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Compaction and CBR Characteristics of Expansive Soil Stabilized with Lime and Waste Beverage Can

Akash Pandey[1], Prof. R. K Yadav[2]
[1]*ME scholar, Dept. of Civil Engineering, Jabalpur Engineering College, Jabalpur*
[2]*Associate Professor, Dept. of Civil Engineering, Jabalpur Engineering College, Jabalpur Madhya Pradesh, India.*

Abstract: ***Country like India, whose large area covered with black cotton soil. In some cases, its property improves by stabilization. Soil stabilization means alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil to meet the required properties of soil. It is very susceptible for the volume change due to change in moisture content of soil. In this case, Waste Beverage cans (WBC) and lime used as stabilizing agent to stabilize black cotton soil. In the first experiment, WBC wastes are used at varying percentage in order to observe the changes arise in various geo-technical properties of soil. In second experiment, geo-technical properties observation with same varying percentage of WBC as experiment first with 5% of lime has been carried out. Compaction (OMC and MDD) and CBR test results are indicated with comparison of both experiments and optimum percentage of WBC are carried out in this study.***
Keywords: Black Cotton soil, Lime, Waste Beverage can, Standard Procter test, CBR.

I. INTRODUCTION

In India black cotton soil is also known as Regur are found. They have variable thickness and are underlain by sticky material locally known.
In this case, expansive soil is taken from Jabalpur region.
In terms of Geotechnical Engineering, Black cotton soil (BC soil) is one which when associated with as engineering structure and in presence of water will show a tendency to swell or shrink. Black cotton soil is not suitable for the construction work on account of its volumetric changes. It swells and shrinks excessively with change of water content. Such tendency of soil is due to the presence of fine clay particles which swell, when they come in contact with water, resulting in alternate swelling and shrinking of soil due to which differential settlement of structure takes place, So the stabilization of black cotton soil has been done in this project work by using lime as an admixture and WBC as fibre.

II. MATERIAL USED

A. Expansive Soil

The soil used was locally available expansive soil which was collected from Jabalpur, Madhya Pradesh. The properties of the soil determined by various experiments have been enumerated below in the table as:

Table 1: basic properties of soil.

S. No.	Properties	Values
1	Liquid Limit (LL)	52.25 %
2	Plastic Limit (PL)	21.68 %
3	Plasticity Index (PI)	30.57 %
4	Specific Gravity	2.52
5	Differential Free Swell (DFS)	55.20 %
6	Optimum Moisture Content (OMC)	24.40 %
7	Maximum Dry Density (MDD)	1.521 g/cc
8	California Bearing Ratio (CBR)	2.20 %
9	Unconfined compression strength (UCS)	0.115 Mpa
10	Soil classification	CH

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B. Lime.

Stabilization is a collective term for any physical, chemical, or biological method, or any combination of such methods that may be used to improve certain properties of a natural soil to make it serve adequately an intended engineering purpose. It is the process of blending and mixing materials with a soil to improve certain properties of the soil.

The main benefits of using lime to stabilize clays are improved workability, increased strength, and volume stability. Lime increases the optimum water content for compaction, which is an advantage when dealing with wet soil.

The compaction curve for lime-treated clay is generally flatter, which makes moisture control less critical and reduces the variability of the density produced. In first few hours after mixing, lime additives cause a steady increase in strength, but at a slower rate than cement. The need for compaction immediately after mixing is therefore less critical for lime than cement. Lime increases the strength of clayey soil by reducing shrinkage and swell characteristics.

C. Waste Beverage Can (WBC).

Beverage cans are globally produced in huge amount. Beverage cans generally consist of aluminum metal. Cans consists waste material is a light metal having specific weight approximately 2.6 to 2.8 (g/cm3) and absorption capacity of water is almost 0%. The main property of aluminum is high resistance to corrosion. The mechanical and chemical property for uniform aluminum wires had uniformly distribution throughout.

The length of the WBC fiber used in the study was approximately 5 cms with aspect ratio 15-20. Mixing them in certain percentage with BC soil may improves soil properties like its density, strength, swelling and unconfined compressive strength and also making sure that the environment is safer and cleaner.

