

A Study of Black Cotton Soil and its Stabilization by use of Lime and Sawdust

Rakesh Verma¹ Mayur Rathore² Lokendra Panwar³ Nupur Patni⁴ Shwetank R. Saagar⁵

¹Assistant Professor ^{2,3,4,5}PG Student

^{1,2,3,4,5}Department of Civil Engineering

^{1,2,3,4,5}SVVV-SVITS, Indore, India

Abstract— With rapid growth of population, fast urbanization and more construction of highway, buildings and other structures has resulted in reduction of good quality available land. The mechanical behavior of such nature of soil has to be improved by employing stabilization of Black Cotton Soil (BC soil) is studied by using Lime and Sawdust. Black Cotton soils are highly clayey soils (Montmorillonite clay mineral). The moisture changes in Black Cotton soils, compressibility and plasticity nature can be greatly improved with the addition of Lime and Sawdust. This paper includes the evaluation of soil properties like Optimum moisture content, dry density, and strength parameter (California Bearing ratio value). Different quantities of Lime and Sawdust (% by weight) are added to the BC soil and the experiments conducted on these soil mixes. The result shows that the use of Lime and Sawdust increases the California Bearing Ratio values i.e. the strength of soil to a great extent.

Key words: Stabilization, Black Cotton Soil, Atterberg limits, Compaction test, California Bearing Ratio, Unconfined Compressive Strength, Lime and Sawdust

I. INTRODUCTION

Soil is defined as sediments or other accumulation of mineral particles produced by the physical or chemical disintegration of rocks plus the air, water, organic matter and other substances that may be included." Black cotton" soil when comes in contact with water it either swells or shrinks and resulting in moments to the structure which are generally not related to direct effect of loading. On account of its high volumetric changes it is not suitable for construction. It swells and shrinks excessively due to present of fine clay particles. Alternate swelling and shrinking of soil is responsible for differential settlement of structure so black cotton soil must be treated by using suitable admixtures to stabilize it. In my research work stabilization of black cotton soil is done by using lime and Sawdust as an admixture. Experimental work has been carried out with 3% of lime content and 3% of Sawdust. BC soils have low shrinkage limit and high optimum moisture content. It is highly sensitive to moisture changes, compressible subgrade material. Hence the subgrade and its undesirable characteristics to be modified using a suitable stabilization technique. Stabilization involves the methods used for modifying the properties of a soil to improve its engineering performance. In the construction of road and airfield prevents the main objective of stabilization is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Lime has been widely used either as a modifier for clayey soil or as a binder. When clayey soils with high plasticity are treated with lime, the plasticity index is decreased and

soil becomes friable and easy to be pulverized, having less affinity with water. Lime also imports some binding action. In developing countries like India the biggest handicap is to provide a complete network of road system in the limited finances available to build road by conventional method. Therefore there is a need to go for suitable method of low cost road construction.

II. MATERIALS USED

A. Lime

Lime is a calcium-containing inorganic material in which carbonates, oxides and hydroxides predominate. Strictly speaking, lime is calcium oxide or calcium hydroxide. The word "lime" originates with its earliest use as building mortar and has the sense of "sticking or adhering." These materials are still used in large quantities as building and engineering materials (including limestone products, concrete and mortar) and as chemical feedstock"s, and sugar refining, among other uses. The rocks and minerals from which these materials are derived, typically limestone or chalk, are composed primarily of calcium carbonate. They may be cut, crushed or pulverized and chemically altered. "Burning" (calcinations) converts them into the highly caustic material quicklime (calcium oxide, CaO) and, through subsequent addition of water, into the less caustic (but still strongly alkaline) slaked lime or hydrated lime (calcium hydroxide, Ca (OH) 2), the process of which is called slaking of lime.

B. Sawdust

Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with a saw or other tool; it is composed of crushed fine particles of wood. Teak wood *Tectona grandis* is worldwide recognized for its durability and stability, the timber is immense stable, has a high oil content Teak has a high degree of natural durability, is moderately hard and heavy with low stiffness and shock resistance but an excellent decay resistance and dimensional stability with a good acid resistance.

1) Mixing Of Sample



Fig. 1

III. ECONOMIC BENEFITS OF LIME AND SAWDUST STABILISATION

- Limitation of the need for embankment materials brought in from outside and the elimination of their transporting costs.
- Reduction of transport movements in the immediate vicinity of the construction site.
- Machines can move about with far greater ease. Delays due to weather conditions are reduced, leading to improved productivity. As a result, the overall construction duration and costs can be dramatically reduced.
- Structures have a longer service life (embankments, capping layers) and are cheaper to maintain.

IV. OBJECTIVE OF STUDY

- To study Black Cotton Soil
- To study the admixtures like lime and Sawdust
- To study the behavior of strength gain in BC soil using process of lime - Sawdust stabilization.

