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Effect on Geotechnical Properties of Lime Treated Black Cotton Soil – A Case Study of Kadukotthana Halli, Malavalli

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Abstract - *The aim of the present investigation is to study the effect of randomly distributed coir fibers for the stabilization of Black cotton soil in which Montmorillonite is the predominant clay mineral. Coir which is the natural fiber obtained from the outer pulp of coconut is a cheaply available eco-friendly product whose application never sustain any damages to environment and is free from resentments and has got wide applications related to ground improvement techniques. In this study an attempt has been made to reinforce the coir fiber with Lime treated Black cotton soil to increase the strength. As lime for stabilization of the fine grained soils is a proven methods of stabilization. For the present study natural fibers of coir are used to reinforce lime treated Black cotton soil since coir is a bio-degradable material. The Black cotton soil is collected from KADKOTTHANA HALLI, MALAVALLI. The test results indicates that addition of coir fibers to lime treated Black cotton soil acts as a bridge between the cracks resulting in increased compressive strength and lower optimum moisture content.*

Key Words: **Black Cotton Soil (BCS), Lime, Specific gravity, liquid limit, plastic limit, compaction, unconfined compressive strength.**

1. INTRODUCTION

In India, expansive soils are called as Black Cotton soil. The name "Back Cotton" as an agricultural origin. Most of these soils are black in colour and are good for growing Cotton. All the black soils are not expansive soils and all the expansive soils are not black in colour. These soils passed high strength in summer and decreased rapidly in winter. The soil has a swelling property due to the presence of *montmorillonite* mineral.

Expansive soil occurs all over the world. India has large tracks of expansive soil known as Black cotton soil [BCS] which is about 20% of total area. This type of soil is available up to a depth of 3.7 meters on an average in the above parts of India. Expansive soil occurring above the water table undergo volume changes with change in moisture content. Black Cotton soils absorb water heavily, swell, become soft and lose strength. These soils are easily compressible when wet and possesses a tendency to heave during wet condition. Black Cotton soils shrink in volume and develop cracks during summer. They are characterized by extreme hardness and cracks when dry. For developing a good and durable road network in black cotton soil areas, the nature of soils shall be properly understood. On such soils suitable construction practices and sophisticated methods of design need to be adopted. Increase in water table causes swell – shrink behavior in these type of soil which leads to cracks and differential settlement resulting in several damages to the foundations, buildings etc. Chemical stabilization is one of the oldest method of stabilization of BCS. In recent days it has been investigated that addition of fibers to soil, increases the ductility and reduces the cracks.

The clay or silty loam essentially forms the natural ground at Kadukotthana Halli, Malavalli. The soil was collected at a depth of 1.0 m meters at Kaduakotthana Halli [near water tank]. It was oven dried and the soil sample for the studies were taken to ensure uniformity, pulverized and sieved through IS 425 micron sieve before using.

2. OBJECTIVE OF THE STUDY

Following are the objectives of this experiment

- To study the Index properties of Black cotton Soil.
- To study the effect of lime on specific gravity, liquid limit, plastic limit, compaction and unconfined compressive strength of Black cotton soil.
- To study the effect of curing of lime for the period of seven days on specific gravity, liquid limit, Plastic limit, compaction and unconfined compressive strength of Black cotton soil.

3. MATERIALS AND METHODS

3.1 Black Cotton Soil

The clay or silty loam essentially forms the natural ground at Kadukotthana Halli, Malavalli, Mandya district. The soil was collected at a depth of 1.0m meters from the same place.

3.2 Lime

Lime is a calcium-containing inorganic mineral in which oxides and hydroxides are predominant. For the present work locally available lime is used.

3.4 Method of Testing

The results were obtained by conducting test of Specific Gravity [IS-2720 (part 3 1980)], Grain-Size Analysis [IS–

2720 (part 4 1975)], Liquid and plastic limit, Compaction, Unconfined Compressive Strength [IS-2720(part10, 1973)].

