Stabilization of Lithomargic Clay Using Sodium Chloride Salt

R. Manjunath, K.S. Vinay, R. Raghu, N.A. VarunRaj and P.R. Vibish

Abstract--- *The increasing demand of human intervention with nature has made to utilize all the available land area being transformed in commercial establishments. In such a scenario, the ground improvement is the need of the hour. There are many methods to improve the index behavioral properties Modification of the properties with the help of admixtures. Mechanical stabilization, stabilization with cement, lime, bitumen and chemicals (salts) etc. Compaction and drainage are the examples of the first type, which improve the inherent shear strength of soil. In this paper attempts have been made to improve the engineering properties of a locally available shedi soil this soil is selected as it is treated to undergo large deformable characteristics in its properties when it comes in contact with moisture contact. There are a great many chemicals which are used for stabilization .Some of the chemicals which are commonly used for stabilizing soils are Calcium chloride, Sodium chloride, Sodium silicate etc. The salts act as soil flocculent. It facilitates compaction and usually causes a slight increase in the compacted density. The salts may be spread on surface, or incorporated into the soil by mix–in- place and plant-mix methods*

Keywords--- *Stabilization, Compaction,Dry Density*

I. INTRODUCTION

THE decreasing availability of good construction sites is forcing engineers to utilize even the poorest sites with subsoil conditions. The poor ground conditions pose the problem of low shear strength and low bearing capacity as well as high compressibility and excessive settlements over long periods of time. The presence of large deposits of weak soil of varying type has necessitated the development and application of various ground improvement techniques. Chemical stabilization is one method of ground improvement. Soil stabilizing additives are used to improve the properties of less–desirable soils. When used these stabilizing agents can improve and maintain soil moisture content, increase soil particle cohesion and serve as cementing and water proofing agents. Usually an increase in density is accompanied by an increase in either Φ or C or both. Particle packing always increases the density which in turn increases the bearing values.

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II. EFFECT OF SODIUM CHLORIDE ON SOIL

Soil water salinity can affect soil physical properties by causing fine particles to bind together into aggregates. This process is known as flocculation and is beneficial in terms of modifying the required engineering properties of the soil. Taking into consideration the abundance of salt and economical viability, the use of sodium chloride is preferable.

Sodium has the opposite effect of salinity on soils. The primary physical processes associated with high sodium concentrations are soil dispersion and clay platelet and aggregate swelling. The forces that bind clay particles together are disrupted when too many large sodium ions come between them. When this separation occurs, the clay particles expand, causing swelling and soil dispersion.

Soil dispersion causes clay particles to plug soil pores, resulting in reduced soil permeability. When soil is repeatedly wetted and dried and clay dispersion occurs, it then reforms and solidifies into almost cement-like soil with little or no structure. The three main problems caused by sodium-induced dispersion are reduced infiltration, reduced hydraulic conductivity, and surface crusting**.** When sodium-induced soil dispersion causes loss of soil structure, the hydraulic conductivity is also reduced.

Another important aspect of soil texture has to do with surface area. Because of their tiny size, a given volume of clay particles has far more surface area than the same volume of a larger sized particle. This simply means that clay soils are at a greater risk than course textured soils for excess sodium to bind to them and cause dispersion. Sands have larger particle sizes, resulting in less surface area; correspondingly, they cannot accept as much sodium as clay particles. Experiments are done to determine better bearing stability values using different bearing capacity equations

III. METHODS AND MATERIALS

The soil taken for the study is the locally available lithomargic clay called as Shedi soil, which is present at a depth of 1to 3 meters below the top lateritic outcrop. These soils are the product of tropical and subtropical weathering which was collected from Kavoor near Mangalore. Surface soil was excavated after removal of vegetation.

Efforts were carried to study the effect of Nacl on Shedi soil, its increase in dry density values along with impact on moisture content. The increase in bearing capacity values was observed only using Terzhagi's equation as it gives better suitability

IV. Experimental Investigation

The Sieve Analysis is conducted to know the different percentage of soil fractions. The Specific gravity (G) is 2.37**.** The Index properties were carried out using the following coda provisions**.** IS: 2720 Part IV (1965) Method of test for soil: Grain Size Analysis. IS: 2720 Part V (1965) Determination of liquid and plastic limits. IS: 2720 Part VI (1965) Determination of Shrinkage factors.

Table 1: Properties Of Soil.

Sl. no	Property		Values
1	Grain Size	Gravel	0%
		Sand	93.36%
		Clay	4.75%
		Silt	20.94%
2	IS Classification		MI
3	LIQUID LIMIT		43.3%
4	PLASTIC LIMIT		38.64%
5	PLASTICITY INDEX		4.66%
6	SHRINKAGE LIMIT		37.37%

V. Compaction

Compaction is the process of packing the soil particles by reducing the air voids in the soil by mechanical means. The above compaction tests were carried out using Indian Standard moulds IS: 2720 (Part VIII) 1965 with light compaction.

