Permeability Characteristics of Cement - Bentonite - Waterglass Slurry on Sandy Soil

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***Abstract*—One of the most effective way to improve the engineering characteristics of sandy soil is permeation grouting. In this approach, the grout is injected in to the ground without disturbing the original soil structure. In this investigation an attempt is made to study the permeability characteristics of Cement – Bentonite – Waterglass slurry in sandy soil. The use of cement causes so many environmental hazards mainly carbon dioxide emission. The efficiency of permeation grouting mainly depends upon the penetration of slurry through the pores of sand. Cement – Bentonite – Water glass) grout of different ratios ie,10:1, 9:1, 8:1,7:1,6:1,5:1,4:1 and 3:1 is used. It is performed using 20 mm diameter perforated PVC pipes in a tank of 30cm x 30cm x 30cm.Here, study the improvement in the permeability characteristics of the grouted soil after 1,3 and 7 days curing are focused**

Keywords*— *Cement-Bentonite-Water glass, Permeation grouting, permeability, Environmental, Carbon Dioxide.

I. INTRODUCTION

Grouting has become the most common ground modification method used for the underground and foundation constructions. Permeation grouting is the process of filling pores or cavities in soil or rock with a liquid form material to decrease the permeability and improve the shear strength. Properties of cement based slurry could be improved in viscosity, bleeding by adding bentonite. Cement – bentonite – water glass (CBG) grouting is done using grout with low environmental impact and it is designed to reduce the use of cement. The most important factors which influence the penetration of grout such as viscosity and granulometry of the grouting materials. The most relevant factors affecting the effectiveness of grouting is the amount of grout hold by the soil, which depends upon grouting pressure, climatic condition, void ratio, moisture content etc. Cementitious bond play an important role on the strength characteristics of the cement admixed clay.

Here, we used bentonite and waterglass alone with cement for making CBG slurry.EASE OF USE

II. OBJECTIVES OF THIS STUDY

- To find the geotechnical properties of soil used
- To find better Water: Cement + Bentonite Ratio
- To Improve the Permeability of Sandy Soil

III. MATERIALS AND METHODOLOGY

A. Sandy Soil:

Table I. Physical Properties of Sandy Soil

Sl No	Properties	Values
1	Initial moisture content (%)	3.776
2	Specific Gravity	2.66
3	Bulk Density (g/cm$^{3)}$	1.476
4	D60 (mm)	1.5
5	D30(mm)	0.88
6	D10(mm)	0.42
7	Cu	3.57
8	Cc	1.39
9	Soil Classification	Poorly Graded Sand

The soil which is to be used is collected from Arattukadavu, Krishnapuram Gramam, Neyyattinkara, Kerala. Table I shows the properties of soil used in this study . Fig I shows the grain size distribution curve of soil used.

B. Cement:

The cement used for the study is Puzzolona Portland Cement. It is collected from Dalmia Cement suppliers, Mariyapuram, Neyyattinkara.

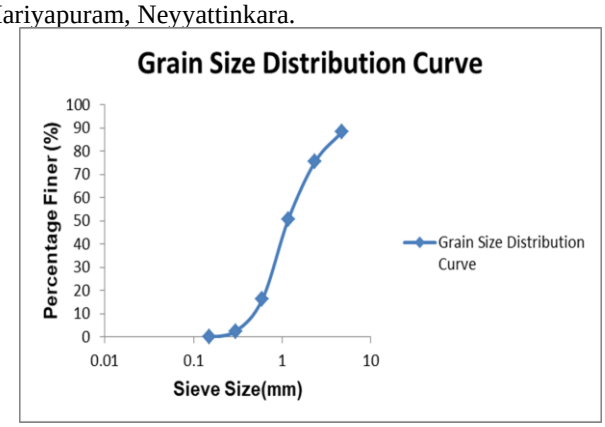

FIG I – GRAIN SIZE DISTRIBUTION CURVE

C. Bentonite:

The bentonite admixture is collected from Sabari chemical shop, Nemom, Thiruvananthapuram. Sodium bentonite is in yellow colour and it is highly plastic and slippery.

D. Sodium Silicate:

Water Glass (WG) is commonly known as sodium silicate slurry. It is commonly used as a temporary solution for water control. Sodium Silicate solution is collected from Sabari chemical shop, Nemom, Thiruvananthapuram

E. Methodology:

Here, a polycarbide tank of size 30cm x 30cm x 30cm is used. The sand soil is filled in the tank. Four PVC of 2 cm diameter are used for the grouting having perforations in surface of the pipe with 3 mm diameter which are 36 in number. The slurry which is prepared at water : cement bentonite ratio of 10:1, and agitated well to get uniform slurry. It is poured in to the PVC pipes uniformly. To reduce the chances of segregation of the slurry, the slurry is agitated and then poured. The procedure above mentioned is repeated for the other water: cement ratios such as 9:1, 8:1, 7:1, 6:1, 5:1, 4:1 and 3:1.

Funnel viscosity test is conducted to find most viscous cement bentonite grout. After that, varying percentage of sodium silicate that is water glass is added. The different percentages of water glass used was 1%, 2% and 3%. After 1, 3 and 7 days of curing constant head permeability test was conducted for grouted specimen.

IV. RESULTS AND DISCUSSION

The permeability characteristics of sandy soil without grouting were conducted based on constant head permeability test. The coefficient of permeability of sandy soil before grouting is 1.187 x 10-3 cm/sec.

A. Effect Of Curing Time On Grouted Soil Specimen

Here, varying percentage of WG added to 3:1 (Water : Cement+Bentonite) ratio. The period of curing used in this study for 1%,2% and 3% WG is 1 day,3days and 7 days.

Table II – Coefficient of Permeability

Sl No	Varying Percentage of WG*	Coefficient of Permeability (cm/sec) x 10^{-3}		
		1 day curing	3 days curing	7days curing
1	1	1.175	1.168	1.053
2	2	1.171	1.162	1.03
3	3	1.16	1.149	1.017

When percentage of WG increases the coefficient of permeability also decreases up to 3%. Also Curing period increases the rate of permeability of decreases. This occurs due to the gelling nature of sodium silicate. Gelling behavior helps to improve the stiffness and reduced the voids present in the sandy soil.

V. CONCLUSION

Grouting technique can be used to enhance the engineering properties of soil or rock foundation materials for structure or excavation support purposes. The efficiency of grouting mainly depends upon the penetration of CBG grout through the voids of sandy soil. Addition of bentonite tends to reduce the velocity of bleeding. Here, concluded that the percentage of WG increases leads to reduce the amount of permeability. When curing time increases the coefficient of permeability decreases.

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