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ASSESSMENT OF INFLUENCE OF BEARING CAPACITY OF SOIL BY GROUTING

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Abstract - **This project work is on assessment of influence of bearing capacity of soil by grouting. From the early days of simple slurry injection to current sophisticated techniques, grouting has played, and continues to play, an important role in remediation and new construction World Wide. As new grouting technology is developed, and existing technologies are refined, the range of applications increases. Soil improvement is carried out for various objectives to improve bearing capacity and reduce settlement of soft ground, control ground water, stabilize excavation bottom, prevent deformation of surrounding ground, clean up contaminated ground and avoid or minimize earthquake liquefaction – induced soil deformations and associated damage. Grouting is the most common technical method used for soil improvement and strengthening. The grout is based on cement, silicate, or other materials, selected to suit particular ground conditions and improvement objectives. The very low bearing capacity of the foundation bed because shear failure and excessive settlements. Further, the high water table and limited depth of the top sandy layer in these areas restrict the depth of foundation thereby further reducing the safe bearing capacity. This paper discusses grouting as one of the possible solutions to the foundation problems of coastal areas by improving the properties of soil at shallow depths. This project presents an experimental procedure for how to improve the bearing capacity of soil. The bearing capacity of sandy soil samples are improved with respect to w/c ratio 1:3, 1:6 respectively. The sample was collected and are subjected to various test. In relation to the subject matter, view of some scholars& authors were reviewed and data presented and analyzed. Conclusions are made at the end of this project**

Index Terms — **sieve analysis, specific gravity, proctor compaction test, grouting, direct shear test**

I. Introduction

The construction of structure on weak ground often requires soil to be improved in order to ensure the safety and stability of surrounding buildings. The ground improvement in granular soils can be achieved by different methods. Grouting is a process whereby stabilizes either in the form of suspension or solution is injected into sub surface soil.

Grouting is a widely used method for strengthening and sealing rock, soil and concrete. The possibilities for sealing structures are of great importance from both an economic and environmental point of view. To improve the technique for grouting with cement – based material, it is necessary to examine the properties of the grout mixture used. Sandy soil is the largest particle in the soil when you rub it, it feels rough. This is because it has sharp edges and it does not hold many nutrients.

Soil stabilization, with cement grouts injected under pressure, has come into widespread use in construction. At present the grouting is highly prevalent in a number of branches of structural engineering and in foundation engineering for the reinforcement of existing foundations.

In planning a grouting program for particular conditions, the engineer needs knowledge of the various types of grout and their properties. The basic types of grouts now in use and their properties are discussed below. Types of admixtures and fillers used and their effects on the grout are also discussed. The most common types of grouts are Portland- cement, clay, chemical, and asphaltic grouts. No one grout is suitable for every situation. The properties of each specific grout make it desirable under certain circumstances. An important requirement for the selection of a grout is that its particles be substantially smaller than the voids to be filled.

A. CEMENT GROUTING

A very fine cement grouts with water to cement ratio as low as two can permeate several feet into well compacted fine sands with D_{15} in the range of 0.15mm. Cement grouting is method of injecting specially formulated cement based mixes under pressure to improve strength or reduce permeability of concrete structures. Cement grouting is usually performed by drilling holes into application area to intercept open cracks, fissures, joints, or cavities, then pumping under balanced pressure and stabilized grout mixes using a combination of cement, water. Cement grouting is also known as slurry grouting or high mobility grouting. Cement grouting may offer an economic advantage over conventional approaches such as removal and replacement, or piling, and can be accomplished where access is difficult and space is limited.

B. GROUTING PROCEDURES

CURTAIN GROUTING
BLANKET OR AREA GROUTING
CONTACT GROUTING
ORDER OF DRILLING AND GROUTING

CURTAIN GROUTING

Curtain grouting is the construction of a curtain or barrier of grout by drilling and grouting a linear sequence of holes. Its purpose is to reduce permeability. The curtain may have any shape or attitude. It may cross a valley as a vertical or an inclined seepage cut off under a dam; it may be a circular around a shaft or other deep excavation; or it may be nearly horizontal to form an umbrella of grout over an underground installation. A grout curtain may be made up of a single row of holes, or it may be composed of two or more parallel rows.