4. RESULTS AND DISCUSSIONS

4.1 Index Properties of Black Cotton Soil

Table – 1: Index Properties of Black Cotton Soil

Soil Properties	Value
Grains Specific gravity	2.35
Liquid Limit, Flow index	WLL 58%, IF = 15.60 %
Plastic limit	42.546
Plasticity index	IP= 15.45
Maximum dry density	1.4 gm/cc
Optimum moisture content	20%
Unconfined Compressive Strength	357 KN/m2
Direct Shear Strength	C=0.07, ϕ=27◦

4.2 Specific gravity of BCS treated with various Percentages of lime.

Table -2: Specific gravity of BCS treated with various Percentages of lime.

Mixture	Specific Gravity
Black Cotton Soil alone	2.35
Black Cotton Soil + 2% lime	2.38
Black Cotton Soil +3%lime	2.4
Black Cotton Soil+4% lime	2.47
Black Cotton soil+5%lime	2.54
Black Cotton Soil+6% lime	2.39
Black Cotton Soil +7% lime	2.23
Black cotton soil + 8% lime	2.04

In the present investigation the specific gravity of BCS alone and BCS treated with various percentages of lime were determined and the result have been represented in Table 2 and chart 1.

From the results it is observed that with the addition of lime up to 5% by weight of soil, the value of specific gravity increases and with further decrease in lime content in the value of specific gravity up to 8% lime.

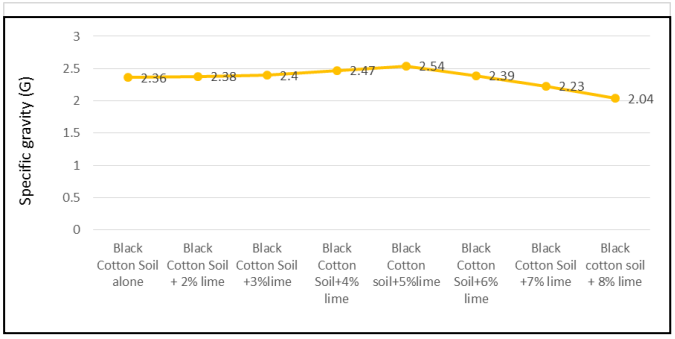

Chart -1: Variation of specific gravity of BCS with various percentage of lime

4.3 Liquid Limit

Table -3: Liquid limit of Black Cotton Soil treated with various percentages of lime

Mixtures	Liquid limit (%)	
	Immediate	Curing (7days)
Black Cotton Soil alone	52	52
Black Cotton Soil + 2% lime	51.3	51.15
Black Cotton Soil +3%lime	50.7	50.6
Black Cotton Soil+4% lime	51.9	51.75
Black Cotton soil+5%lime	50.4	50.25
Black Cotton Soil+6% lime	49.6	49.5
Black Cotton Soil +7% lime	49.4	49.3
Black cotton soil + 8% lime	49.1	49

In the present investigation the liquid limit of Black Cotton Soil alone and Black Cotton Soil treated with various percentages of lime is determined and the results have been represented in Table3, chart 2 and chart 3.

As seen from the results, the liquid limit of Black Cotton Soil alone is 52% on addition lime to Black Cotton Soil from 2-4 %, the liquid limit increases. But further addition of lime there is a decrease in the liquid limit.

This may be due to formation of clusters due to hydration. Addition of lime above 4% leads to disintegration of clusters which leads to an increase in the surface area and hence decreases in liquid limit.

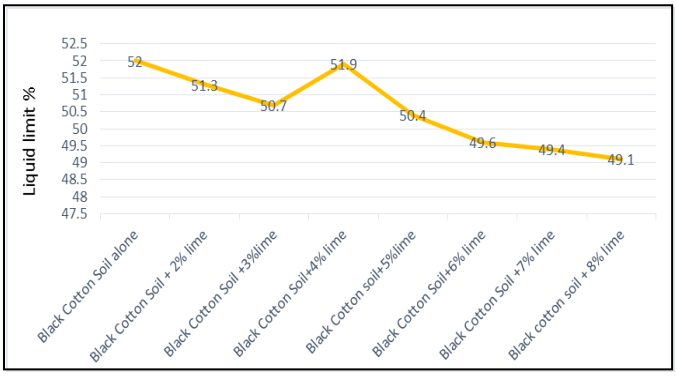

Chart -2: Immediate results of BCS treated with various percentage of lime.

