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Stabilization of Black Cotton Soil using Salts and Their Comparative Analysis

[1]Swarna Swetha Kolaventi, [2]Sanjay Gokul Venigalla, [3]D.Rakesh
[1]Assitant Professor, [2]Assitsnt Professor, [3]Assitsnt Professor
Department of Civil Engineering, Dhanekula Institute of Engineering & Technology,
Vijayawada – 521139, Andhra Pradesh

Abstract - **Black cotton soil is a typical expansive soil which loses its strength in presence of water resultant in swelling of the soil and in the absence of water it shows multiple cracks due to shrinkage. Black cotton soils cover about 20% of land area in India and are predominantly located in the Deccan trap covering the states of Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Tamilnadu, Uttar Pradesh and Rajasthan. It is also called as regur. Most Indian Black cotton soils are rich in Montmorillonate, a type of clay mineral. This mineral is responsible for swell-shrink behavior of the soil. The soil varies in color from grey to deep black. In the beginning it was considered that black color was due to the presence of humidified organic matter. Subsequent work has however, shown that the color is due to small concentration of titanium oxide. Soil stabilization is a process in which the bearing power of the soil can be increased by the use of controlled compaction; proportioning and the addition of suitable add mixtures and stabilizers. Soil stabilization deals with the physical, physic-chemical and chemical methods to make the stabilized soil serve its purpose. Present project is to investigate the effect of adding different chloride compounds including (nacl, $cacl_2$) on the engineering properties of black cotton soil. Various amount of salt (2%, 4%, 6%and 8%) were added to the soil to study the effect of salts on the compaction characteristics, consistency limits and compressive. The main findings of this study were that the increase in the percentage of each of the chloride compounds increase the maximum dry density and decrease the optimum moisture content. The liquid limit, plastic limit and plasticity index decreased with the increase in salt content. The strength increases as the salt content increases.**

Keywords - Soil Stabilization, Black Cotton Soil, Atterberg Limits, Strength

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I. INTRODUCTION

The Black cotton soil is a type of expansive soil with high plasticity and can retain moisture throughout the dry season which is why they are valuable for growing crops. It exhibits low bearing capacity, low permeability and high volume change due to presence of montmorillonite in its mineralogical content and these properties makes it unfit for construction of embankment and other engineering structures.

Black cotton soil is expansive clay with the potential for shrinkage or swelling under moisture change. They usually exhibit high shrink-swell characteristics with surface cracks, opening during the dry seasons which are more than 50 mm or more wide and several mm deep. These cracks close during the wet season and an uneven soil surface is produced by irregular swelling. Such soils are especially troublesome as pavement sub-grades.

In India about 51.8 million hectare of the land area are covered with black cotton soil The black cotton soils are very hard when dry, but lose it strength completely when in wet conditions. Black cotton soils are a worldwide problem that poses several challenges for civil engineers. These black cotton soils in India are a boon to farmers but problematic to civil engineers. Civil engineering structures experience large scale damage due to change in properties of soil. Black cotton soils always pose challenge to Geotechnical engineers.

This Paper describes an investigation into the effect of addition chloride compounds like Nacl,$Cacl_{2.}$

II.EXPERIMENTAL PROGRAM

The soil used in this paper was a silty clay soil, which was brought from Vijayawada located east of proposed Andhra Pradesh Capital City. This type of soils represent a widely spread typical soil in the middle and southern of vijawada. The soil samples were taken at a depth of about (1 m) below the ground surface. The properties of the soil, and atterberg limits are given in table (1) while the classification and the grain size distribution of the soil are shown in Fig. (1) and Fig. (2) Respectively, the soil lies above the A-line (Fig.1), thus the soil is classified as high plasticity clay soil (CH) according to the unified classification system.

Table (1) Properties of the soil used in this research

Property	Value
Liquid limit	60
Plastic limit	28
Plasticity index	48
Specific gravity	2.02
Clay fraction	40
Silt fraction	41

