

Studies on Stabilization of Black Cotton Soil Using Lime

Harish G R¹

¹Assistant Professor , New Horizon College of Engineering, Bengaluru- Karnataka, India

Abstract – Subgrade is an important components in the pavement structure. It takes all the load and transfer it in to the ground over a larger area. The performance and durability of pavement also depends on type of subgrade soil and its engineering properties.. During construction we come across different types of soil among that Black cotton soil also known as expansive soil is one of the problematic soil. In these unavoidable situation improvement of geo mechanical properties are very much essential. Stabilization is one of the method of ground improvement techniques. In this present study stabilization of black cotton soil has been carries out using lime. The test results has been shown that there is an improvement in strength properties of soil and also decrease in plasticity index . substantial increase in CBR value has been observed.

Key Words: Black cotton soil, Lime, stabilization, ucs CBR .

1.INTRODUCTION

Due to increase in freight traffic there is a demand for strong and long lasting pavement for better transportation of freight and passengers. To provide better foundation for construction of pavements improvement of geo mechanical properties of weak soil is very much required and this can be achieved by different methods. Stabilization is one of the conventional and widely used method to strengthen the weak subgrade soils. In this research stabilization of black cotton has been carried out using lime. Several researchers [1-8] concluded that there was substantial increase in strength of soil when treated with lime. In this study lime has been used as stabilizers and introduced in varying percentage to study the strength properties of soil. Engineering properties of soil has been found out as per specifications. UCS test was carried out by varying percentage of lime and cured for different period and test was carried out in both soaked and unsoaked condition and CBR test was carried out after seven days of curing. The engineering properties of soil and grain size distribution of curve is given in table 1 and chart 1 respectively.

Table -1: Engineering properties of black cotton soil

Sl No.	Property	Values
1	Specific Gravity	2.69
2	H.R.B classification	A-7-6
3	Consistency limits	
	Liquid Limit (%)	68
	Plastic Limit (%)	42

	Plasticity Index (%)	26
5	Compaction Characteristics	
	(1) Modified Proctor Test	
	(a) OMC (%)	22.56
	(b) Maximum Dry Unit Weight (kN/m ³)	15.16
7	California Bearing Ratio Test (CBR)	
	(1) unSoaked condition (%)	4
	(2) Soaked condition (%)	<2
	Unconfined compression strength	
8	Unsoaked (kPa)	230
	Soaked (kPa)	100

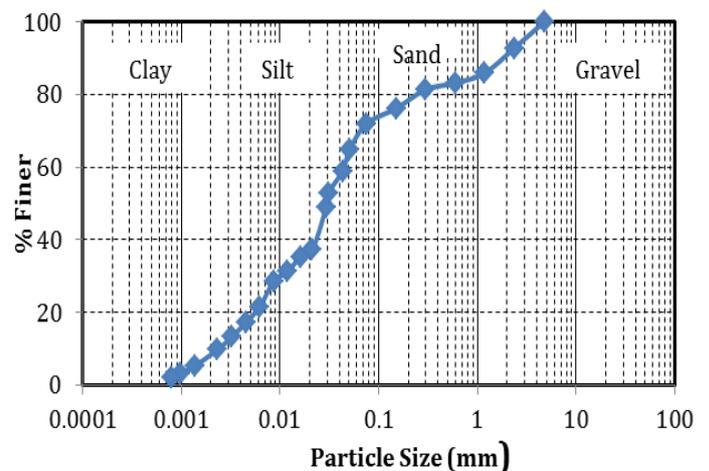


Chart -1: Grain size distribution curve

2. EXPERIMENTAL INVESTIGATION

The consistency limits, compaction characteristics, unconfined compressive strength and CBR values of the Lime treated black cotton soil were determined. 3, 6 and 9% of LIME was considered for investigation.

2.1 Consistency limits

Chart.2 shows the variation of consistency limits with lime content. Liquid limit decreases from 68 % to 60 %, plastic limit increases from 42 % to 50% and plasticity index decreases from 26 % to 9 % respectively for lime contents varying from 0 to 9%.

