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A Study of Black Cotton Soil Stabilization with Lime and Waste Plastic Bottle Stirrup

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Abstract: ***In this research work, B C soil stabilization is done with the help of lime and plastic waste material (plastic bottle stirrup) simultaneously in various proportions. First, properties of soil sample which is locally extracted are found out and then Optimum percentage of lime is found with that soil sample on which soil is effectively compacted. After, getting the optimum percentage of Lime, various proportions of waste plastic are added in the stabilized soil and changes in the properties of stabilized soil are studied finally. The optimum percentage of soil, when added with lime only is 4% and then further stabilization is done by mixing plastic waste in different proportion i.e.0.5%, 1.0%, 1.5% and 2.0%%. Engineering properties like optimum moisture content, maximum dry density, CBR values of stabilized soil determined respectively. The optimum soil stabilization is obtained at with 4% lime and 1.5% plastic waste were mixed The Unsoaked CBR value increased from 2.1% to 6.15% and soaked CBR value increased from 1.74% to 5.35%***

Keyword: B C soil, Lime, Waste Plastic bottle and their proportions.

I. INTRODUCTION

Soil is the basic construction material available which is mostly used in Road construction. If desirable soil is not available at the construction site than it is necessary to improve soil properties by the soil stabilization processes, we improve or enhance the engineering properties of soil. The objectives of any stabilization technique used are to increase the strength and stiffness of soil. Different methods have been developed previously to stabilize weak and unsuitable soils. Some of these methods are mechanical (granular) stabilization, cement stabilization, lime stabilization, bituminous stabilization, chemical stabilization, thermal stabilization, electrical stabilization, as well as grouting stabilization by geotextile and fabrics. Recently, researchers have introduced another way of soil stabilization by using waste materials. Plastics and other waste material are the leading waste materials that to be suitable for soil stabilization. They reduce the cost of stabilization at a large rate.

This thesis (research) presents appropriate and easy to implement ways of recycling waste material as reinforcing material for the stabilization of expansive soil to improve and achieve the required properties for construction works.

II. LITERATURE REVIEW

C. Scott Fletcher and W. Kenneth Humphries [1991] Dosages of fiber ranging from 0.09 to 1.5 percent of the dry soil. Fiberlengths were 19 and 25 mm. The addition of fiber increased the CBR values 65 to 133 percent over unreinforced specimens depending on fiber configuration and dosage. CBR values using 25 mm-long, 0. 76-mm monofilament fiber reinforcement increased significantly up to a dosage of 1 percent

A.K. Choudhary et al. [2010] Strips of HDPE were mixed with local soil and tested to determine CBR values and secant modulus. The tests show that reinforcing soil with waste HDPE strips enhances its resistance to deformation and its strength. The maximum CBR value of a reinforced soil is approximately 3 times that of a unreinforced soil

Karthik et al. [2014] Studies about the soil stabilization by partially replacing red soil with Fly Ash. He conducted various tests such as CBR, specific gravity, MDD with OMC, UCC, liquid limit and plastic limit. He concluded that 9% partial replacement of fly ash in the soil results in improved properties and he also said that those soils showed good bearing capacity

Dhatrak A.I. et al [2015] In his paper a series of experiments are done on soil mixed with different percentages of plastic (0.5%, 1%, 1.5%, 2%, 2.5%) to calculate CBR. On the basis of experiment that he conducted using plastic waste strips he concluded that waste plastic strips will improve the soil strength and can be used as sub grade.

Gardete D., Luzia R., (IPCB) [2017] The contents of plastic waste used were 1%, 2% and 3%, weight of plastic waste / dry weight of soil. The results show that the stabilization cause a rise in resistance, expressed in CBR values (California Bearing Ratio), for low contents of plastic waste.

Maximum bulk dry density decreased with the rise within the content of plastic waste. CBR values were increased by more than 20% when compared to the original soil

Rebecca Belay Kassa1 et al. [2020] This paper shows the outcomes of an attempt to reinforce and stabilize expansive clay soil with plastic bottle stirrups. The plastic strips were prepared and added at three different mixing ratios (0.5%, 1% and 2%) by weight and in three different aspect ratios (5 mm × 7.5 mm, 10 mm × 15 mm, 15 mm × 20 mm). The experimental results showed that there was a significant improvement in shear strength parameters.

