	18.9	18.8	18.7	18.6
4.	19	18.9	18.9	18.6	18.7
5.	19	18.9	18.8	18.7	18.6
6.	19	18.9	18.7	18.6	18.5
7.	19	18.9	18.7	18.6	18.5
8.	19	18.9	18.7	18.5	18.4
9.	19	18.9	18.7	18.5	18.4
10.	19	18.8	18.7	18.6	18.5
11.	19	18.9	18.7	18.7	18.5
12.	19	18.9	18.7	18.6	18.5
13.	19	19	18.8	18.7	18.6
14.	19	18.8	19.8	18.7	18.6
15.	19	19	18.7	18.5	18.4
16.	19	18.8	18.7	18.4	18.5
17.	19	18.7	18.6	18.5	18.4
18.	19	18.9	18.7	18.4	18.5

Table 4 Copper -6V

E.Copper-12V

Scale	0 hours	24 hours	48 hours	72 hours	96 hour
1.	19	18.8	18.6	18.4	18.3
2.	19	18.8	18.6	18.4	18.3
3.	19	18.7	18.5	18.4	18.3
4.	19	18.8	18.7	18.6	18.5
5.	19	18.7	18.5	18.5	18.4
6.	19	18.7	18.6	18.4	18.3
7.	19	18.7	18.5	18.3	18.2
8.	19	18.8	18.5	18.3	18.1
9.	19	18.9	18.5	18.3	18.1
10.	19	18.7	18.5	18.4	18.3
11.	19	18.8	18.6	18.5	18.3
12.	19	18.7	18.6	18.5	18.4
13.	19	18.9	18.7	18.5	18.4
14.	19	18.8	18.6	18.5	18.4
15.	19	18.9	18.6	18.4	18.2
16.	19	18.8	18.6	18.5	18.3
17.	19	18.8	18.5	18.3	18.1
18.	19	18.8	18.5	18.3	18.1

Table 5 Copper -12V

Comparison between Mild Steel and Copper

VOLTAGE	MILD STEEL	COPPER
6V	0.52 MM	0.54 MM
12V	0.54MM	0.72MM

TABLE 6 COMPARISON BETWEEN MILD STEEL AND COPPER

DISCUSSION

The above table shows the average settlement in all the points of the setup at 96 hours. The surcharge load also an important factor in the consolidation process. When the load is applied on top of the surface, the consolidation process was rapid up.

CONCLUSION

The following conclusions can be drawn from the experimental study of electro osmotic consolidation tests.

- With increase in Voltage across electrodes, amount of settlement is also increased.
- The rate of settlement increases with the increase in voltage.
- The maximum settlement (after 5 days) was obtained as 1.52 mm with copper electrode along with surcharge and 1.21 mm with Mild Steel electrode along with surcharge.
- The application surcharge helps in improved rate and amount of settlement.

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