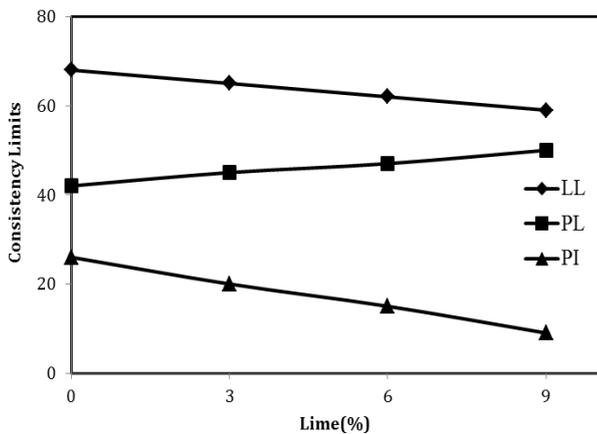


Chart -2: consistency limits

2.2 Compaction characteristics

Chart 3 shows the comparison of compaction characteristics untreated and lime treated black cotton soil. It can be observed that, the maximum dry density decreases and optimum moisture content remains almost the same with addition of lime. Particles are surrounded by a diffuse hydrous double layer and this is due to the ion exchange of calcium. This reaction alters the density of the electrical charge around the fine particles and the particles are attracted closer to each other to form flocks (flocculation). The soil particles are slowly cemented increasing the particle resistance compactive effort leading to reduction in the unit weight of the soil.

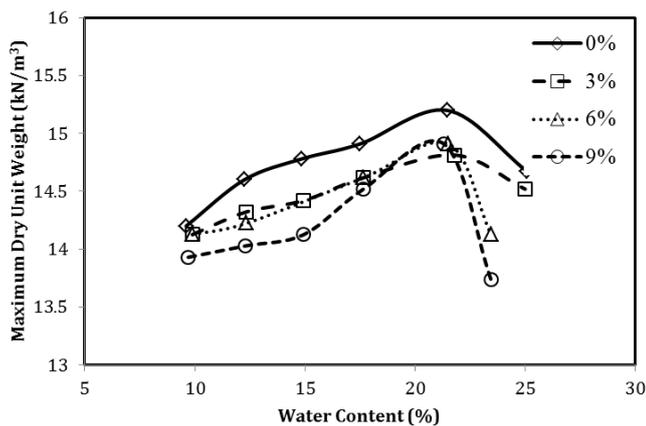


Chart -3: compaction characteristics

2.3 Unconfined Compressive Strength

A series of unconfined compressive strength tests were carried out on untreated and lime treated black cotton soil under both unsoaked and soaked conditions. Lime dosage was varied between 3 to 9% in an increment of

3%. The samples of 38mm diameter and 76mm height were prepared by static compaction. The prepared samples were tested under unsoaked and soaked conditions. The treated samples were cured for a period of 3, 7, 14 and 28 days in a desiccator to maintain 100% relative humidity. Under unsoaked condition, the samples were directly subjected to testing soon after curing. Under soaked condition, the cured samples were covered by a membrane with porous stone placed at top and bottom of the sample. These samples were placed in a water bath such that the water enters from bottom and the samples get saturated by capillary action. The samples were subjected to soaking for a period of about 24 hours. At the end of 24 hours, the samples were taken out and subjected for air drying for about 30 minutes and test was carried out

Chart 4. shows the variation of unconfined compressive strength of lime treated black cotton soil with curing period and % of lime respectively under both unsoaked and soaked conditions. The unconfined compressive strength is found to be increased with an increase in % of lime and it decreased after 6%. The strength increased from 230kPa to 1300kPa and 100 kPa to 540 kPa under unsoaked and soaked condition respectively with a curing period ranging from 3 to 28 days and further decreased after optimum dosage of 6%.

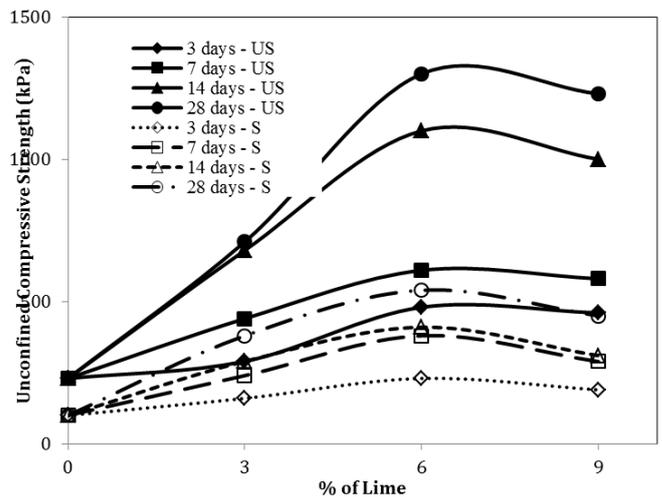


Chart -4: unconfined compression strength

2.3 California Bearing Ratio (CBR)

Chart.5 shows the variation of CBR with % of lime. The CBR samples treated with 3, 6 and 9 % of lime were cured for 7 days and then subjected to soaking for 4 days followed by air drying and testing. The CBR value was found to be increased

with an increase in lime dosage and it increased from <2% to 10% with lime content of 9%.

