BEHAIVIOR OF EXPANSIVE SOIL WITH LIME AND WASTE PLASTIC

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Abstract: Industrial development in India has necessitated construction of infrastructure facility such as highways, airports seaports and residential, commercial buildings. There is a need to select a good soil conditions for proper safety consideration of all these projects. Such soils exhibit extreme stages of consistency from very hard to very soft when saturated. Expansive soils contain minerals that are capable of absorbing water. They undergo severe volume changes corresponding to changes in moisture content. They swell or increase in their volume when they imbibe water and shrink or reduce in their volume on evaporation of water. Because of their alternate swelling and shrinkage, they result in detrimental cracking of lightly loaded civil engineering structures such as foundations, retaining walls, pavements, airports, side -walks, canal beds and linings. In this article, black cotton (BC) 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 determined. After, getting the optimum percentage of Lime, various proportions of waste plastic are added in the stabilized soil and changes in the properties of the stabilized soil are studied. It is found that lime and plastic waste together enhances the strength significantly. Further, there is considerable reduction in swelling and shrinkage cracking of the soil with the addition of these. Use of plastic waste in soil stabilization may solve the problem of recycling of the plastic bottles and together with lime it gives strong and stable soil behaviour. The study is of practical significance for constructing roads in problematic expansive soil areas.

IndexTerms **- Stabilization, Expansive Soil (BC Soil), Lime, Waste Plastic Bottles.**

I. INTRODUCTION

Infrastructure is a major sector that propels overall development of Indian economy. The foundation is very important for any structure and it has to be strong enough to support the entire structure. For foundation to be strong the soil around it plays a very important role. Expansive soils like black cotton soil always create problems in foundation. The problems are swelling, shrinkage and unequal settlement. Plastic wastes have become one of the major problems of the world. Use of plastic bags, bottles and other plastic products is exponentially increasing year by year. 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 research work presents appropriate and easy ways to implement of recycling waste material as reinforcing material for the stabilization of expansive soil to improve and achieve the required properties for construction works.

II. TYPE STYLE AND MATERIAL AND METHODOLOGY USED

2.1 Black Cotton 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 Gurariya which is about 3km away from district Vidisha (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. A picture of black cotton soil is shown in figure 1. Further, Index Properties and C.B.R. of black cotton soil are given in table 1.

Figure 1: Black Cotton Soil

Table 1: Index Properties of black cotton soil

S.No.	Properties	Result
1	Specific Gravity	2.65
2	Liquid Limit %	50.5
3	Plastic Limit %	27
4	Shrinkage Limit %	17.5
5	Plasticity Index %	23.5
6	OMC %	17
7	MDD (gm/cc)	1.7
8	D FSW %	50
9	CBR %	2.1

2.2 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. A picture of lime used is shown in figure 2.

Figure 2: Lime

2.3 Waste Plastic Strips

Cold drink bottles are collected and cut into strips of aspect ratio two. The dimensions of waste plastic bottle strips used in this study are 7.5mm × 15mm. These strips are added in the soil- cement 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 waste plastic strips is shown in figure 3.

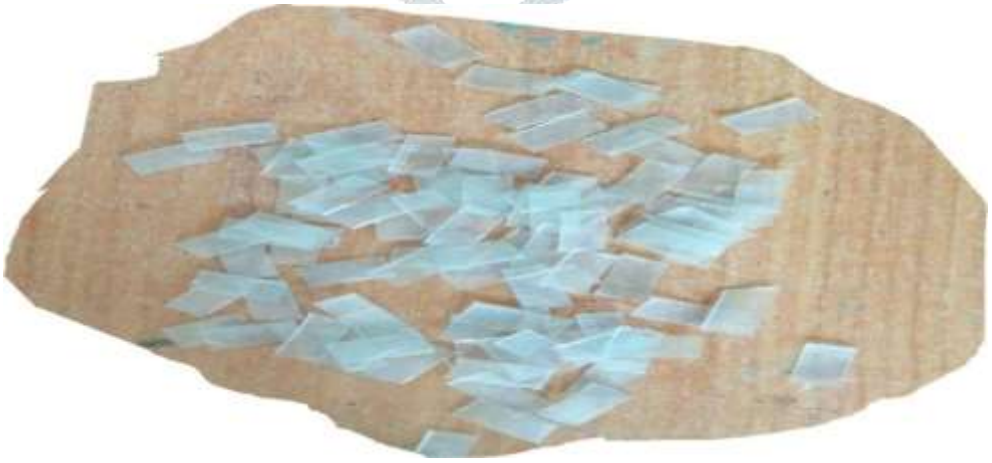

Figure 3: Waste Plastic Strips

2.4. Methodology

The natural soil is collected from Village Gurariya which is about 3km away from district Vidisha (MP) and was air-dried, sieved and tested. 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.

2.4.1 Sample Preparation and Tests Conducted

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.