A. Variations with Different Normality

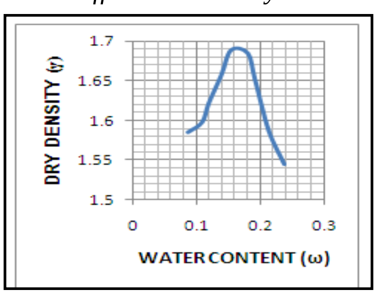

Figure 1: Compaction Using Zero Normal Solution

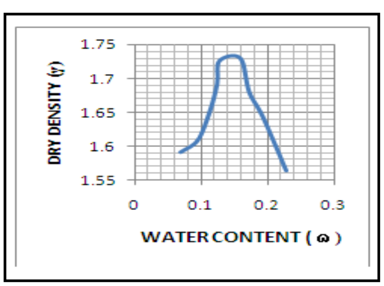

Figure 2: Compaction Using Two Normal Solution

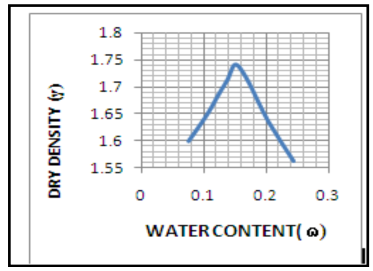

Figure 3: Compaction Using Four Normal Solution

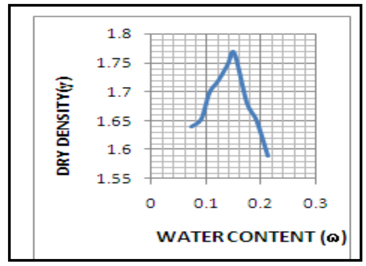

Figure 4: Compaction Using Saturated Normal Solution

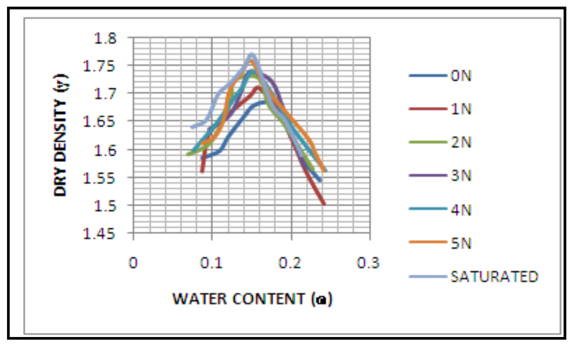

Figure5: Variations of Compaction with Different Normality

Table 2: Variations of Compaction with Different Normality

Normality	0	1	2	3	4	5	Saturated
OMC (%)	17.9	15.9	15.8	15.1	15.1	14.9	15.2
Dry density (max) (g/cc)	1.684	1.710	1.730	1.74	1.74	1.757	1.767

VI. Triaxial Test Results

Tests were carried out for zero normality, two and saturated Normalities to know the maximum increase in shear value along with increase in c and Φ values of shedi soil. The tests were carried using the coda provisions of. The tests were carried for zero Normality; two and four normality's respectively to obtain c and Φ Values.

VII. Safe Bearing Capacity

The ultimate bearing capacity of the soil is that pressure or load intensity which just causes the shear failure of the supporting soil, immediately below and adjacent to a footing

The increase in the bearing capacity values with different equations was checked for different c and Φ values. With Terzhagi's equation. The depth to width ratio (D/B) <1. The shape factor considered for case of square footing are, S_C =1.3 and $S\gamma = 0.8$.

$$Q_{ultimate} = CN_C S_C + q N_q + 0.5\gamma B N_\gamma S_\gamma$$

$$N_C = (N_q\text{-}1) \cot \Phi$$

$$N_q = \frac{a2}{a \cos 2\,(45+\Phi/2\,)}$$

$$a = e^{(0.75\pi\ -\Phi/2)\tan\phi}$$

$$N_\gamma = \tan \Phi /2\ (\ K_{p\gamma} / \cos^2 \Phi\ \ -1)$$

$Q_{ultimate} =$ 162.05 KPa for c = 8.4 KPa and $\Phi=10^0.25$
$Q_{ultimate} =$ 180.06 KPa for c = 8.8 KPa and $\Phi=11^0$
$Q_{ultimate} =$ 209.36 KPa for c = 9.4 KPa and $\Phi=12^0.25$

VIII. Concluding Remarks

Over the past decade several researches and experiments were conducted to stabilize the soils using various admixtures. The main objective of this research was to understand the effect on soil properties upon the addition of sodium chloride (Nacl) salt.

- There was considerable increase in the Maximum Dry Density by addition of sodium chloride (Nacl) salt from 16.84 kn/m^3 for zero Normality to 17.67 kn/m^3 for saturation normality level.
- There was a considerable decrease in the optimum moisture content from 17.9% for zero normality to 15.2% for Saturation normality level.
- The value of Ultimate Bearing Capacity of shedi soils also had increased by 11.2% for 2 Normality and by 29.2% rise for saturated soil sample by keeping zero normality values as base values .By this we can conclude that the addition of salts indeed helps in strengthening the soils in a better way.

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