BLANKET OR AREA GROUTING

In blanket grouting, the grout is injected in to shallow holes drilled on a grid pattern to improve the bearing capacity and or to reduce the permeability of broken or leached rock. Such grouting is sometimes called consolidation grouting. Blanket grouting may be used to form a grout cap prior to curtain grouting lower zones at higher pressures, or it may be used to consolidate broken or fractured rock around a tunnel or other structure underground.

CONTACT GROUTING

Contact grouting is the grouting of voids between the walls of an underground excavation and its constructed lining. These voids may result from excavation over break, concrete shrinkage, or a misfit of lining to the wall of the excavation. The crown of a tunnel is a common locale for contact grouting.

ORDER OF DRILLING AND GROUTING

For Grout Contains, holes are initially drilled on rather widely spaced centers usually ranging from 20 to 40 ft. These holes are referred to as primary holes and are grouted before any intermediate holes are drilled. Intermediate holes are located by splitting the intervals between adjoining holes; the first intermediates are midway between primary holes and the second intermediates are halfway between primary and first intermediate holes. Spacings between holes are split in this fraction until the grout consumption indicates the rock to be satisfactorily tight.

All holes of an intermediate set in any section of the grout curtain are grouted before the next set of intermediates is drilled. Although primary holes are most often drilled on 20- 40 ft, other spacings are equally acceptable. If grout frequently breaks from primary hole to another, an increase in the primary spacing is indicated. If experience in apparently similar conditions suggests that a final spacing of between 5 and 10 ft will be satisfactorily, a primary spacing of 30 ft may be in order since it will break down to 7.5 ft with the second set of intermediates.

If the blanket grouted area is to serve the capping zone for deeper grouting, it must be tightened sufficiently by grouting to prevent appreciable penetration by the higher pressure grout injected in to lower horizon.

C. AIMS AND OBJECTIVES

1. To determine the nature of the sandy soil particles.
2. To determine the degree of the sandy soil compatibility.
3. To carry out the improvement of sandy soil through grouting.
4. To carry out some laboratory test sieve analysis test, specific gravity test, standard proctor compaction test, direct shear test, grouting test.

D. SCOPE OF THE STUDY

This project is based on the quality and influence of bearing capacity of sandy soil by grouting.

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II. METHODOLOGY

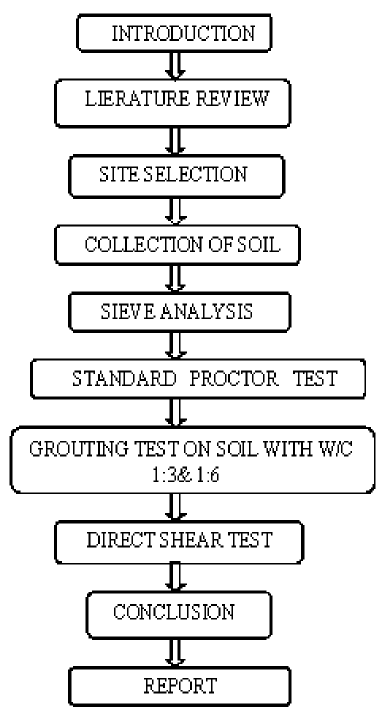

Fig.2.1 Flow chart

III. RESULT AND DISCUSSION

Table 3.1 SIEVE ANALYSIS FOR SANDY SOIL

S.NO	SIEVE SIZE IN (mm)	EMPTY WEIGHT OF SIEVE W_1 (gms)	WEIGHT OF SIEVE+ RETAINED SOIL W_2 (gms)	WEIGHT OF RETAINED SOIL (W_2-W_1) gms	% OF SOIL RETAINED (W_2-W_1)X100/500	CUMULATIVE PERCENTAGE OF SOIL RETAINED	% OF FINE SOIL
1.	4.75	360	370	10	2	2	98
2.	2.00	367	435	68	13.6	15.6	84.4
3.	1.00	419	517	98	19.6	35.2	64.8
4.	600	372	492	120	24.0	59.2	40.8
5.	300	358	502	144	28.8	88.0	12.0
6.	150	360	405	45	9.0	97.0	3.0
7.	Pan	324	399	15	3.0	100.0	0.0