III. MATERIAL USED IN THE RESEARCH WORK

Soil: Principal component used for embankment construction and highways subgrade is soil. The performance of pavement specially flexible pavement depends on the type and properties of subgrade soil. In this study soil is taken from Village Bilhari which is about 3km away from Nowgong PWD office District Chhatarpur (MP). The soil is then passed from 425 micron sieve and the soil passed from the sieve is collected and the test is performed in this soil

Fig.1 Soil

1) *Lime:* Hydrated lime is used in this study (Powered Form) Hydrated lime is created when quicklime chemically reacts with water. It is hydrated lime that reacts with clay particles and permanently transforms them into a strong cementitious matrix

Fig.2 Lime

2) *Waste Plastic Strips:* Cold drink bottles are collected and cut into strips. The dimensions of waste plastic bottle strips used in this study is 7.5mm × 15mm. These strips are added in the soil- lime mixture in different proportion by weight. In this study strips used are 0%, 0.5%, 1.0%, 1.5% and 2.0% of dry weight of soil. A Picture of strips is shown below

Fig.3 Plastic Stirrup

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IV. RESEARCH METHODOLOGY

The natural soil is collected from Village Bilhari Nowgong (MP) and was air-dried, sieved and tested in laboratory, PWD Nowgong Division. Different tests were performed on soil to discover its index properties and also the effect of soil after mixing additives (Lime and waste Plastic). Since there are very wide differences in soil types, soil classification has become very important especially for the field of geotechnical civil engineering. "Index properties" is a type of classification that is based on classification and identification of soil properties. Typical examples of index properties are; Specific gravity, liquid limit, plastic limit, and Plasticity index. The different tests were conducted in order to determine the different characteristics and properties of the B C soil with and without additives. The procedure of each of the tests has been described below.

A. Preparation of Material

Local Soil is collected from site and brought to soil lab and spread for air drying. After this, screening of soil is done to sort out the organic matter, coarser particles, grass twigs etc. After this index properties of soil are found and then mixing of lime is done. For mixing the Lime to the soil, steps to be follow

Compaction of all soil samples were done at their respective maximum dry density (MDD) and optimum moisture content (OMC), equivalent to the standard proctor compaction tests.

Then, Soil is mixed with Lime at different proportions (i.e. 2%, 4% and 6%) to find out the optimum percent of lime with respected soil sample. After finding the optimum percent of lime with local soil which is 4% in our case, waste plastic with 4% lime is mixed with soil sample simultaneously and finally different values adopted in the present research work for the percentage of waste Plastic are:

1) Soil + 4% Lime + 0.5% Plastic
2) Soil + 4% Lime + 1.0% Plastic
3) Soil + 4% Lime + 1.5% Plastic
4) Soil + 4% Lime + 2.0% Plastic

Fig.4 Preparation of Sample

B. Various Test Involved In Research Work

1) Natural Moisture Content [IS 2720 (part II)-1973]
2) Liquid Limit Test [IS 2720 (Part 5) – 1985]
3) Plastic Limit Test [IS 2720 (part 5) – 1985]
4) Free Swell Index [IS: 2720 (Part 40) 1977]
5) Specific Gravity Test [IS 2720(part III)-1980]
6) Compaction Test [IS 2720 (part VII) – 1980]
7) California Bearing Ratio (CBR) Test [IS 2720 (Part 16) – 1987]

Fig.5 Testing photos

V. RESULT AND DISCUSSIONS

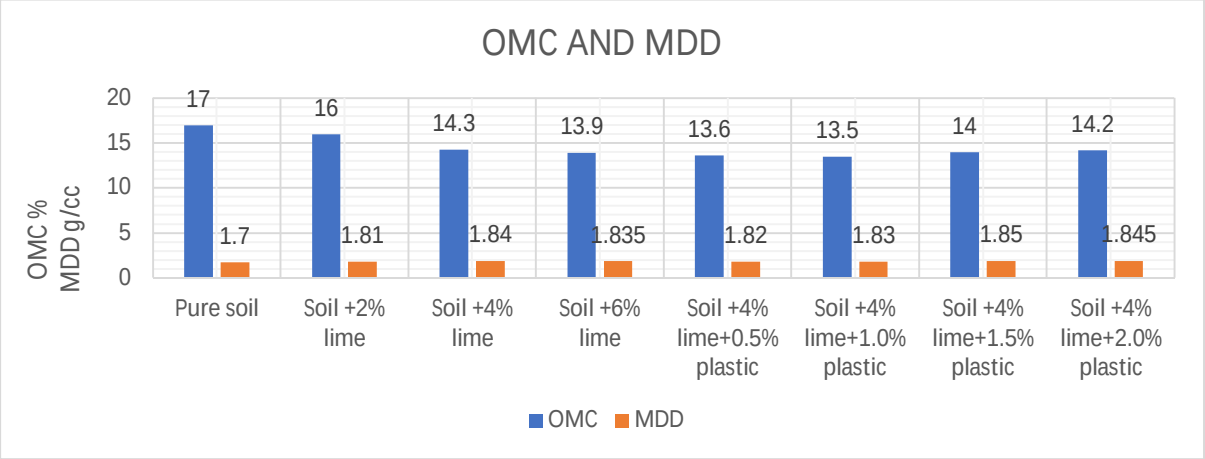
A. *Results of index Properties of local Soil used in this Research work*