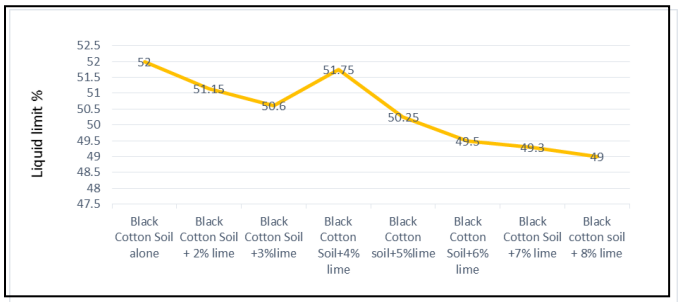

Chart -3: Liquid limit of BCS with various percentage of lime after seven days curing.

4.4 Plastic Limit

Table -4: Plastic limit of Black Cotton Soil treated with various percentages of lime.

Mixtures	Plastic limit (%)	
	Immediate	Curing (7days)
Black Cotton Soil alone	42.54	42.54
Black Cotton Soil + 2% lime	43.1	43.2
Black Cotton Soil +3%lime	43.3	43.6
Black Cotton Soil+4% lime	43.5	43.7
Black Cotton soil+5%lime	43.3	43.5
Black Cotton Soil+6% lime	43.2	43.1
Black Cotton Soil +7% lime	42.8	42.7
Black cotton soil + 8% lime	42.1	41.8

In the present test the Plastic limit of Black Cotton Soil alone and Black Cotton Soil treated with various percentages of lime is determined and the results have been represented in Table 4 and chart 4 and chart 5.

Plastic limit of Black Cotton Soil is 42.54 %. On addition of 2- 4% lime the plastic limit of Black Cotton Soil increases but with further addition of lime, the plastic limit of soil decreases.

From the results, Plastic limit of Black Cotton Soil increases with increase in lime content up to 4%. With further addition of lime, the plastic limit of Black Cotton Soil decreases.

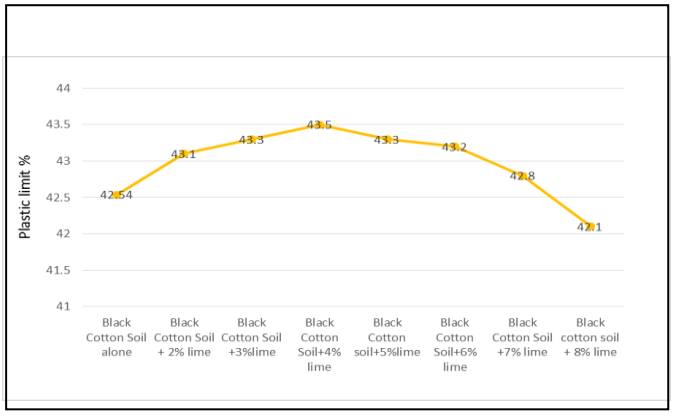

Chart -4: Immediate results of Plastic limit of BCS treated with various percentage of lime.

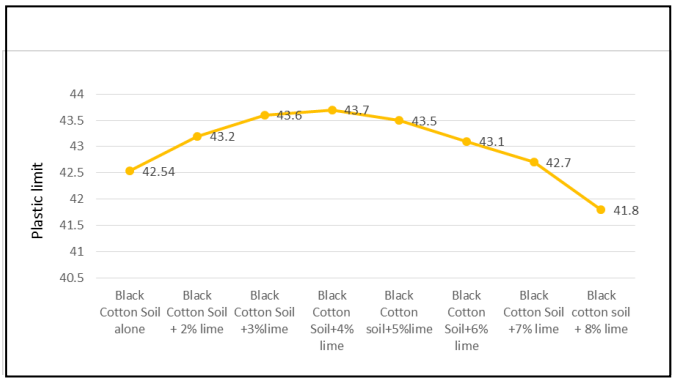

Chart -5: Plastic limit of BCS with various percentage of lime after seven days curing.

4.5 Compaction

In the present test the Compaction behavior of Black Cotton Soil alone and Black Cotton Soil treated with various percentages of lime has been studied.

