EXPERIMENTAL STUDY OF INFLUENCE THE BEARING CAPACITY OF SANDY SOIL BY USING CEMENT GROUTING

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Abstract- Due to the presence of week soil with poor engineering features,such as structures built in the coastal zone require deep foundations. In these places, the soil profile is primarily loose sand, which is subsequently underlain by clayey soil at a depth of 3 to 4 meters. The constructions that have been built here have seen a lot of settlement. To improve this type of sand grouting is used to increase the bearing capacity of soil to decrease settlement in this study. The shear strength of the grouted sand improves as the cement quantity increases,effects of cement grouting sand shear strength and bearing capacity of the soil improves to experimental findings show that 4% cement grout is more effective than 2 % and 6% cement grout. The findings of numerous studies indisputably show that grouting may be utilized to greatly improve the strength properties and reduce the permeability of sandy soils.

Keywords- Cement Grouting, Sand replacement, Permeation

1 Introduction

Grouting is a ground improvement technique that involves injecting a fluid-like substance capable of producing a gel and adhering soil particles. Permeation grouting, compaction grouting, and hydraulic fracturing are all options for grouting. The unrestricted flow of grouting into the soil cavities with minimum influence is referred to as permeation grouting. Solution grouts and suspension grouts are two types of grout. The method of permeation grouting is commonly employed to lower ground permeability and regulate the ground flow of water, but it may also be used to reinforce and stiffen the ground. [1, 2]. The soil sample in coastal areas is frequently made up of relatively loose sandy soils that extend 3 to 4 meters below ground level and are loamy by clayey soils of medium stiffness. Excessive settlements may occur in buildings erected on such soils, resulting in punched shear collapse. Grouting is an effective technique for repairing poor soil. [3]. In 1958, post-grouting innovation was first used on the pile foundation design of the Maracaibo bridge, in which the load-carrying capacity of the footings was increased by grouting prefabricated piles, and a study on the development of a low-cost shake table was conducted (Zhou, Xu et al. 2021). This technique is applied to various engineering infrastructure projects and has offered substantial social and economic benefits due to its simplicity, speed, and low cost[4]. Because of its ability to tackle several common foundation problems, such as the development of low- to intermediate constructions over soft to extremely soft clayey soil of vast depth, larger capacity micro piles are in high demand today. For this sort of soil, the standard approach of constructing large cast-in-situ masonry piles is both costly and time-consuming. The group behavior of cast-in-situ filled with concrete micro piles in densely packed clayey soil is explored in this research. The experimental data on the behavior of micro piled rafts under static axial horizontal compressive force are discussed in this work[5]. The influence of sand particle size distribution on cement mortar flow behavior and bonding strength was investigated. The coarse sand filler used 25–30 % less water than the fine sand filler in the cement-based mortar [6]. Compaction grouting might be an efficient way to prevent vulnerable soils from liquefying. Grouting resulted in the biggest improvement in the sand. Although the silts were improved, the grouting was less successful[7].

2. Experimental Procedures

2.1 Material

The kind of granular media and the aim of grouting influence the choice of grouting materials. Grouting materials often used for granular media grouting include cement, bentonite, clay, and lime. The sand was employed as the grouting media and cement will be used as the filling material in this investigation. For the production of cement grouts, grade Portland Cement (OPC) that conforms to PS 232-2008 will be utilized that properties of cement shown inTable 1,2. The cement sacks are stored in airtight containers to prevent any changes in their qualities over time.

Table 1: The properties of the cement utilized

Trial No.	Weight of Cement (gm)	Water (cc)	Water(%)	Needle Penetration (mm)
01	400	100	25	15
02	400	110	27.5	27
03	400	112	28	34
Standard consistency = 28%				

Table 2: Cement properties

Determination No.	01
Normal consistency	0.28
A time when water is added to cement	10:25 am
Time at the initial setting	12:17 pm
Total time is taken for the Initial setting	112 minutes
Time at Final setting	03:04 pm
Total time is taken for the Final setting	279 minutes

The properties of the cement utilized, as well as its fundamental amenities are determined by ASTM tests such as specific gravity and other tests.