V. EXPERIMENTAL WORK

In this project The project have conducted various experiment to find the stabilization of the black cotton soil using the lime and Sawdust the various test conducted to find the stabilization of the black cotton soil ,procedure are listed below:

5.1 Liquid Limit	5.3 Sieve Analysis	5.5 California Bearing Ratio Test
5.2 Plastic Limit	5.4 Standard Proctor Compaction Test	5.6 Unconfined Compressive Strength

A. Liquid Limit Tests

The liquid limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dried soil, at the boundary between the liquid and plastic states of consistency. The moisture content at this boundary is arbitrarily defined as the water content at which two halves of a soil cake will flow together, for a distance of 1/2 in. (12.7 mm) along the bottom of a groove of standard dimensions separating the two halves, when the cup of a standard liquid limit apparatus is dropped 25 times from a height of 0.3937 in. (10 mm) at the rate of two drops/second. . IS-2720-PART-V-1985

S. No	LL of Black Cotton Soil in %		Black Cotton +3% Lime +3% Sawdust	
	Sample 1	Sample 2	Sample 1	Sample 2
1	61.6	57.9	60.21	54.67

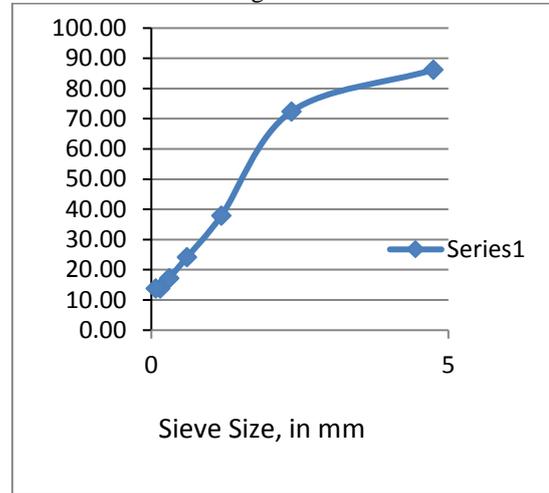
B. Plastic Limit Tests

The plastic limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dry soil, at the boundary between the plastic and semisolid states of consistency. It is the moisture content at which a soil will just begin to crumble when rolled into a thread 1/8 in. (3 mm) in diameter using a ground glass plate or other acceptable surface. IS-2720-PART-V-1985

S.No.	Composition of soil	Plastic Limit
1	Black Cotton soil	36.22
2	Black Cotton soil+3% Lime +3% Sawdust	38.37

C. Sieve Analysis

A sieve analysis is a practice or procedure used assesses the particle size distribution of granular material



Graph 1: Seive Analysis Result



Fig. 2: Sieve Analysis
Coefficient of Curvature (Cc) = 3.34
Cu = 15

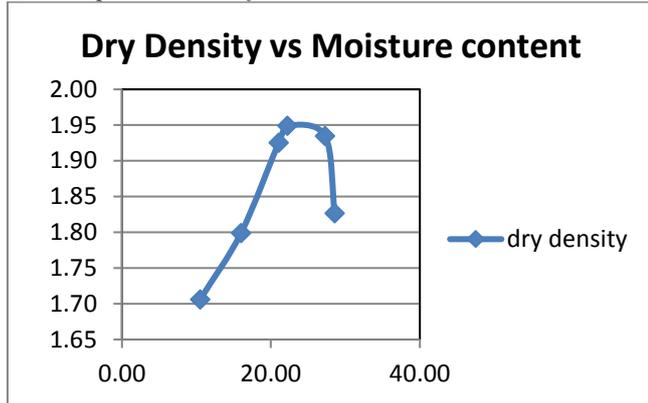
(As per IS classification Netural black cotton soil is poorly graded)

D. Standard Proctor Compaction Test

Compaction is one kind of densification that is realized by rearrangement of soil particles without outflow of water. It is realized by application of mechanic energy. It does not involve fluid flow, but with moisture changing altering. IS: 2720 part VII.

