Stabilization of Soils By Using Chemical Composition (Na_2siO_3)

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Abstract- *The constructional activities in some particular areas often demand deep foundations because of the poor engineering properties and the related problems arising from weak soil at shallow depths. The very low bearing capacity of the foundation bed causes 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 by improving the properties of soil at shallow depths by using sodium silicate*

Since 1945, various researchers have reported on the effectiveness of sodium silicate has a stabilizing admixture. Sometimes the silicate was used alone and some times in the combination with various other chemicals. Sodium silicate has to improve building materials more than a century. This study presents characterization of sodium silicate prepared from kankra kaolin.

Keywords- chemical composition, Stiffness of soil, Sodium silicate, Stabilization, Bearing capacity.

I. INTRODUCTION

1.1. General

The constructional exercises in the coastal areas frequently request profound establishments as result of a result of the poor designing properties, what's more, the related issues emerging from weak soil at shallow depths. The very low bearing limit of the establishment bed causes shear failure and excessive settlement. Further, the high-water table and limited depth of the best sandy layer in these regions limit the profundity of establishment in this manner further decreasing the protected bearing limit. This project talks about grouting as one of the conceivable answers for the establishment issues of the beachfront region by enhancing the properties of soil at shallow depths.

The term ground improvement basically refers to the improvement to the Engineering properties of soil which is not present in its natural state. Ground improvement refers to the increase in shear strength decrease in permeability, and decrease in compressibility.

One method is to excavate the week soil and then replace it with soil having the desired properties. But this method is only are depths of 3m and water table must be below 3m. Otherwise it will be Uneconomical to excavate large amount of soil and replace it.

Selection of ground improvement techniques basically depends upon a number of factors like the soil condition, type of structures, time available for the project completion material and equipment Availability, degree of compaction and also the transportation facility.

Many of the foundation problems can be effectively solved by compaction, which will cause reduction in total settlement Dynamic compaction gives best results up to depth of 10 to 20m. The relative density of Sandy soil properties cannot be increased by compaction or by vibration, the best method is grouting.

The settlement of saturated cohesive soil consists of the sum of three components:

- Immediate settlement occurring as the load is applied.
- Consolidation settlement occurring gradually as excess pore pressures generated by loads are dissipated.
- Secondary compression essentially controlled by the composition and structure of the soil skeleton.

1.2. Literature Review

Pfeifle and Das (1979)[1]

They presented laboratory model tests results for the case of rough rectangular footings in sand with a rigid rough base located at a limited depth. The results were compared to the predicted results of Mandel and Salencon (1972) and

Meyerhof (1974). The authors concluded that the critical depth of location of the rough rigid base beyond which it has no effect on the value of the ultimate bearing capacity is about 50%-75% higher than that predicted by the theory. And the previous theories do not predict correctly the bearing capacity for the case when the rigid base is located at shallow depth. This experimental investigation is very limited to one case of layered soils, and the friction angle ϕ of the sand used varies in a small range (42°-45°), and the conclusion may be valid only for this range of ϕ.

Hanna and Meyerhof (1980)[2]

They extended the previous theory to cover the case of footings resting on subsoil consisting of a dense layer of sand overlying a soft clay deposit, and they presented the results of this analysis in the form of design charts.These values were compared with the recommended values given in the Canadian Foundation Engineering Manual. The values of these factors given in the manual agree reasonably well with the experimental ones, except for the depth and shape factors, for which the theoretical values are on the conservative side when applied to inclined loads.

Hanna (1981)[3]

He extended his previous theory to cover the case of footings resting on subsoil consisting of a strong sand layer overlying a weak sand deposit. Applying the same theory that at ultimate load, a soil mass of the upper layer is pushed to the lower sand layer, and by calculating the forces on the assumed vertical punching failure surface, the ultimate bearing capacity can be calculated theoretically. Charts are presented in this paper and can be used in the design of footings. In order to verify the theory presented, model tests on strip and circular footings resting on dense sand layer overlying loose sand layer were done, and the results of the tests agreed well with the theory presented.

Georgiadis and Michalopoulos (1985)[4]

They presented a numerical method for evaluating the bearing capacity of shallow foundations on layered soil, which may contain any combination of cohesive and non-cohesive layers. Several potential failure surfaces were analyzed and the minimum material factor for which the foundation is stable was determined. Comparisons between the results obtained with this method, a number of semi-empirical solutions for homogeneous and two-layer soil profiles, experiments and other numerical methods including finite elements, demonstrated the validity of the proposed method. Moreover, the bearing capacity computed with the various semi- empirical formulas are usually scattered. In the case of more than two layers in a soil profile, the bearing capacity can be computed with a finite element analysis or numerical analysis.

