SOIL STABILIZATION OF LOOSE SANDY SOIL BY GROUTING

VARUN BASWAL[1], PROF. VIKAS KATARIA[2]

[1]B-tech, Student, Dept. of Civil Northern India Engineering College, Delhi
[2]Assistant Prof., of Civil Northern India Engineering College, Delhi

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Abstract - *Soil is known for its imperative character in construction world which varies its engineering properties from places as soil profile in coastal area often consists of very loose sandy soils extending to a depth of 3 to 4 m from the ground level. The low shearing resistance of the foundation causes local and punching shear failure and hence structure built on these soil may suffer excessive settlement and detrimental to the entire structure. The present investigation was aimed at obtaining solutions for these problems. The improvement in relative density and thereby the load carrying capacity of loose sandy soils of different gradations. Grouting is quite familiar term in foundation engineering, the purpose of which is to fill the voids of the formation material by replacing the existing fluids/air with the grout and thereby improving the engineering properties of the medium. The most commonly used grout material i.e. - ordinary Portland cement -has many advantages such as high strength, high durability, environmentally free and of low cost. It is done by hand mixing the grout uniformly with the soil.*

Key words: - Foundation Engineering, Grouting, Sieve Analysis, Sandy Soil

1. INTRODUCTION

Ground improvement and ground modification refer to the improvement in or modification to the engineering properties of soil that are carried out at a site where the soil in its natural state does not possess properties that are adequate to withstand the load of the structure. It can be done by increase the shear strength, decrease the permeability and compressibility, number of methods have been developed for ground improvement from ground surface to depths of 20 m or more by in-situ treatment. The improvement may be accomplished by drainage, compaction, preloading, reinforcement, and grouting, electrical, chemical or thermal methods. Among the various soil stabilization procedures, the most suitable one is selected depending upon the type of soil available, time, cost involved etc.

Grouting is quite a well-known technique in the field of civil engineering, especially in foundation engineering. Grouting is effective in both sand and silt deposits. Grouts are liquid suspensions or solutions that are injected into the soil mass to improve its behaviour. Such liquids can permeate into the void space of the soil and bind the soil particles together. The primary purpose of grouting is to fill the voids of the formation material by replacing the existing fluids with the grout and thereby improving the engineering properties of the medium especially reducing the permeability.

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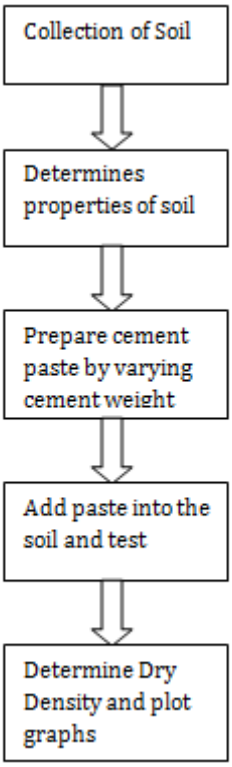
METHODOLOGY OF WORK:-

The process involved collection of soil sample and then determines different types of soil properties by performing different tests. Then prepare the cement paste by varying cement weight and add it to soil sample and then perform the tests. Dry density by different variation of cement can now be plotted on the graph and the results can be compared.



Materials and Methods:-

The selection of proper grouting materials depends upon the type of granular medium and the purpose of grouting. Cement, Bentonite, clay and lime are the grouting materials normally used for grouting a granular medium. In the present paper, sand was used as the grouting medium and cement was used as the grouting materials.

43 grade Ordinary Portland cement conforming to IS 269 – 1989 was used for the preparation of cement grouts. The cement bags were kept in air tight bins to avoid any change in the properties with the time of storage. The experiments were planned in such a manner that once a bag of cement was opened, the whole cement was utilized within 10 days.

Grout impregnation by hand mixing

The grouting material like cement without admixtures was hand mixed uniformly with the soil for the preparation of test specimens.

Around 200gm of soil was chosen for the preparation of samples. The predetermined quantity of cement (10, 15 and 20% by weight of soil) was then added to the soil and thoroughly mixed with a trowel.

Water was (5, 10, 15 or 20% by weight of soil and cement) sprinkled over the cement sand mixture and thoroughly mixed with a trowel. These specimens were kept at room temperature.

Results and Discussion:-

Several tests were performed to carry out the investigations based on the type of soil used for grouting purpose with different percentage of cement and corresponding water which is being sprinkled over the soil and cement sample.