Waste beverage cans (WBC) were cut and mixed randomly with soil in 2, 4, 6, 8 and 10% (dry weight of soil) before use. Two standard tests were carried on the prepared samples: compaction and California Bering Ratio (CBR). Test results showed that WBC significantly affected the compaction characteristics and strength properties of the BC soil.

III. EXPERIMENTAL WORK

A. Preparation of Sample.

This work presents an investigation of the effect of waste beverage cans (WBC) strips on strength and swelling properties of BC soil.

Different samples were prepared with the mixture of oven dried soil and addition of 2%, 4%, 6%, 8% and 10% of WBC on the basis of dry weight of the soil. In order to get homogeneous mix, proper care was taken while mixing the samples. The OMC, MDD and CBR value of different samples containing different percentage of WBC was found out from which Optimum WBC percentage was determined.

Then again prepare same samples with fixed percentage of lime (5%) treated soil and variation of OMC, MDD and CBR was evaluated.

B. Compaction Test.

The modified proctor test was performed as per IS 2720 (Part VII) 1980. The soil was taken and various percentages of WBC and lime (5%) were added with dry soil. The appropriate quantity of water was added with soil, WBC and lime mixture and the wet specimen was compacted in mould in five layers by modified proctor rammer of 5.34 kg. The MDD and OMC for various samples were determined from this test.

C. California bearing ratio (CBR).

The CBR tests were executed for different percentage of WBC and as per IS 2720 (part-16) 1987.The samples were prepared in a cylindrical mould of 150 mm diameter and 175 mm height by compaction of the mixture of Soil-WBC and Soil-WBC-Lime to modified proctor's MDD. Samples were made such as Soil with (2, 4, 6, 8 and 10%) WBC and soil with WBC and (5%) lime. The samples were experimented for each variable proportion and the samples were soaked in water for 96 hours before test was conducted.

All the experiments were executed at a penetration rate of 1.25 mm/min until a penetration of 12.5 mm was obtained. CBR values were calculated and comparison graph obtained for samples

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IV. RESULT AND DISCUSSIONS

According to experimental program, numerous tests were executed on soil with various percentages of WBC and lime. The effect of WBC and lime inclusion on OMC-MDD relationship, and CBR values were considered. The outcomes are presented below-

TABLE 2: OMC-MDD and CBR value of soil sample with varying percentage of WBC.

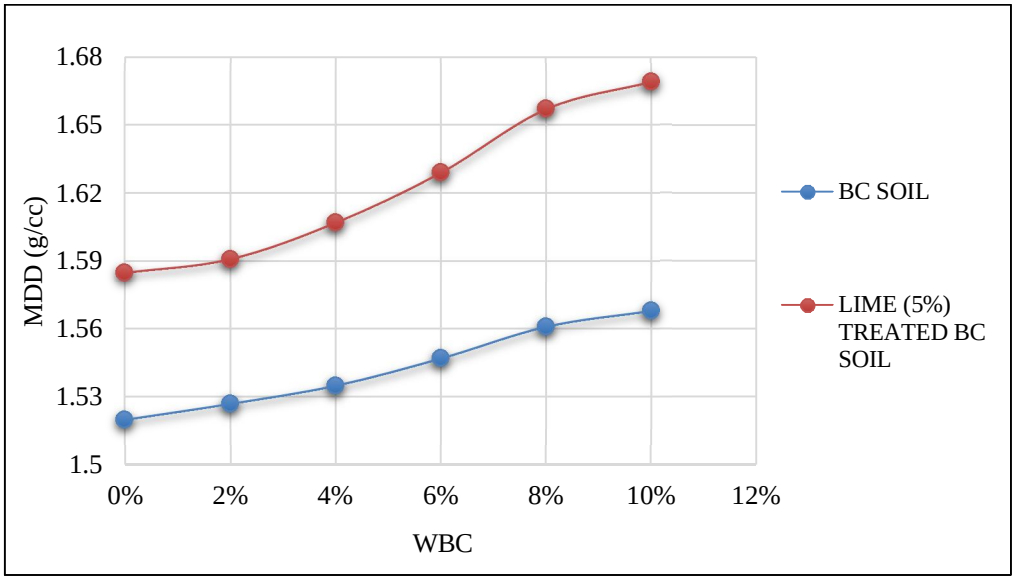
Soil + (%)WBC	Maximum Dry Density (g/cc)	Optimum Moisture Content (%)	C.B.R (%)
Soil + 0% WBC	1.520	24.40	2.22
Soil + 2% WBC	1.527	23.87	4.80
Soil + 4% WBC	1.535	23.14	6.42
Soil + 6% WBC	1.547	22.46	7.82
Soil + 8% WBC	1.561	21.69	9.42
Soil + 10% WBC	1.568	20.47	8.61