Das (1988)[5]

He presented a technique to improve the ultimate bearing capacity and settlement conditions of shallow foundations on soft clay soil, which consists of placing the footings over a compact granular fill, lay over the clay layer. Placing geotextile at the interface of the clay layer and the sand layer can further increase the bearing capacity. The purpose of placing the granular layer is to distribute the load on a larger area of the clay layer, and the purpose of placing the geotextile mesh is to reduce the depth of the sand layer required to distribute the load. The objective of this research was primarily to present the results of model tests conducted on a strip foundation resting on a sand layer overlying a weak clay layer, and compares the results with the theory of Meyerhof and Hanna (1978). Secondly, to compare results of the bearing capacity of footings on layered soil with and without the use of the geotextile mesh at the interface of the two layers in order to evaluate any advantage derived from the inclusion of the geotextile.

1.3. Aim

To stabilize the soil by adding sodium silicate to achieve high and effective properties of the soils

II. MATERIALS AND METHODS

2.1. Materials Collection Data

In this study Black cotton soil (IS sieve 4.75mm passed), Red soil (IS sieve 4.75mm passed), and Sodium silicate (Na_2siO_3) powder commercially available in market were used for the Settlement of Soils and for entire tests.

- The Black cotton soil and Red soils were obtained from Bal Nagar, Hyderabad, Telangana.
- Sodium silicate can change the property to raise the normal properties of soil in effective manner.
- To obtain the maximum dry density of soils to settleable.

Fig 2.1. (a) Black cotton soil

Fig 2.1. (b) Red soil

Fig 2.1.(c) Sodium silicate (Na_2siO_3) powder.

2.2. Study objects

- To study the properties of Red soil and Black cotton soil.
- To stabilize soils with sodium silicate.
- Different types of laboratory tests on soils.

2.3. Methodology

Take a representative oven-dried sample, approximately 3 kg in the given pan. Thoroughly mix the sample with sufficient water to dampen it with approximate water content of 4-6 %.Add 10% of sodium silicate powder to the samples.Weigh the proctor mould without base plate and collar. Fix the collar and base plate. Place the soil in the Proctor mould and compact it in 3 layers giving 25 blows per layer with the 2.5 kg rammer falling through. The blows shall be distributed uniformly over the surface of each layer.Remove the collar; trim the compacted soil even with the top of mould using a straight edge and weigh.Divide the weight of the compacted specimen by volume and record the result as the bulk density.Remove the sample from mould and slice vertically through and obtain a small sample for water content. Add water in sufficient amounts to increase the moisture content of the soil sample by one or two percentage points and repeat the above procedure for each increment of water added. Continue this series of determination until there is either a decrease or no change in the wet unit weight of the compacted soil

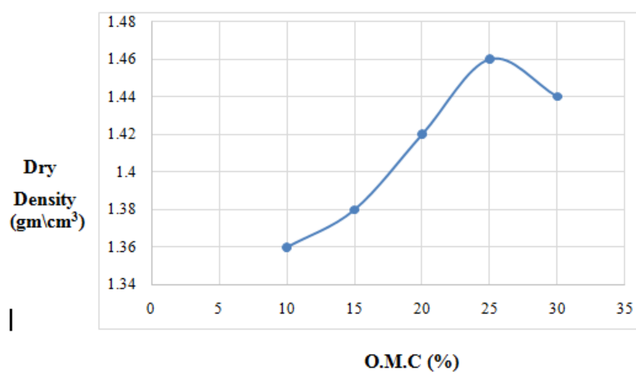
III. RESULTS AND DISCUSSIONS

3.1.Standard Proctor Test Results

Black Cotton soil

Results:

i) Max Dry densityfor Black Cotton soil is 1.47gm/cm^3.
ii) Optimum Moisture Content for Black cotton soil is 25%.

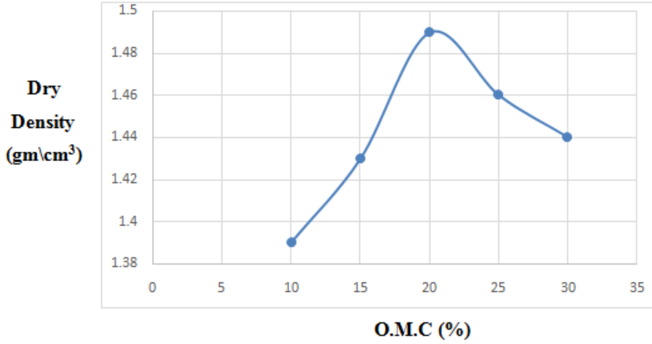


Graph: 3.1. Black cotton soil

Red soil

Results:

i) Max Dry densityfor Red soil is 1.48gm/cm^3.
ii) Optimum Moisture Content for Red soil is 27%.