Following are the test performed for analysis of the properties of soil:

1) Sieve Analysis
2) Specific Gravity by Density Bottle
3) Standard Proctor Test

After conducting all the above tests we were able to classify the different properties of soil which will be discussed as we proceed further.

SIEVE ANALYSIS:-

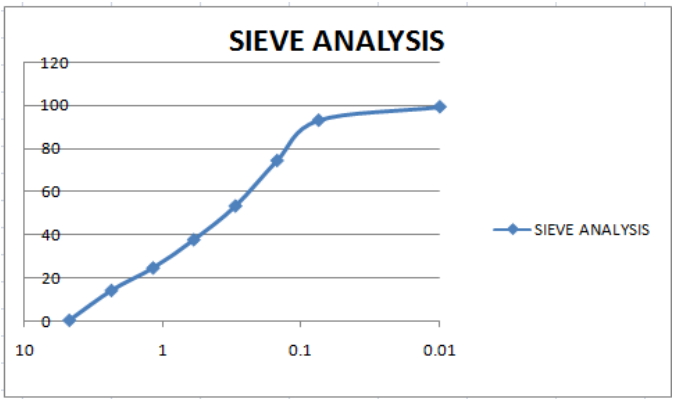
A sieve analysis is a procedure used to assess the particle size distribution of a granular material. The size distribution is often of critical importance to the way the material performs in use

Being such a simple technique of particle sizing, it is probably the most common.

Table 1: Soil passing Different Sieves

Sieve	Mass retained (gm)	Percentage of soil retained (%)	Cumulative	Percentage finer (%)
PAN	3	0.6	0.6	99.4
75	31	6.2	6.8	93.2
150	93	18.6	25.4	74.6
300	105	21	46.4	53.6
600	78	15.6	62	38
1.18	65	13	75	25
2.36	52	10.4	85.4	14.6
4.75	69	13.8	99.2	0.8

A graph of log sieve size vs. % finer is drawn in Ms Excel. The graph is known as grading curve. Corresponding to 10%, 30% and 60% finer, obtain diameters from graph these are D_{10}, D_{30}, D_{60}, using these obtain Cc and Cu which further represent how well the soil is graded i.e. whether the soil is well-graded, gap-graded or poorly graded.



SPECIFIC GRAVITY BY DENSITY BOTTLE

Specific gravity G is defined as the ratio of the weight of an equal volume of distilled water at that temperature both weights taken in air.

Fig: 1 Density Bottle fill with water

Fig: 2 Density Bottle fill with water and sand

Table 2: Specific Gravity Calculation

S. No.	Observation Number	1	2	3
1	Weight of density bottle (W_1 g)	32	32	32
2	Weight of density bottle + dry soil (W_2 g)	48	44	42
3	Weight of bottle + dry soil + water (W_3 g)	91	88.56	87
4	Weight of bottle + water (W_4 g)	81	81	81
	Sp. Gravity G	2.66	2.7	2.5

The **Average Specific Gravity** of soil = (2.66+2.7+2.5)/3 = 2.62.The specific gravity of the soil particles lay within the range of 2.65 to 2.85.

Fig.3

STANDARD PROCTOR TEST

Proctors test is carried out to determine compaction of soil to understand compaction characteristics of different soils with change in moisture content.

S. No.	CALCULATIONS	TRIAL 1	TRAIL 2	TRAIL 3	TRAIL 4
1	Mass of mould + compacted soil(gm) M2	6135	6270	6308	6326
2	Mass of compacted soil(gm) M3=M2-M1	1865	1950	1980	2006
3	Bulk density	1.865	1.95	1.98	2.006
4	Mass of container + wet soil(gm) W1	39.1	41.7	44	50.4
5	Mass of container W2	14	12	12	14
6	Mass of container + dry soil(gm) W3	35	37	38	43
7	Mass of Dry soil(gm) W4	21	23	26	29
8	Water Content (%)	19.52	20.43	23.076	25.54
9	Dry Density	1.5604	1.6191	1.60875	1.598

Dry density of soil:

$$= \frac{M / V}{1 + w}$$

Where W=Total mass of soil, V= Volume of Soil, w=water content

Fig.3

The above figure depicts the standard proctor apparatus and below figure demonstrates the soil sample used to test.