TABLE 3: OMC-MDD and CBR value of soil sample with lime and varying percentage of WBC.

Soil + (%)WBC + 5% LIME	Maximum Dry Density (g/cc)	Optimum Moisture Content (%)	C.B.R (%)
Soil + 0% WBC + 5% LIME	1.585	18.36	3.77
Soil + 2% WBC + 5% LIME	1.591	17.67	6.35
Soil + 4% WBC + 5% LIME	1.607	16.51	8.15
Soil + 6% WBC + 5% LIME	1.629	15.82	9.67
Soil + 8% WBC + 5% LIME	1.657	14.98	11.28
Soil + 10% WBC + 5% LIME	1.669	14.22	10.84

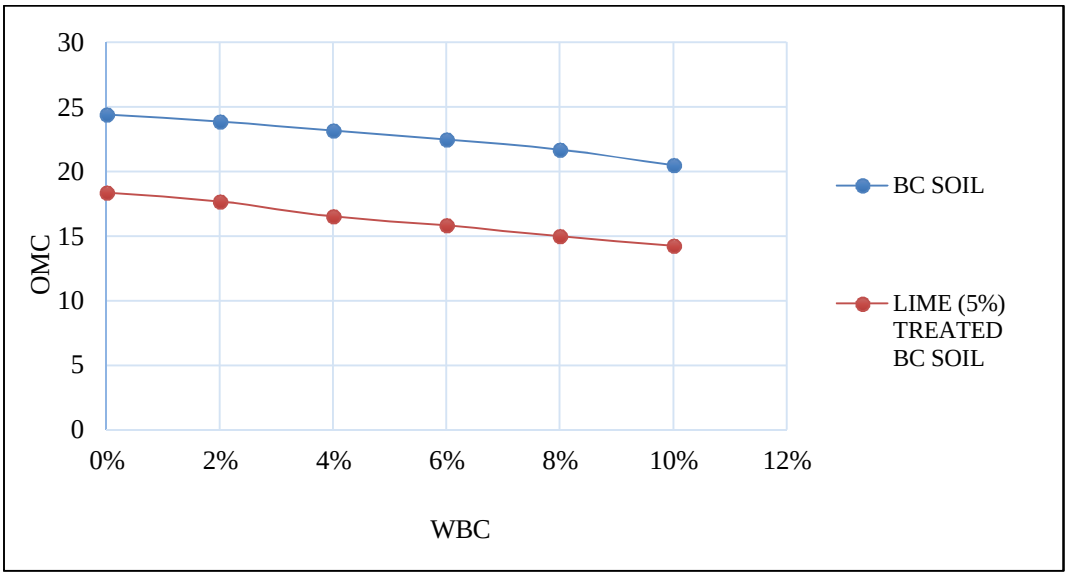
A. Compaction test.

It is observed in Table 2 and 3 and Graph 1 and 2 that with the inclusion of WBC, the MDD increased throughout addition of WBC. On addition of lime 5% to this optimum percentage of WBC it was observed the maximum value of MDD. While OMC value decreases for increasing the WBC content. The sample containing 5% lime and WBC gives the minimum value of OMC.



GRAPH 1: MDD value of soil sample with lime and varying percentage of WBC.