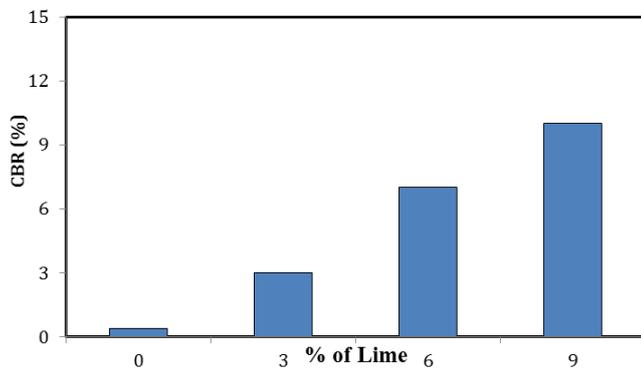


Chart -5: California bearing ratio

3. CONCLUSIONS

A detailed experimental investigation was carried out on untreated and Lime treated black cotton soil. The consistency limits, compaction characteristics, unconfined compressive strength test, CBR of both untreated and Lime treated black cotton soil were investigated. Based on the test results, following major conclusions were drawn.

Addition of Lime imparted reduction in plasticity index and free swell index. At 9% of Lime, plasticity index reduced by 17%

The addition of Lime leads to slight reduction in the maximum dry unit weight when compared with the natural soil and this is due to the resistance offered by the flocculated structure of the soil – lime mix against impact.

The unconfined compressive strength of the black cotton soil treated with Lime increased with an increase in the % of Lime and curing period. The strength increased by 8 times with a curing period of 28 days under both unsoaked and soaked conditions when compared with the untreated black cotton soil. The CBR of the lime treated black cotton soil increased when compared to untreated black cotton soil and with 9% of lime, the CBR of 10% was obtained with a curing period of 7 days.

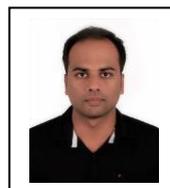
ACKNOWLEDGEMENT

The authors can acknowledge final year students for their involvement and enthusiastic work in the research

REFERENCES

- [1] Zhao Honghua, Liu Jun, Guo jing, Zhao chunji and Gong Bi-wei (2014) "Reexamination of Lime Stabilization Mechanisms of Expansive Clay" Journal of Materials in Civil Engineering – ASCE
- [2] Bulbul Ahmed, Md.Abdul Alim and Md.Abu Sayeed (2013) "improvements of Soil strength using Cement and Lime admixtures" Earth Science 2013;2(6):139-144
- [3] Niroj Kumar Mishra, Sudhir Rath and Pradip Kumar Pradhan (2012) "Lime Stabilization of weak subgrade for Construction of rural Roads" International Journal of Earth
- [4] Martin D. Liu, Buddhima Indraratna, Suksun Horpibulsku and Jirayut Suebsuk (2012) "Variations in strength of Lime-treated soft clays" Proceedings of the institution of Civil Engineers, Ground Improvement, Volume 165 Issue G14
- [5] T.L. Ramdas, N. Darga Kumar and G. Yesuratnam (2011) " Geotechnical characteristics of three expansive soils treated with Lime and Flyash" International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04 pp.46-49
- [6] Peteris Skels, Thomas Ingeman, Andres Stuhr Jorgense, Kaspars Bondars and Edmund Skele (2011) "Quicklime (Cao) Stabilization of Fine-Grained Marine Sediments in Low Temperature Areas" 3rd International Conference Civil Engineering proceedings, Building Materials
- [7] Nadgouda K.A and Hegde RA (2010) "The Effect of Lime Stabilization on properties of Black Cotton Soil" Indian Geotechnical conference-2010
- [8] M Anjan Kumar and G V R Prasada Raju (2009) "Use of Lime Cement Stabilized Pavement Construction" Indian Journal of Engineering and Materials Science Volume 16, pp.269-276

BIOGRAPHY



Specialization M-Tech in Transportation Engg and Mgmt . Currently working as Assistant Professor in New Horizon College of Engineering Bengaluru. Area of interest Ground improvement techniques, Pavement evaluation and management.