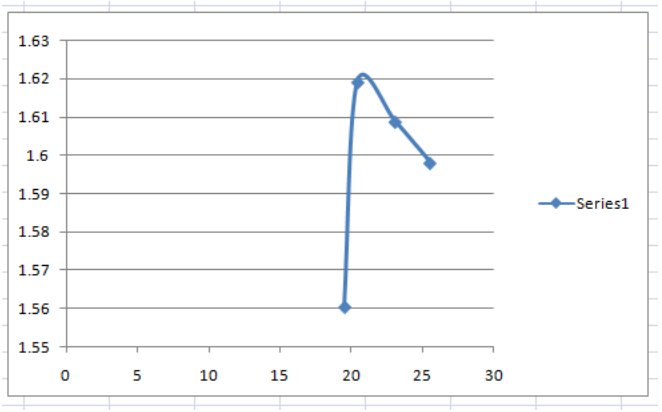


Fig 4

The maximum dry density (from Graph) = 1.6191

Optimum water content (from Graph) = 20.43%

GROUTED SOIL:-

The grouting is the method where some kind of stabilizing agent inserted into the soil mass under pressure. The agent reacts with the soil and /or itself to form a stable mass. The most common grout is an admixture of cement and water, with or without sand.

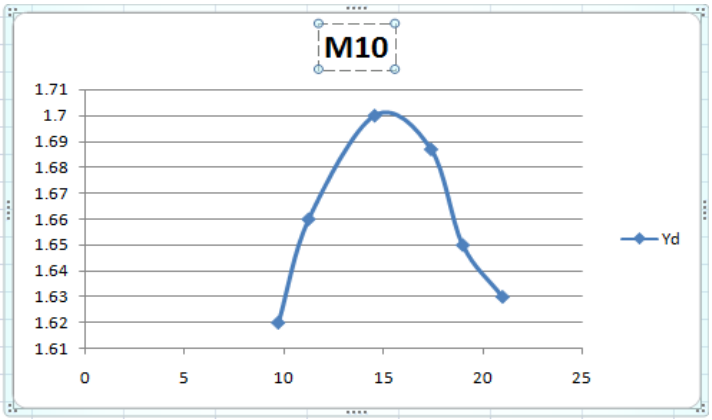
In this paper, the standard proctor test on M10, M15 and M20 is done so as to carry out the comparison between the grouted soil and the sandy soil

M10

The M10 soil is prepared by mixing 10% cement by weight of soil to the soil sample. About 4% by weight of soil and water is then sprinkled over the mixture. The mixture is then hand mixed by the help of trowel.

S. No.	CALCULATIONS	TRIAL 1	TRIAL 2	TRAIL 3	TRAIL 4	TRAIL 5
1	Mass of mould + compacted soil(gm) M2	6090	6166	6267	6280	6283
2	Mass of compacted soil(gm) M3=M2-M1	1770	1846.	1947	1960	1963
3	Bulk density	1.77	1.84	1.947	1.96	1.96
4	Mass of container + wet soil(gm) W1	40	38	44	45	42
5	Mass of container W2	14	11	11	14	12
6	Mass of container + dry soil(gm) W3	38	35.19	39.78	40.30	37.2
7	Mass of Dry soil(gm) W4	24	25	29	27	25
8	Water Content (%)	9.7	11.2	14.5	17.4	19
9	Dry Density	1.62	1.66	1.7	1.68	1.65

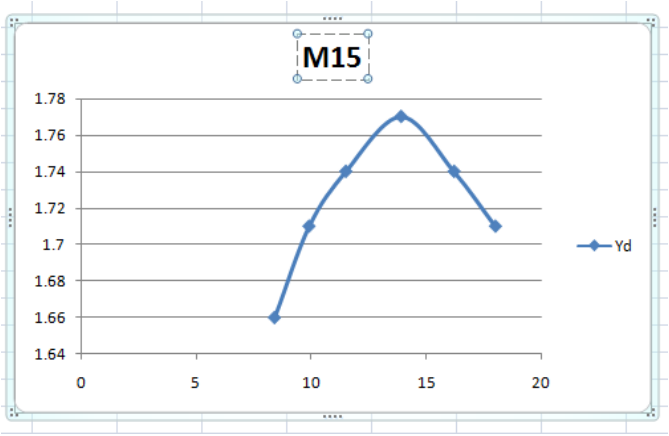
The graph showing the M10 cement addition into soil



M15

The M15 soil is prepared by mixing 15% cement by weight of soil to the soil sample. About 4% by weight of soil and cement is then sprinkled over the mixture. The mixture is then hand mixed by the help of trowel.