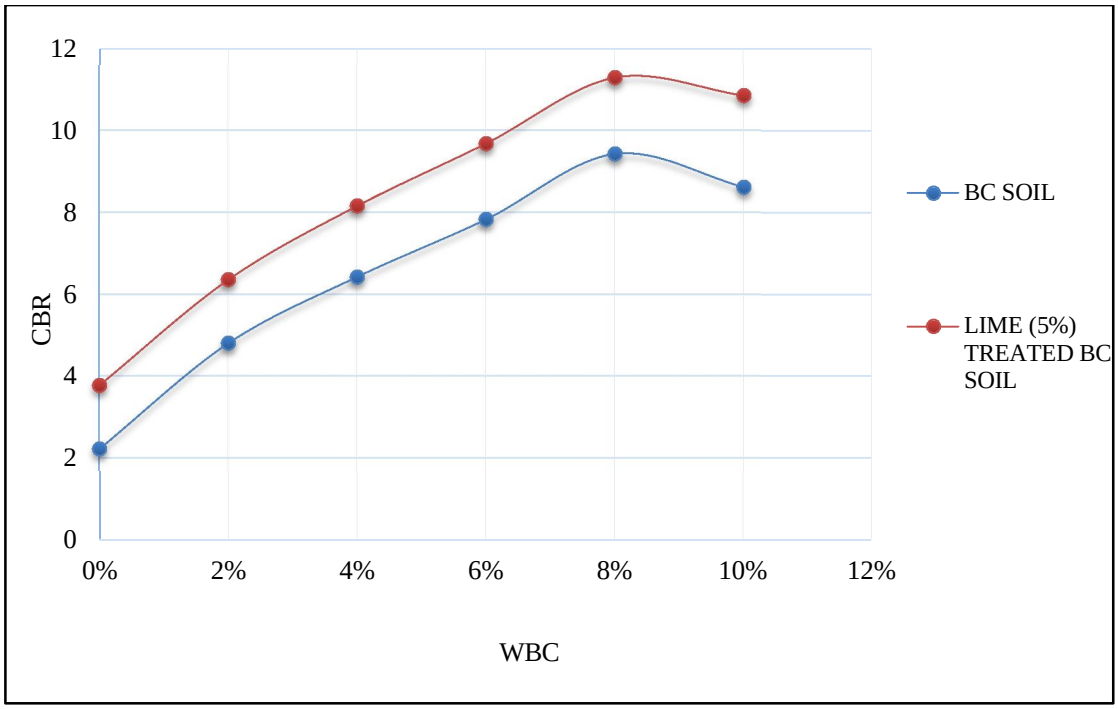
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GRAPH 2: OMC value of soil sample with lime and varying percentage of WBC.

B. California Bearing Ratio (CBR).

The results of soaked CBR test (Graph-3) indicated that the CBR value constantly increased upon inclusion of WBC by dry weight up to 8%. Lime (5%) were added to the soil sample containing varying percentage of WBC. The CBR value increased with varying percentage of WBC on both lime treated or non-treated BC soil up to 8% then decreases. The maximum value of CBR was obtained for a soil sample containing 8% WBC and 5% lime by dry weight of the soil sample.



GRAPH 3: CBR value of soil sample with lime and varying percentage of WBC.

V. CONCLUSION

For the stabilization of black cotton soil, the optimum quantity of WBC was found to be 8% with fixed percentage of lime i.e. 5% by weight of dry soil. The two materials were mixed in the above proportion in the black cotton soil. The proctor density was increased from 1.520 g/cc to 1.669 g/cc while value of OMC decrease from 20.40 to 14.22. The CBR value increased from 2.22% to 11.28%.

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VI. FUTURE SCOPE OF THE WORK