Maximum Dry Density = 1.9 gm/cc
OMC = 24%

1) Compaction Test of Natural Black Cotton Soil



Graph 2: Compaction Test Result



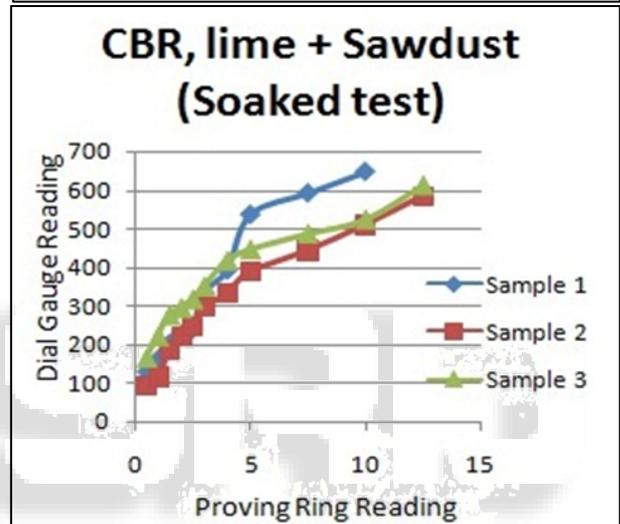
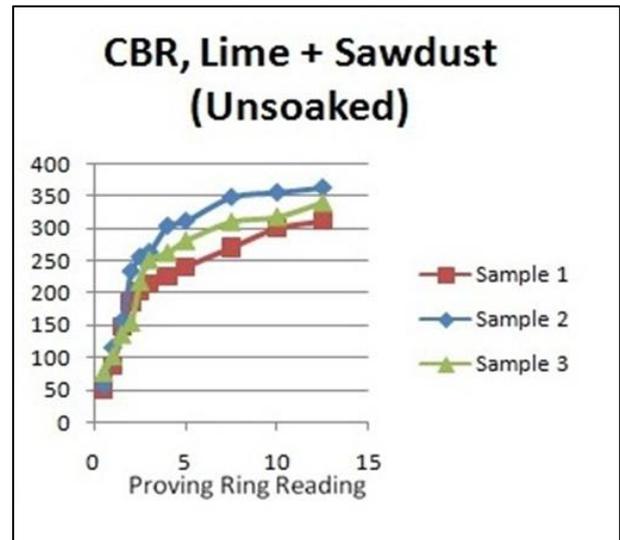
Fig. 3: Mixing of Sample

E. California bearing ratio test

The California bearing ratio (CBR) is a penetration test for evaluation of the mechanical strength of road subgrades. The test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard crushed rock material. The CBR rating was developed for measuring the load-bearing capacity of soils used for building roads. California bearing ratio is the ratio of force per unit area required to penetrate in to a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm/min. IS-2720-PART-16-1979.

	Natural Black Cotton Soil	Lime + Sawdust
CBR UnSoaked	6.33	15.12
CBR soaked	4.22	5.4

Table 3: CBR Test Results



Graph 3: CBR Result

F. Unconfined Compressive Strength

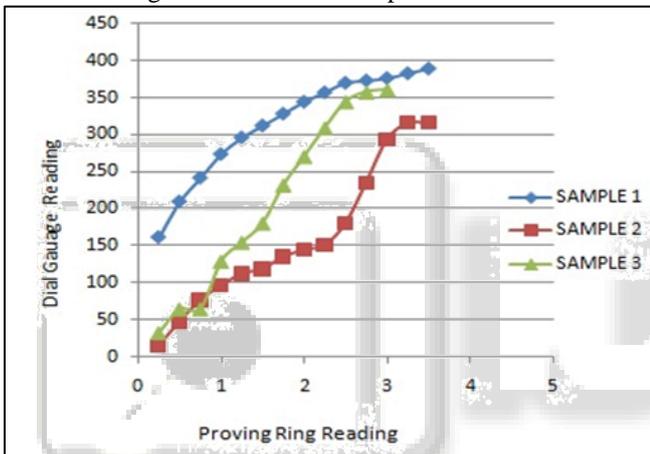
The unconfined compression test is used to measure the shearing resistance of cohesive soils which may be undisturbed or remolded specimens. An axial load is applied using either strain-control or stress-control condition. The unconfined compressive strength is defined as the maximum unit stress obtained within the first 20% strain. IS-2720-PART-X-1991



Fig. 4: Sample for UCS Test



Fig. 5: Unconfined Compression Test



Graph 4: UCS Result

Avg. strength (q_u) = 112 kn/m^2

Maximum shear strength ($QU/2$) = 56 KN/M^2

VI. CONCLUSIONS

On the basis of study and experimental investigations it was observed that the property of black cotton soil effectively improved by use of 3% of lime and 3% Sawdust contents. In this research 3% of lime and Sawdust was used to stabilize the black cotton soil. Points which were drawn from this research are listed below-

- It was observed that on addition of 3% lime and 3% Sawdust decreases the liquid limit.
- M.D.D. was increased with 3% Lime and 3% Sawdust content
- The C.B.R. value of black cotton soil improves with 3% Lime and 3% Sawdust content.
- Unconfined Compressive Strength of black cotton soil improves with 3% Lime and 3% Sawdust content.

REFERENCES

- [1] "Consideration of Lime- Stabilization layers in Pavement design", National lime association.

- [2] IS-2720-PART-X-1991, IS-2720-PART-16-1979, IS: 2720 part VI.
- [3] International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 5, May 2012 1 Stabilisation of Black Cotton Soil Using Admixtures.
- [4] Ms. Arpita V Patel Asst. Professor, Department of Civil Engineering, Parul Institute of Engineering and Technology, Waghodia, Vadodara Study of Geotechnical properties of black cotton soil contaminated by castor oil and stabilization of contaminated soil by sawdust.
- [5] Relevant IS codes
- [6] "Soil mechanics and Foundation engineering", B.C. Punmia.
- [7] "Soil mechanics and Foundation engineering", K. R. Arora.