2.2 Test

In this study, shear strength, strength properties, and permeability of cemented grouted sand are investigated in depth. Grouting materials' physical characteristics are also investigated. The following are detailed descriptions of the various test techniques.

2.3 Sand

In this research, cement is mixed with sand as a grouting material. Research material sand is collected from the "Indus river, Layyah", which is used in the present investigation. The grain size distribution curve is shown in Figure 1 below.

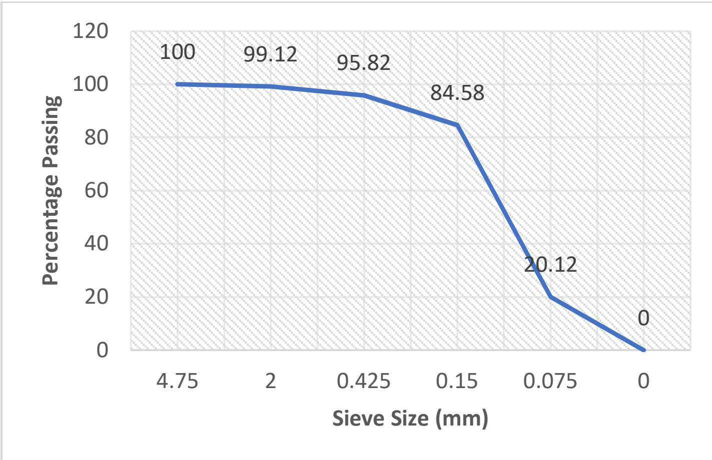
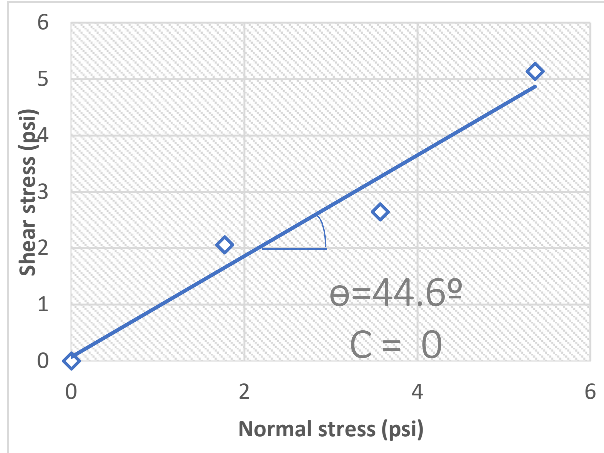


Figure 1 (a) Grain size distribution curve of sand



(b) Shear stress &Normal stress curve

2.4 Permeability test

The property of a permeable material that allows water or other fluids to travel through its interconnecting spaces is known as permeability. Gravel is extremely permeable, but stiff clay or due to plastic clay is not. A constant head test or a falling head test can be used in the lab to evaluate the coefficient of permeability. The permeability was determined in the current study using continuous head testing. The rigid wall specifications were 150 mm x 150 mm x 150 mm. The sand was put into the mould with a dry density of 14.5 kN/m3 in mind. Water was allowed to flow through the sand's medium at a consistent rate. Once a constant condition was established, the discharge was measured.

3. Research Methodology

The dirt is poured into the tank without causing any damage to the four grout pipelines. Figure 2 depicts the inflow of cement and cement grouting into a 21cm x 24cm tank. The cement grout solution slurry is combined with the necessary percentage of water and poured evenly into all four grout pipes. There will be no pressure-induced flow of grout into the perforated pipes if the slurry solution is agitated constantly and completely.