Sand fraction	16.5

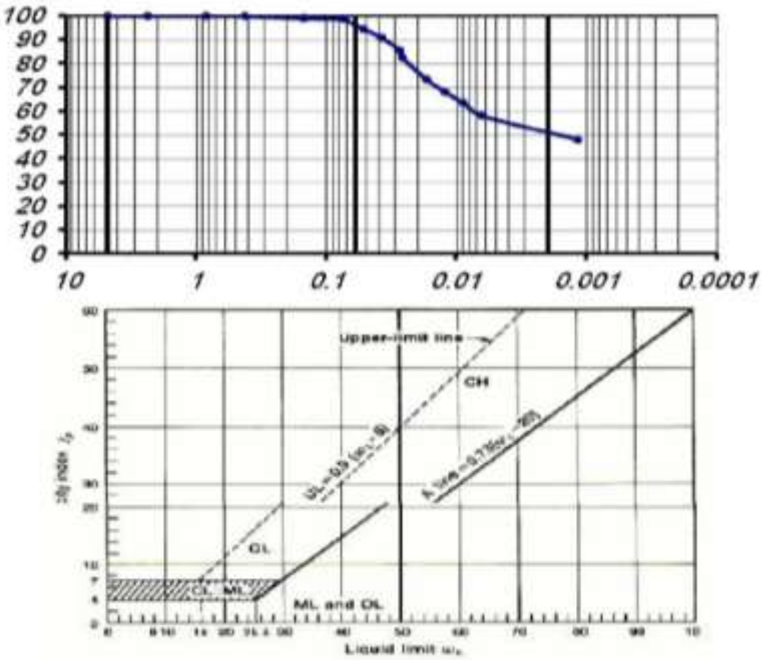


Fig. (1) Plasticity chart (Bowles, J. E. (1982)

III. SOAKING SOLUTIONS

Distilled Water: Distilled water was used in all tests.

Chlorides Solutions

The concentration of each chloride salt (NaCl and $CaCl_2$) was obtained by dissolving in distilled water to obtain the specific concentration for each type of salt in ppm, and then mixed with soil. The soil specimens were prepared by modified Procter test procedures according to ASTM (American Society for testing and materials) (D 1557). Three different concentrations for each chloride salt (2%, 4%, 6%and 8%) were prepared.

IV. SOIL TESTS

Atterberg Limits

The liquid limit test has been conducted using the Cassagrande apparatus according to ASTM (D423-66). The plastic limit test was conducted according to the ASTM (D424-59). These tests were carried out to investigate the effect of addition of salt on the consistency limits. The effect of salt content on the Atterberg limits is shown in Fig. (4).

Compaction Test

The modified proctor compaction test was carried out to determine the moisture-dry density relationship according to ASTM (D 1557). Each chloride salts (NaCl and $CaCl_2$) were dissolved in water and mixed with soil then left for 1 day. The soil was compacted into 929.75 cm^3 mould in five layers. Figure 3 shows the dry density-moisture content relation for different type and percentages of salts compared with that relation in the natural soil

V RESULTS AND DISCUSSION

Atterberg Limits

Figure (2) shows the effect of salts content on the Atterberg limits. The liquid limit, plastic limit, and plasticity index decrease as the salts content increased. This behavior is due to the decrease in the thickness of the diffused double layer as the salt content increased.

Compaction test

The relation between dry density and moisture content for different salts type (NaCl and $CaCl_2$) and different concentration percentages (2%, 4%, and 8%) are plotted in fig. (3).The result showed that the addition of salts to the soil increase the dry density and decrease the optimum moisture content. They attributed this behavior to the fact that at low moisture content the soil structure (before compaction) tends to change from edge-to-face type of flocculation to face-to-face flocculation (salt flocculation) with increase in salt concentration. Consequently under the influence of dynamic compaction, the clay particles become more oriented and the compacted dry unite weight increases with increase in salt content. The decrease in the optimum moisture content as the salt content increased may be explained due to the higher the face-to-face flocculation the lower is the amount of water required to lubrication.

Table (2) Index & Engineering Properties of Untreated Soil

S.no	Property	For B.C.Soil
1	Liquid Limit	60%
2	Plastic Limit	28%
3	Plasticity Index	48%
4	Free Swell index	70%
5	Maximum Dry Density	16 (KN/m3)

Table (3) Index & Engineering Properties of Treated Soil (Nacl)

S.no	Property	2%	4%	6%	8%	10%
1	Liquid Limit	52%	52%	48.425	44%	44%
2	Plastic Limit	26%	25%	23.16%	20.73%	20.73%
3	Plasticity Index	26%	27%	25.26%	23.27%	23.27%
4	Free Swell Index	45%	43%	42%	40%	40%
5	Maximum Dry Density (KN/m3)	16	16.8	17.5	18.7	18.7