Properties	Result
Specific Gravity	2.65
Liquid Limit %	50.5
Plastic Limit %	27
Shrinkage Limit %	17.5
Plasticity Index %	23.5
OMC %	17
MDD (gm/cc)	1.7
D FSW %	50
CBR %	2.1

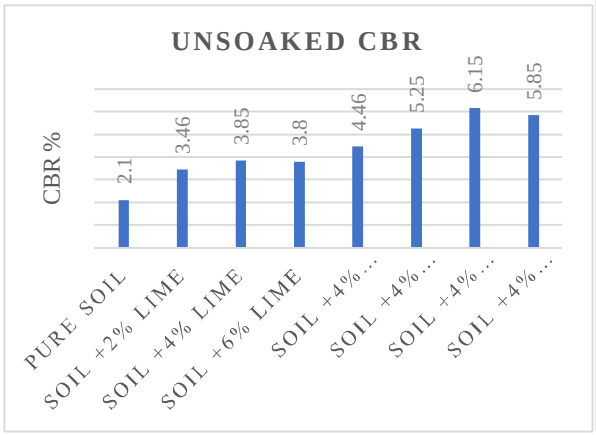
B. *Results of Soil when Added with Lme and Plastic*

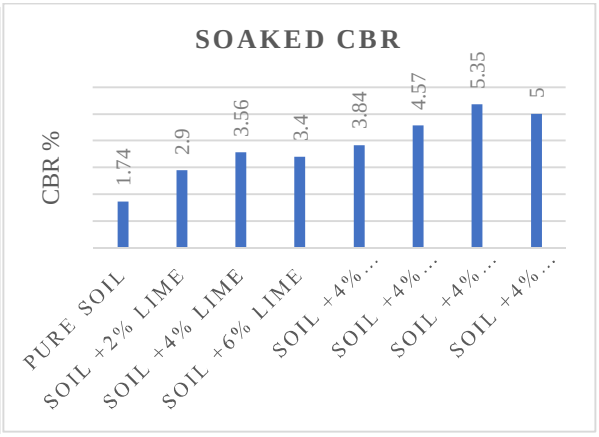
Properties	P I	OMC	MDD	UnSoaked CBR	Soaked CBR
Soil +2% lime	22.9	16	1.81	3.46	2.9
Soil +4% lime	20.8	14.3	1.84	3.85	3.56
Soil +6% lime	18.1	13.9	1.835	3.8	3.4
Soil +4% lime+0.5% plastic	-	13.6	1.82	4.46	3.84
Soil +4% lime+1.0% plastic	-	13.5	1.83	5.25	4.57
Soil +4% lime+1.5% plastic	-	14	1.85	6.15	5.35
Soil +4% lime+2.0% plastic	-	14.2	1.845	5.85	5.0

C. Effect on OMC and MDD



D. Comparison of CBR values





VI. CONCLUSIONS

A. In standard proctor test, the optimum moisture content gradually decreased from 17% to 13.9% when lime content increased from 0% to 6%.

B. The maximum dry density values increased from 1.74 g/cc to 1.84 g/cc for 0 % to 4% lime content. But after adding 6% lime, the maximum dry density value gets decreased. Therefore the optimum values are obtained for a soil blended with 4% lime and the corresponding optimum moisture content is 14.3% and the maximum dry density is 1.84 g/cc

C. The Unsoaked CBR value for black cotton soil is 2.1%. After adding lime content to soil, the CBR values increased from 2.1% to 3.85% for 0% to 4% lime. But from 6% lime content the CBR values gets decreased. In another study there is a gradual increase of CBR values from 3.85% to 6.15% with inclusion of plastic stirrup content from 0% to 1.5% and the values decreased with further addition of Plastic stirrup percentage. The maximum CBR value is observed for soil added with 4% lime and 1.5% Plastic stirrup.

D. The soaked CBR value for black cotton soil is 1.74%. After adding lime content to soil, the CBR values increased from 1.74% to 3.56% for 0% to 4% lime. But from 6% lime content the soaked CBR values gets decreased. In another study there is a gradual increase of CBR values from 3.56% to 5.35% with inclusion of plastic stirrup content from 0% to 1.5% and the values decreased with further addition of Plastic stirrup percentage. The maximum Soaked CBR value is observed for soil added with 4% lime and 1.5% Plastic stirrup.

E. The Free Swell Index for black soil is obtained as 50% and its value is decreased to 34.7% for soil blended with 4% lime.