Table 5 and chart 6 shows the maximum dry density and optimum moisture content values of Black Cotton Soil treated with various percentages of lime. With the addition

of 2- 4% lime, the maximum dry density increases. Further addition of lime to Black Cotton Soil, decreases the maximum dry density value. Hence from the results, 4% lime is taken as the optimum percentage.

Table -5: Maximum dry density and optimum moisture content with various percentage of lime treated BCS.

Mixtures	MDD (KN/m³)	OMC (%)
Black Cotton Soil alone	1.4	20
Black Cotton Soil + 2% lime	14.45	31
Black Cotton Soil +3%lime	14.5	32
Black Cotton Soil+4% lime	14.6	33
Black Cotton soil+5%lime	14.2	27
Black Cotton Soil+6% lime	14	26
Black Cotton Soil +7% lime	14.2	29
Black cotton soil + 8% lime	14.1	27

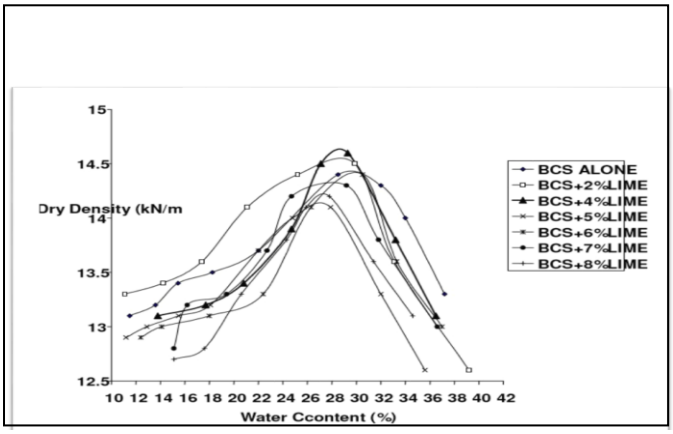

Chart -6: Compaction behavior of lime treated Black cotton soil with various percentage of lime.

4.6 Unconfined Compressive Strength

Table -6: Unconfined Compressive Strength of Black Cotton Soil treated with various Percentages of lime treated BCS.

Mixtures	UCS (KN/m²)	
	Immediate	Curing (7 days)
Black Cotton Soil alone	357	348
Black Cotton Soil + 2% lime	392	406.4
Black Cotton Soil +3%lime	420	444.8
Black Cotton Soil+4% lime	462	492
Black Cotton soil+5%lime	469.4	479
Black Cotton Soil+6% lime	422	410.6
Black Cotton Soil +7% lime	368	358.4
Black cotton soil + 8% lime	328	324

Black Cotton Soil mixed with 2-8 % lime was tested for Unconfined Compressive Strength for both immediate and 7days of curing.

The test results are tabulated in Table – 6, chart 7 and chart 8. Results indicate that addition of lime to Black Cotton Soil shows an increase in strength and the strength increases with increase in percentage of lime up to 4%. The trend observed from the chart 8 shows that increase in unconfined compressive strength up to 4% lime there after the trend shows decrease in the strength of soil mixture.

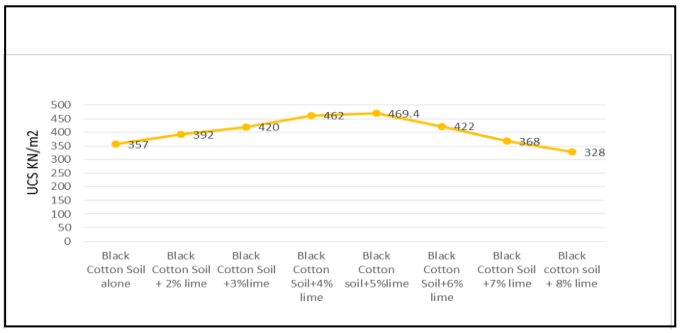

Chart -7: Immediate results of Unconfined Compressive Strength of BCS treated with various percentage of lime.