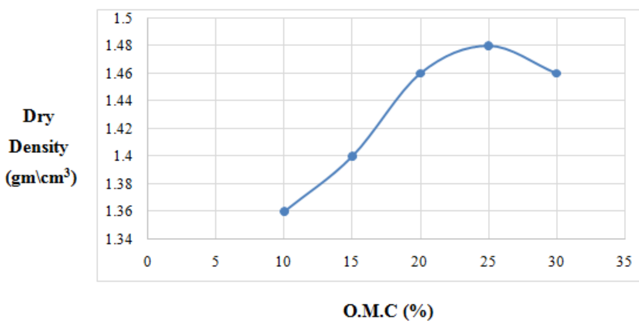
Graph:3.1. Red soil

3.2.Standard Proctor Test Results (Addition of Sodium Silicate)

Black Cotton soil

Results:

i) Max Dry densityfor Black Cotton soil is 1.49gm/cm^3.
ii) Optimum Moisture Content for Black cotton soil is 21%.

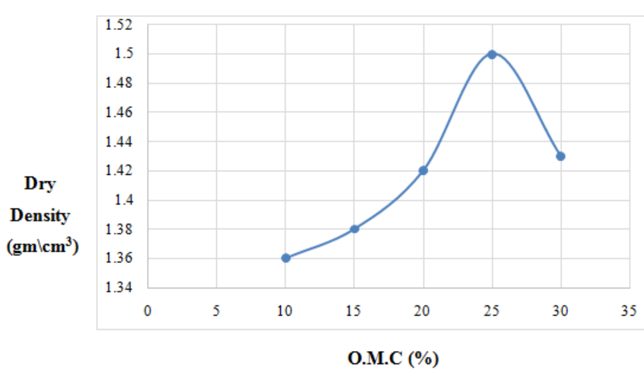


Graph: 3.2. Black cotton soil

Red soil

Results:

i) Max Dry densityfor Red soil is 1.49gm/cm^3.
ii) Optimum Moisture Content for Red soil is 20%.

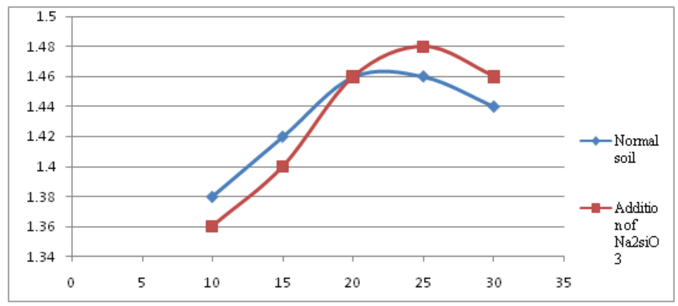


Graph:3.2. Red soil

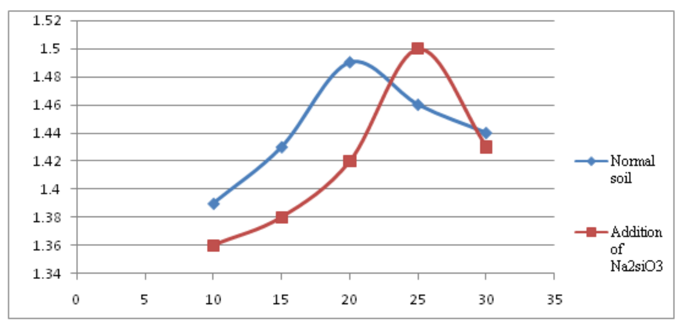
3.3Comparison of soils:

Table-3.3Comparison of Soils:

Standard Proctor Test	Black Cotton soil		Red soil	
	Max dry density(gm/cm^3)	OMC (%)	Max dry density(gm/cm^3)	OMC (%)
Normal soil	1.47	25	1.48	27
Addition of sodium silicate	1.49	21	1.49	20



Graph 3.3: Black cotton soil



Graph 3.3: Red soil

IV. CONCLUSION AND REFERENCES

4.1. Conclusion

Based on this experimental investigation made on Black cotton soil and Red soil was concluded as

- Soil is reacting with stabilising material i.e., sodium silicate and it undergoes frequent changes in shrinkage as well as expansion.
- Sodium silicate acts very fast and improves various properties of soil such as resistance to shrinkage during moisture conditions and increase in the compression resistance along with time.

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