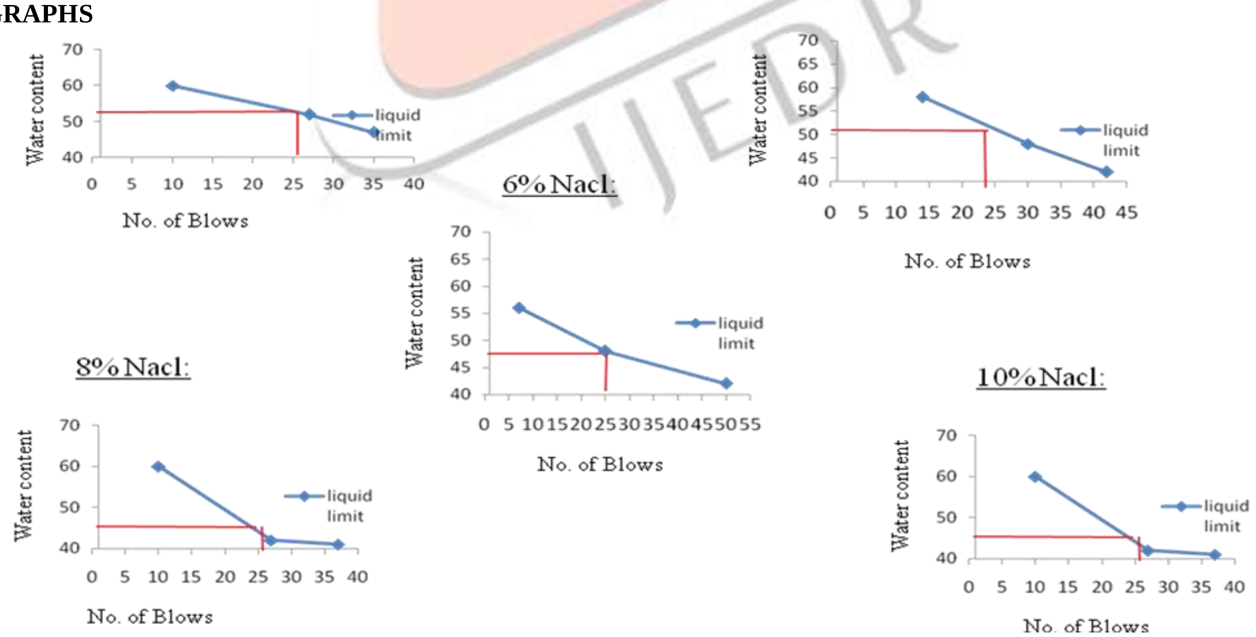
Table (4) Index & Engineering Properties of Treated Soil:($Cacl_2$)

S.no	Property	2%	4%	6%	8%	10%
1	Liquid Limit	48%	47%	46%	42%	42%
2	Plastic Limit	24%	23%	22.26%	21.93%	21.93%
3	Plasticity Index	26%	24%	23.74%	20.07%	20.07%
4	Free Swell Index	41%	39%	37%	35%	35%
5	Maximum Dry Density (KN/m^3)	18	18.7	19.4	20.75	20.75

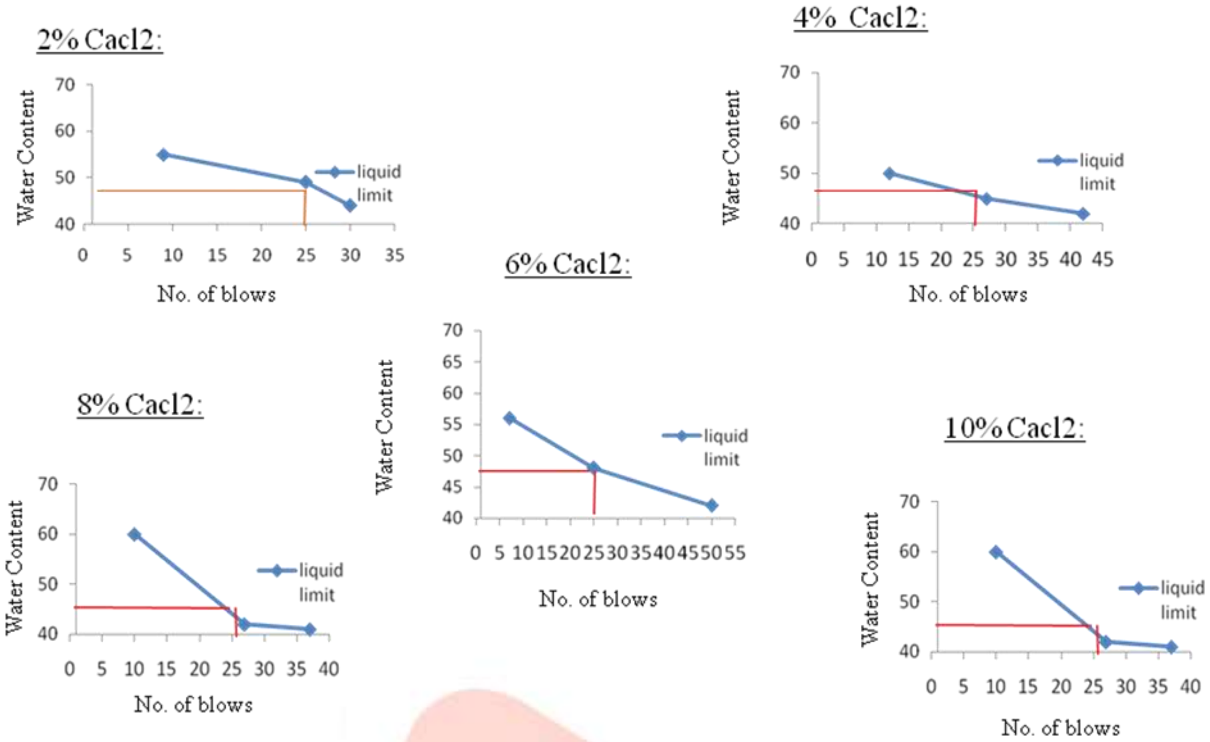
Table(5) Comparison Between Index & Engineering Properties of Untreated Soil & Treated Soil(Nacl & $Cacl_2$)