Figure 4: Sample Preparation

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:

- Soil + 4% Lime + 0.5% Plastic
- Soil + 4% Lime + 1.0% Plastic
- Soil + 4% Lime + 1.5% Plastic
- Soil + 4% Lime + 2.0% Plastic

2.4.2 Various Test Involved In Research Work

- Natural Moisture Content [IS 2720 (part II)-1973].
- Wet Sieve Analysis [IS 2720 (Part 4) – 1985].
- Liquid Limit Test [IS 2720 (Part 5) – 1985].
- Plastic Limit Test [IS 2720 (part 5) – 1985].
- Specific Gravity Test [IS 2720(part III)-1980].
- Compaction Test [IS 2720 (part VII) – 1980].
- California Bearing Ratio (CBR) Test [IS 2720 (Part 16) – 1987].

III. Result and Discussions

Table 2. Shows results of Index Properties of black cotton soil when added with lime and waste plastic Strips.

Table 2: Index Properties of black cotton soil when added with Lime 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

3.1 Effects of Lime and Waste Plastic Strips on OMC and MDD

Effects of lime and waste plastic strips on OMC and MDD are shown in figure 4. It can be observed that OMC decreases while MDD increases with lime and waste plastic strips.

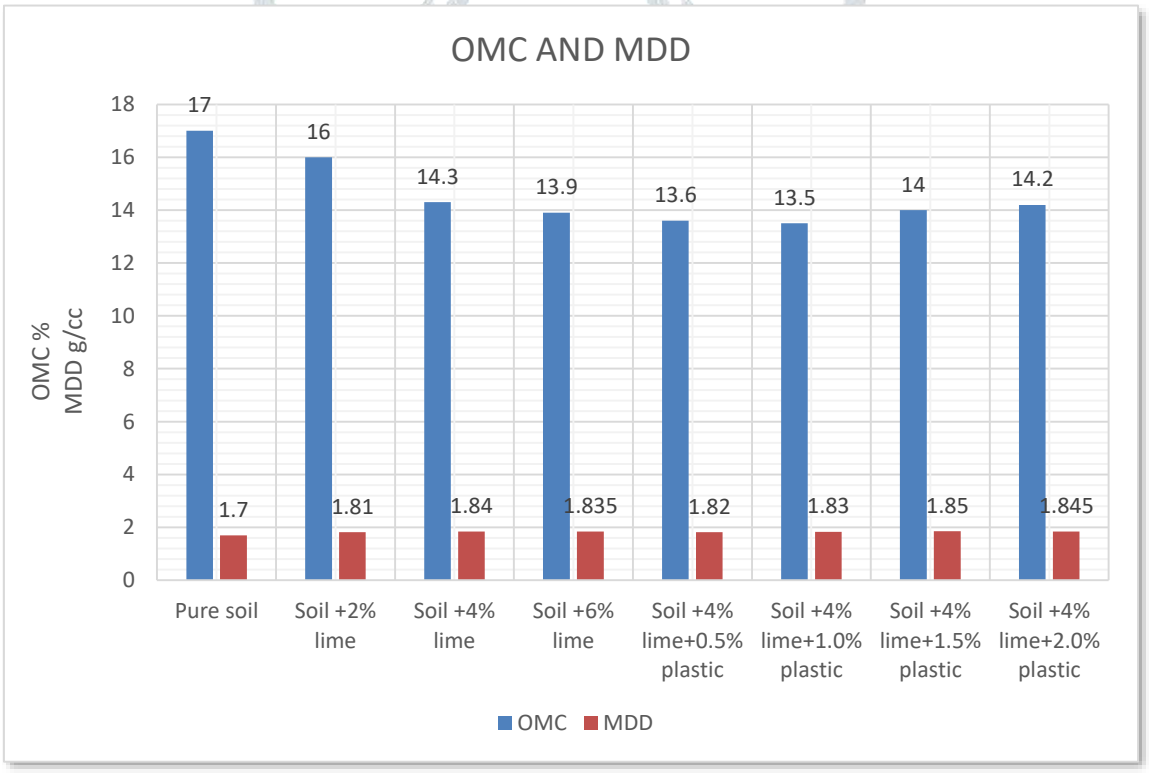

Figure 5: Effects of Lime and Waste Plastic Strips on OMC and MDD

3.2 Effects of Lime and Waste Plastic Strips on unsoaked and soaked CBR values

Comparisons of unsoaked and soaked CBR values are shown in figure 6-7 and figure 8-9 respectively. It can be observed that unsoaked and soaked CBR values are increases with lime and waste plastic strips.