Table 3.2 SPECIFIC GRAVITY FOR SANDY SOIL

S.NO	WORKING PRINCIPLE	SANDY SOIL
1.	Weight of density bottle w_1 (gms)	666
2.	Weight of bottle + dry soil w_2 (gms)	1148
3.	Weight of bottle + soil + water w_3 (gms)	1655
4.	Weight of bottle + water w_4 (gms)	1400
5.	Weight of sample in the bottle (w_2-w_1) gms	482
6.	Weight of volume of water (w_4-w_1) –(w_3-w_2)	227
7.	Specific gravity = (w_2-w_1)/(w_4-w_1)-(w_3-w_2)	2.12

Table 3.3 STANDARD PROCTOR COMPACTION TEST FOR SANDY SOIL

S.NO	OBSERVATIONS	TRIAL -1	TRIAL -2	TRIAL -3
1.	Weight of mould w_1(gms)	4580	4580	4580
2.	Weight of mould + compacted soil w_2 (gms)	6230	6350	6540
3.	% of water added	4	5	6
4.	Compacted soil W_3=w_2-w_1 (gms)	1650	1770	1960
5.	Density γ=w_3/v	1.65	1.77	1.96
6.	Dry density $\gamma d = \gamma(1+w)$	1.58	1.68	1.84

Volume of metallic mould =1000 ccm^3

Table 3.4 OPTIMUM MOISTURE CONTENT FOR SANDY SOIL

S.NO	OBSERVATIONS	TRIAL -1	TRIAL -2	TRIAL -3
1.	Weight of container w_1(gms)	8	20	8
2.	Weight of container + wet soil w_2 (gms)	77	100	62
3.	Weight of container + dry soil w_3 (gms)	73	94	57
4.	Water content W=(w_2-w_3)/(w_2-w_1)	5.79	7.5	9.3
5.	% of added water	2	4	6
6.	Voids ratio $e = (G.\gamma_w)/(1+wG)$	1.746	1.687	1.633

A. DIRECT SHEAR TEST FOR SANDY SOIL

Table 3.5 BEFORE GROUTING OF SOIL

HORIZONTAL DIAL GAUGE READING	PROVIDING READING CORRESPONDING THE LOAD IN Kg		
	1.00	1.50	2.00
0	0	0	0
20	8	13	15
40	10	16	18
60	11	17	21
80	13	19	25
100	15	22	27
120	16	25	31
140	17	27	35
160	18	29	38
180	20	31	42
200	22	35	45
250	24	36	49
300	-	-	50

Table 3.6 GROUTING OF SOIL WITH W/C RATIO 1:3

HORIZONTAL DIAL GAUGE READING	PROVIDING READING CORRESPONDING THE LOAD IN Kg			
	1.00	1.50	2.00	2.50
0	0	0	0	0
20	2	3	6	10
40	4	5	8	12
60	6	7	10	14
80	8	9	11	16
100	9	11	14	17
120	10	12	17	19
140	11	14	19	21
160	12	15	22	23
180	13	17	25	25
200	14	18	26	27
250	15	20	27	29
300	16	21	29	31
350	17	23	31	33
400	18	25	32	35
450	20	27	33	38
500	22	28	34	40

Table 3.7 GROUTING OF SOIL WITH W/C RATIO 1:6

HORIZONTAL DIAL GAUGE READING	PROVIDING READING CORRESPONDING THE LOAD IN Kg			
	1.00	1.50	2.00	2.50
0	0	0	0	0
20	10	15	18	25
40	15	18	20	29
60	18	20	23	33
80	20	22	27	37
100	21	24	29	41
120	23	26	31	45
140	25	27	32	49
160	27	28	34	54
180	29	30	37	56
200	30	32	38	57
250	31	34	42	58
300	33	35	47	60
350	34	37	50	65
400	35	39	53	70
450	36	41	55	73
500	36	43	57	76