F. The Plasticity Index values have reduced from 23.5% to 18.1% with mix of 6% lime to black soil.

G. Hence there is an improvement of properties of black soil by adding lime 4% and plastic stirrup 1.5% by weight of dry soil to utilize them as an engineering material for various purposes such as foundation soil, pavement sub grade etc.

VII. SCOPE FOR FURTHER STUDY

A. The study can be conducted on more types of waste material like glass, fly ash brick kiln dust etc and it's combination
B. The study can be conducted on with different type of soils such as sand, silt and other clay samples.
C. The investigation can be carried out using other stabilizers such as sands etc.
D. The study is carried out through proctor compaction and CBR tests. It can be extended with tests such as unconfmed compressive tests and tri-axial tests.
E. The study can be conducted by adding different length and different aspect ratio of plastic stirrup and it's fiber

VIII. ACKNOWLEDGMENT

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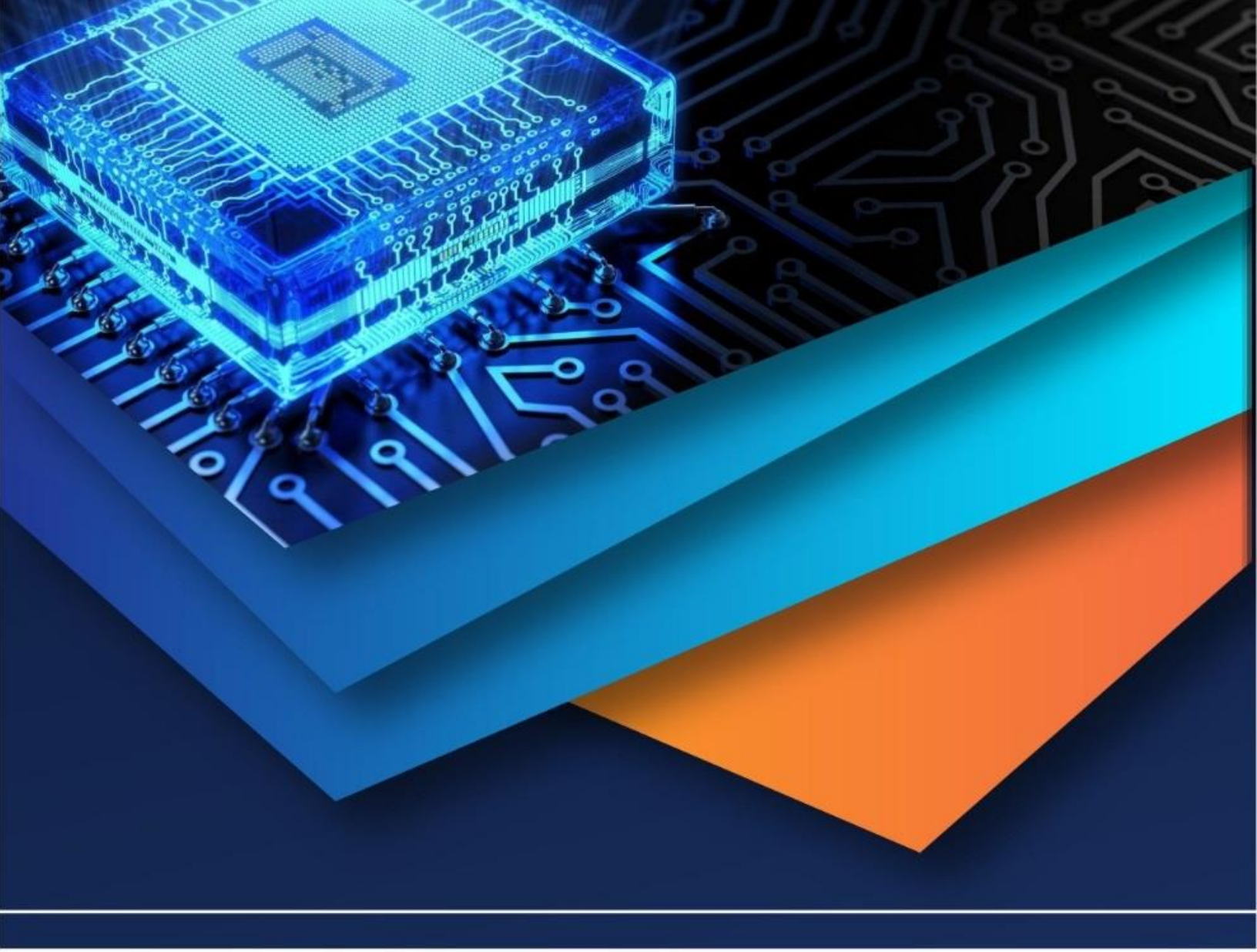

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