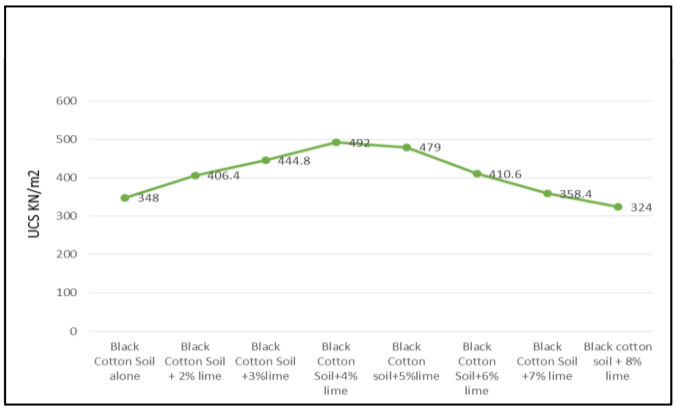

Chart -8: Unconfined Compressive Strength of BCS treated with various percentage of lime after seven days curing.

5. CONCLUSIONS

Based on the detailed investigation, analysis of results, the following conclusions have been drawn.

1) Addition of lime alters the Index properties of lime.

2) Based on the Index properties of Black Cotton Soil treated with various percentages of lime, 4 % lime addition is found to be optimum percentage.

3) Addition of lime to black cotton soil up to 4% shows an increase in specific gravity.

4) Addition of lime to Black Cotton Soil up to 4%, shows an increase in the liquid limit as well as plastic limit. Further addition of lime shows a decrease in the value.

5) Addition of lime to Black Cotton Soil up to 4% shows an increase in compaction behavior of Black Cotton Soil.

6) Addition of lime to Black Cotton Soil up to 4% shows an increase in unconfined compressive strength of Black cotton soil.

6. FUTURE SCOPE OF WORK:

The future scope of the present work can be summarized as follows.

1) To know the effect of addition of lime for a prolonged period, it is necessary to increase the curing period up to 6 months.

2) To know the beneficial effects of coated and uncoated coir fibers on the geotechnical properties.

3) The coir fibers coated with bitumen can be tested to know their beneficial effects.

REFERENCES

[1] Eng Chew Ang and J Erik Loehr (2001):" Specimen size effects for fiber-rein forced silty clay in Unconfined compression", Geotechnical testing journal, Vol 26,191-200.

[2] IS - 2720 (part 6) (1972): "Determination of Shrinkage Limit" Bureau of Indian standards New Delhi.

[3] IS -2720 (part 10) (1973): "Determination of Unconfined Compression strength "Bureau of Indian standards New Delhi.

[4] IS - 2720 (part 4) (197 5): "Determination of grain size". Bureau of Indian standards New Delhi.

[5] IS -2720 (part 3) (1980): "Determination of specific gravity of fine grained soils "Bureau of Indian standards New Delhi.

[6] IS -2720 (part 5) (1985): "Determination of Liquid Limit & Plastic limit" Bureau of Indian standards New Delhi.

[7] Kassim K.A, Hamir R and. Kok (2005): "Modification and stabilization of Malaysian cohesive soils with lime "Journal of Southeast Asian Geotechnical Society, 123-132.

[8] MadhaviLatha G, Vidya S Murthy (2007): "Effects of reinforcement form on the behavior of geo synthetic reinforced sand" Science Direct, Geotextiles and Geo membranes, 25 (2007), 23 -32.

[9] Ramesh H.N , Nanda H.S &Manoj Krishna K.V (2005) "Effect of lime & Sodium Salts on the geotechnical properties of shedi soil" Indian Geotechnical Conference (2005), 177-180.

[10] Ramesh H.N, Manoj Krishna K.V. and Mamatha H.V (2010) "Compaction and strength behavior of lime-coir fiber treated black cotton soil" Geo mechanicsand Engineering, an International journal, 19-28.

[11] SivapullaiahP.V, Sridharan A, and Ramesh H.N (1995): "Mechanisms of controlling the Index properties of lime treated Black cotton soil in the presence of Sulphaf'lndian Geotechnical journal, Vol 25(3), 379-394.

[12] Sivapullaiah P.V., Prashanth J.P and Sridharan A (1998): "Delay in compaction and importance of the lime fixation on the strength and compaction characteristics of soil" Ground improvement, (1998)2, 27 -32.

[13] Somwanshi Amit Bhimrao (2009): "Effects of reinforcement parameters on the behavior of geo synthetic reinforced foundation beds" A thesis, Faculty of Engineering, IIScB'lore, and India.