B. DETERMINATION OF SHEAR STRESS FOR SANDY SOIL

Table 3.8 BEFORE GROUTING

NORMAL LOAD Kg	DISPLACEMENT	PROVING RING READING	CORRECTED AREA cm^2	CORRECTED LOAD kg	SHEAR STRESS kg/cm^2
1.00	0.25	24	33.0	7.56	0.23
1.50	0.25	36	33.0	11.4	0.34
2.00	0.30	50	32.4	15.7	0.49

Table 3.9 GROUTING WITH W/C RATIO 1:3

NORMAL LOAD Kg	DISPLACEMENT	PROVING RING READING	CORRECTED AREA cm^2	CORRECTED LOAD kg	SHEAR STRESS kg/cm^2
1.00	0.50	22	30.0	6.93	0.24
1.50	0.50	28	30.0	9.0	0.30
2.00	0.50	34	30.0	11.0	0.36
2.50	0.50	40	30.0	12.9	0.43

Table 3.10 GROUTING WITH W/C RATIO 1:6

NORMAL LOAD Kg	DISPLACEMENT	PROVING RING READING	CORRECTED AREA cm^2	CORRECTED LOAD kg	SHEAR STRESS kg/cm^2
1.00	0.45	36	30.6	11.3	0.369
1.50	0.45	43	30.6	13.6	0.44
2.00	0.45	57	30.6	18.0	0.58
2.50	0.45	76	30.6	23.9	0.78

The test result gives the shear stress values in the corresponding loads. The bearing capacity of soils is calculated before grouting of sandy soil is 262 KN/m^3. The bearing capacity of soils is calculated after grouting of sandy soil with w/c ratio of 1:3 and 1:6 is 473KN/m^3 and 405KN/m^3. The bearing capacity of sandy soil is increased to 80% and 54% with respect to the water cement ratio 1:3 and 1:6 respectively.

IV. CONCLUSION

Grouting method increases the shear strength of weak soil and therefore reduces the risk of liquefaction. This method of stabilization is best worked for loose sandy soil. Each of those techniques is applied in different situations for the same purposes. Compaction grouting is successfully applied to densify a thick loose sand layer in urban environment. This method densifies loose sandy soil and mitigates liquefaction of soil by injection in the soil without entering in its pores. Permeation grouting is very effective in increasing the resistance of un compacted soils against liquefaction by injection in the soil pores without changing its physical structure. Jet grouting is suitable method to underpinning of existing foundation to improve the strength of liquefiable soil but it neither stiffen the ground nor reduce shear stresses of soil. Jet columns provide bearing support and reduce settlement if liquefaction is limited to a specific zone. Soil grouting is a most economical method for ground improvement techniques.

REFERENCES

1. Emilio M. Morales, mark k. Morales, 2003, “state of practice in soil liquefaction Mitigation and engineering counter measures”.
2. Geotechnical news, 2008, “The grout line”, germany.
3. Ohno, Y. et al., 2005, “Cyclic shear characteristics of treated sand with colloidal silica grout”.
4. Oka, F . et al., 2003, “ Deformation and strength characteristics of improved sandy by a grouting materials and its application to liquefaction analysis of manmade island”, Department of civil Engineering, Kyoto university, Kyoto, japan.
5. Orense, R, 2008, “ liquefaction remediation by compaction grouting, dept of civil & environmental engineering”, university of Auckland.
6. Orense, R, Morita, Y, Ide, M, 2010, “Assessment and mitigation of liquefaction risk for existing building foundation”.
7. Plescan and rotaru, 2010, “Aspects concerning the improvement of soil against liquefaction”.
8. Raju V.R, Sridhar valluri, 2008, “practical application of ground improvement”, symposium on Engineering of ground & environmental geotechniques(SEG2).
9. Welsh.j.p, Burke .G. K, 2002, “ Advances in grouting technology”, Hayward baker inc., 1130 Annapolis road, Odenton, Maryland, USA.
10. Yilmaz D., Babccu F., Batmaz S., KAvruk F, 2008, “Liquefaction analysis and soil improvement in beydag dam. Geotechnical and geological Engineering”.