S.no	Property	Untreated Soil	Treated Soil (Nacl)	Treated Soil ($Cacl_2$)
1	Liquid Limit	60%	44%	42%
2	Plastic Limit	28%	20.73%	21.83%
3	Plasticity Index	48%	23.27%	20.17%
4	Free Swell Index	70%	40%	35%
5	Maximum Dry Density (KN/m3)	16	18.7	20.75

VI GRAPHS



Fig(2) Liquid limit of treated soil with Nacl



Fig(2) Liquid limit of treated soil with $Cacl_2$

VII CONCLUSION

- By comparison between these salts we got better results for Calcium chloride (Cacl2) than Sodium Chloride (Nacl)
- The properties of the black cotton soil are improved by the addition of sodium chloride & calcium chloride at 8% .
- Comparing the cost, Sodium Chloride (Nacl) is cheaper when compared to Calcium Chloride (Cacl2). So in economic point of view it is better to use Sodium Chloride (Nacl) for stabilizing large area.

VIII REFERENCES

[1] ASTM Standard. (1989), Soil and Rock, Vol.0408
[2] **Bowles, J. E. (1982),** "Engineering Properties of Soil". Vol.2. New York: McGraw-Hill.
[3] **Chen, F. H. (1981),** "Foundation on Expansive soil", Amsterdam: Elsevier Scientific Publishing Company.
[4] **Frydman, I. R. & Ehrenreich, T. (1977),** "Stabilization of heavy clay with potassium chloride", Journal of Geotechnical Engineering, 8, 95-107
[5] **Head, K.H. (1980),** Manual of Soil Laboratory Testing Vol.1,2 Penetch Press, London.
[6] **Janathan Q. Addo, Sanders, T. G. & Chenard, M. (2004),** Road dust suppression: "Effect on unpaved Road Stabilization
[7] **Kezdi, A. (1980),** "Soil Testing Handbook of soil Mechanics, Vol.1, Soil Physics, Elsevier Scientific Publishing Company, Amsterdam.
[8] **Netterberg, F. and Maton, L.J. (1975)** "Soluble Salt, and PH Determinations on Highway Materials". Sixth Req. Conference for Africa on Soil Mechanics and Foundation Engineering.
[9] **Netterberg, F. (1970),** "Occurrence and Testing For for Deleterious Salts in Road Construction Materials with Particular Reference to Calcretes ". Proc. of the Symposium on Soil, and Earth Structures in Arid Climates, Adelaid, Australia.
[10] **Perloff. W. H. (1976),** "Soil Mechanics, Principals and Application", New York: John Wily, & Sons.
[11] **Shawn Birst and Jill Hough, (1999),** "Chemical Additive Usage on Unpaved Roads in The Mountain Plains States" Upper Great Plains Transportation Institute, North Dakota University.
[12] **Sina Kazemian and et. al., (2010),** "A Review of Stabilization of Soft Soil by Injection of Chemical Grouting", Australian Journal of Basic and Applied Science, 4(12): 5862-5868, 2010 ISSN 1991-8178.
[13] **University of Iawa, (2002),** "Foundation on Difficult Soils". the Spring Semester, internet.