Figure 2: Permeation of grouting occure

A tank made of a poly-carbide sheet measuring 21cm x 24cm is used to prepare permeation grouted samples. The grouting sand is placed in the tank. For the grouting, four PVC pipes with a diameter of 20 mm are utilized, each with three-millimeter holes on the surface. The grout is dispersed circumferentially and the grouting is more effective by plugging the bottom of the PVC pipe. The grout is placed into the four PVC pipes similarly after being mixed in a cement solution with cement ratios of 7:1, 6:1, 5:1, and 4:1 and thoroughly agitated to provide a consistent grout solution. The shotcrete sample was maintained wet for 14 days during the curing process. When doing a plate load test, the mold is poured with the loosest sand possible. The sample is then placed in the Universal Testing Machine's two compression jaws (UTM). A 6-inch round plate distributes the load evenly. The sand is squeezed, and the results are used to calculate the load settling curve. The following is the load settling curve: On ungrouted soil, a shear strength test is performed, and the results of greater force and settlements are recorded. Graph 4 depicts a relationship between maximum load and settlements.Plate load tests are carried out for different grout ratios ranging from 7:1 to 4:1 water-cement ratio. After an efficient curing time of 7 days, grouted samples are tested to a plate load test, and the results are documented.

4. Results

Table. 2 Grouting proportions

Mixing the proportion of grout and their notations		
Notation	**Water**	**Cement**
G1	7	1
G2	6	1
G3	5	1
G4	4	1

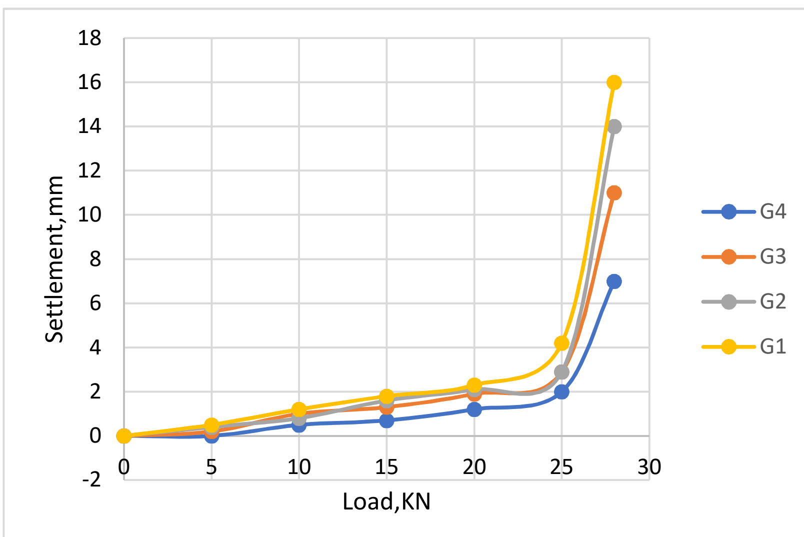


Figure 3:Combine load settlement graph

Figure 3 combine load settlement denotify relationship between load and settlement of sand and sample testing specimines rename as G1,G2,G3,G4. From the result graph G4 curve is more effective than others three sample of group.Strength of cement grouting specimines is more effectiveto bearing te load impact.

5 Conclusion

The study looks at the strength of grouting materials in order to enhance sand bearing capacity. The efficiency of cement grouting is typically determined by the penetration of cementitious material through to the pores of sand. Various tests may be used to assess the influence of cement grouting on poor bearing capacity: The ultimate load reduces as the grouting ratio lowers.

- The strength of sand increases constantly by using grouted materials. So Loading conditions increase from24 kN to 44 kN at 5:1 grouting.
- Due to curing and cement content increasing the cohesion ''c'', shearing resistance steadily increased. Curing impact is more significant at the high value of content as compared to the low value of content. In the situation of values of c and, Ø the initial soil moisture of the cementitious material has a considerable impact. While the following equation decreases dramatically as the initial moisture contents of the grout increase, the value of increases as the initial liquid limit of the grout increases, except in the situation of fine sand. It is found that 4% cement grout is much more successful in medium and coarse sand than 2 percent and 6 percent.

Furthermore, when medium sand is grouted with 4% cement, the strength of the epoxy-coated sand is substantially higher than the strength of the sand in its loosest state. Because of the larger pore space available, coarse sand takes less cement than medium sand for grouting to be successful.

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