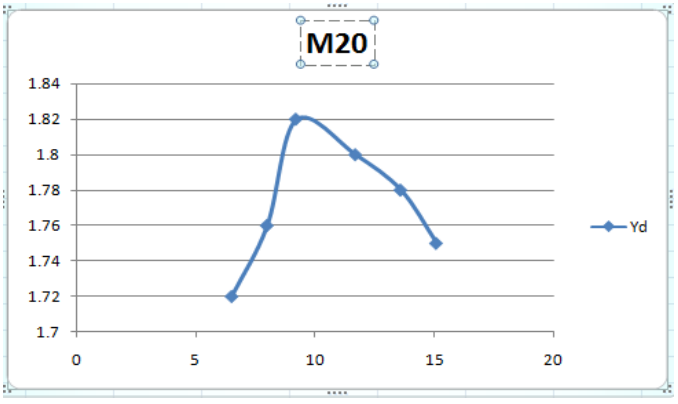
S. No.	CALCULATIONS	TRIAL 1	TRAIL 2	TRAIL 3	TRAIL 4	TRAIL 5
1	Mass of mould + compacted soil(gm) M2	6120	6190	6260	6336	6341.188
2	Mass of compacted soil(gm) M3=M2-M1	1800	1870	1940.1	2016	2021.188
3	Bulk density	1.8	1.87	1.94	2.01	2.02
4	Mass of container + wet soil(gm) W1	42	36.08	44	42	54
5	Mass of container W2	12	13	14	14	12
6	Mass of container + dry soil(gm) W3	39.73	34	40.9	38.6	49.7
7	Mass of Dry soil(gm) W4	27	21	27	24	26
8	Water Content (%)	8.4	9.9	11.	13.	16.2
9	Dry Density	1.66	1.71	1.74	1.77	1.74



M20

The M20 soil is prepared by mixing 20% cement by weight of soil to the soil sample. About 4% by weight of soil and cement is then sprinkled over the mixture. The mixture is then hand mixed by the help of trowel.

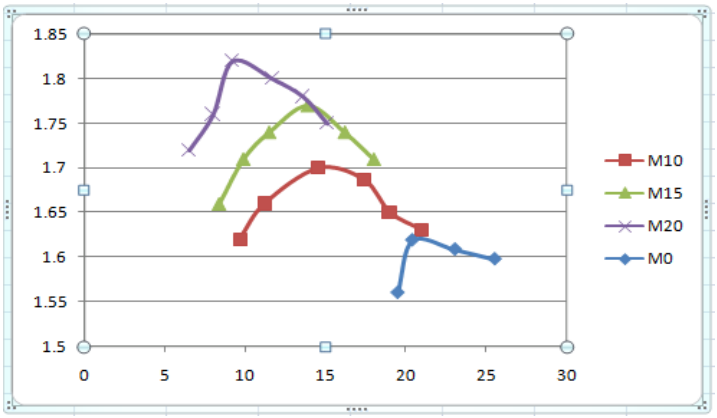
S. No.	CALCULATIONS	TRIAL 1	TRAIL 2	TRAIL 3	TRAIL 4	TRAIL 5
1	Mass of mould + compacted soil(gm) M2	6151	6220	6307	6330	6342
2	Mass of compacted soil(gm) M3=M2-M1	1831	1900	1987	2010	2022
3	Bulk density	1.831	1.9	1.987	2.010	2.022
4	Mass of container + wet soil(gm) W1	36	42	42	54	40
5	Mass of container W2	14	12	12	21	15
6	Mass of container + dry soil(gm) W3	34.635	39.765	39.515	50.607	37
7	Mass of Dry soil(gm) W4	21	28	27	29	22
8	Water Content (%)	6.5	7.98	9.2	11.7	13.6
9	Dry Density	1.72	1.76	1.82	1.8	1.78



Conclusion:-

Based on the above experimental investigation made on sandy soil and grouted soil was concluded as the grouted soil has compaction high when compared to ordinary sandy soil.

The graph between sandy soil and grouted soil is drawn as shown below:



The dry density is in the order M20 > M15 > M10 > M0, hence we may conclude that the strength of grouted soil is greater than the ordinary sandy soil.

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