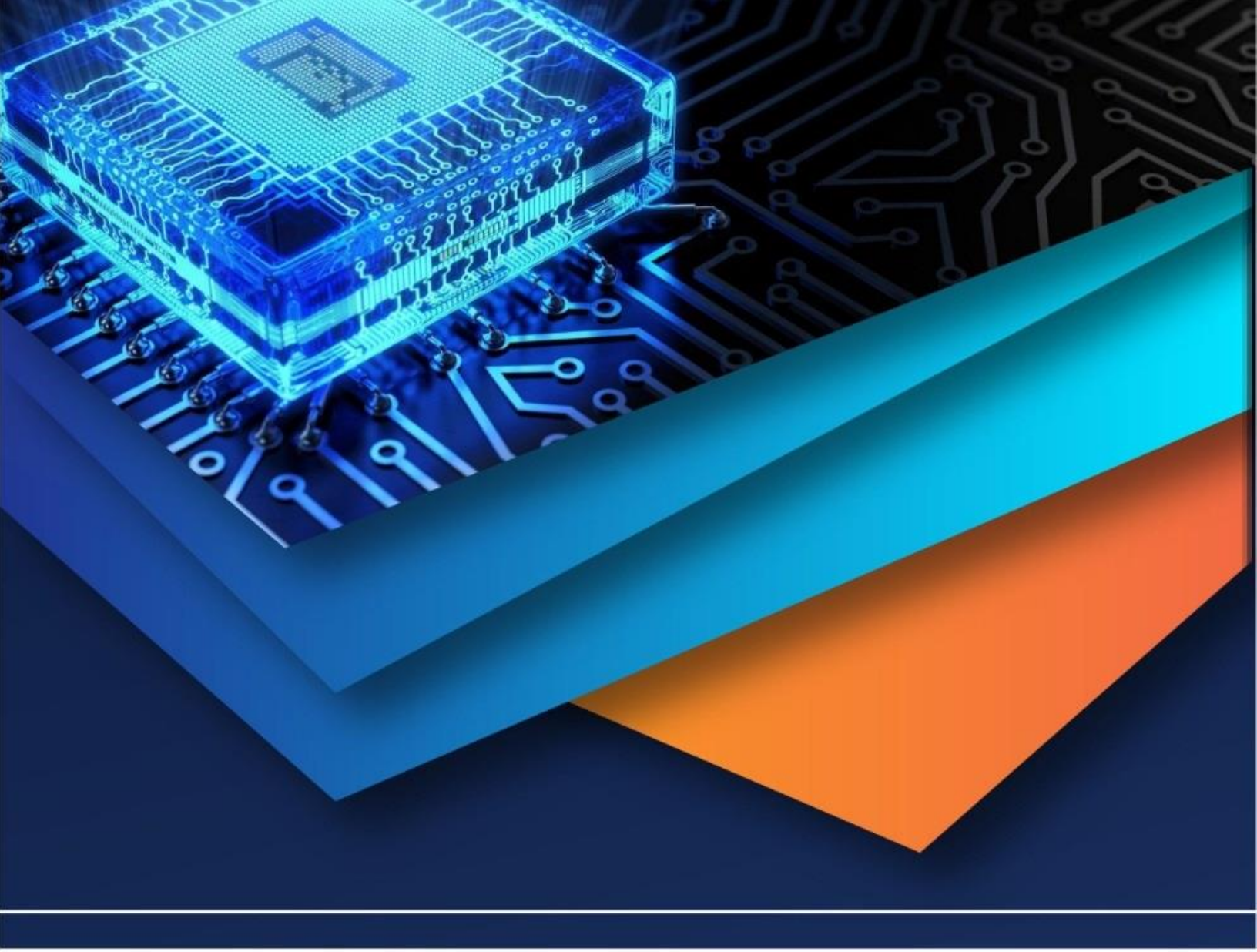
In this study, the effect of waste beverage can on various properties of black cotton soil is determined. The further study could be done on-

A. The lime can be replaced by stone dust, sand, cement etc.
B. WBC waste could be replaced by other fibers or geo textiles as per availability and economy such as jute (natural fibers) or polypropylene, shredded rubber tire (artificial fibers), geo textile or geo-synthetic. From the above materials, mixes of different proportions or combinations can be made for improving the properties of soil which may be used for construction of embankment or soil sub grade in highways.
C. Similar experimental analysis can be done on other soils like silt, silty clays etc.
D. The permeability characteristics of black cotton soil with various percentages of WBC can be checked.
E. The consolidation characteristics of black cotton soil could be determined using different percentages of WBC.
F. The comparative study for effective utilization of WBC for improving black cotton soil can be done.

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