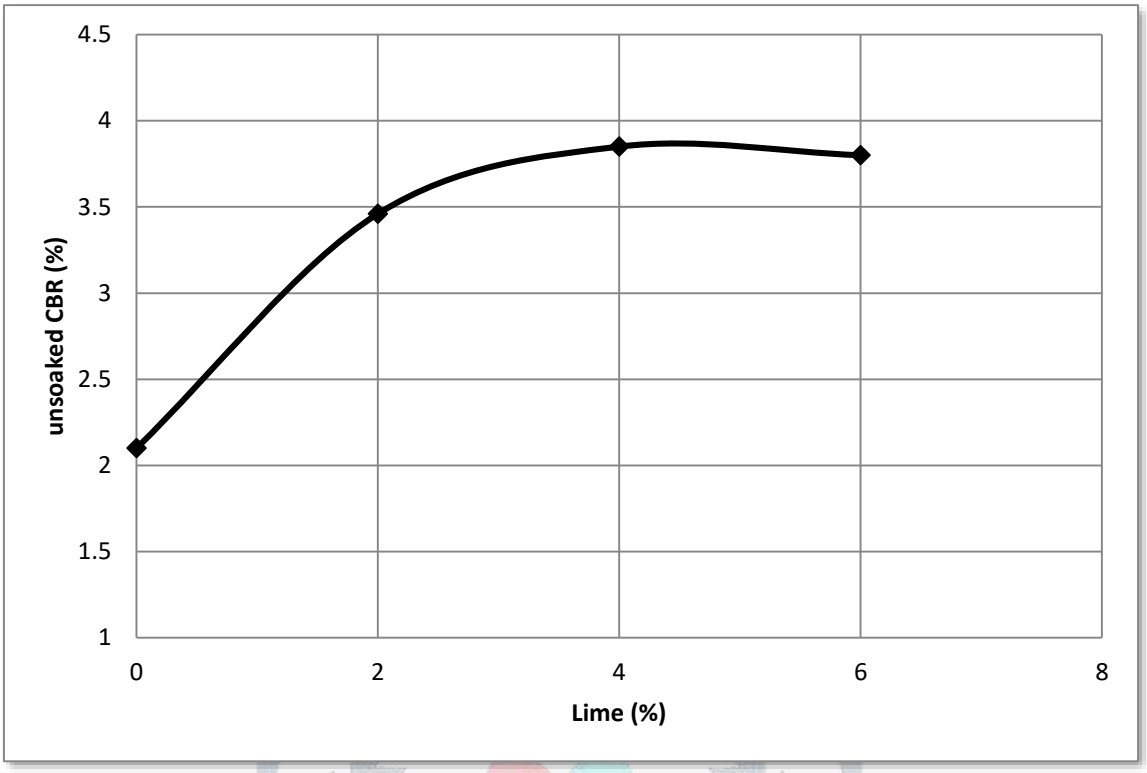

Figure 6: Effects of Lime on unsoaked CBR values

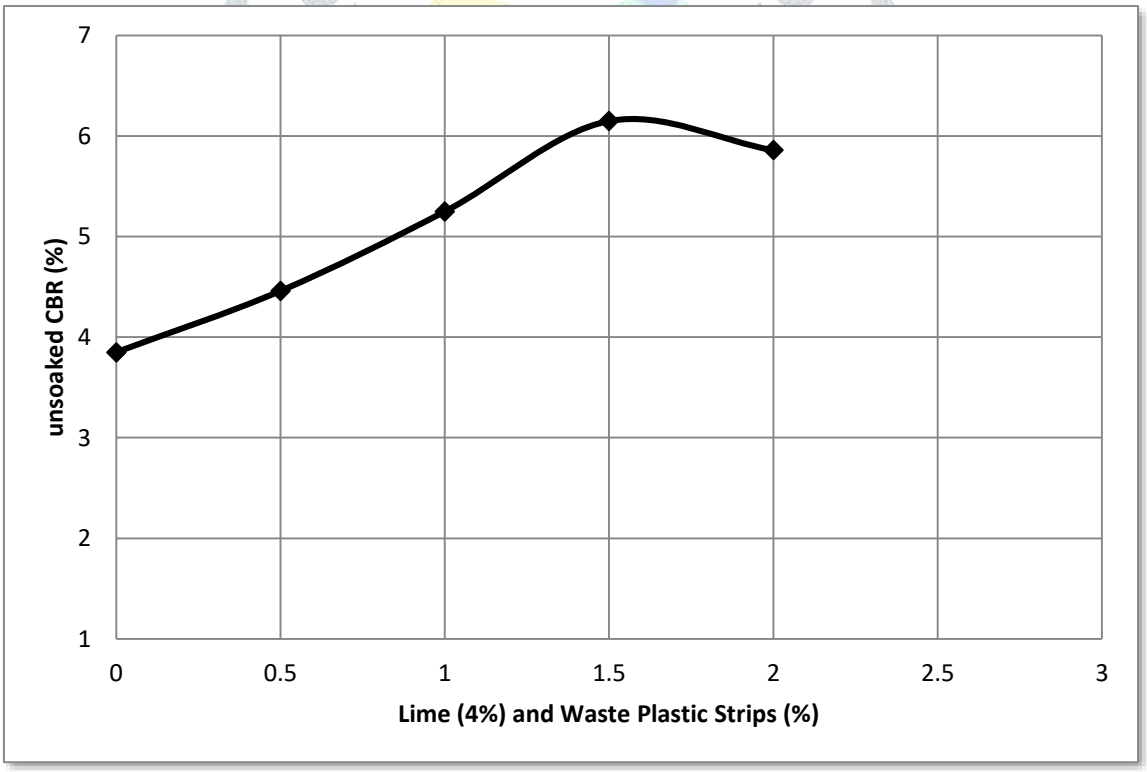

Figure 7: Effects of Waste Plastic Strips on unsoaked CBR values

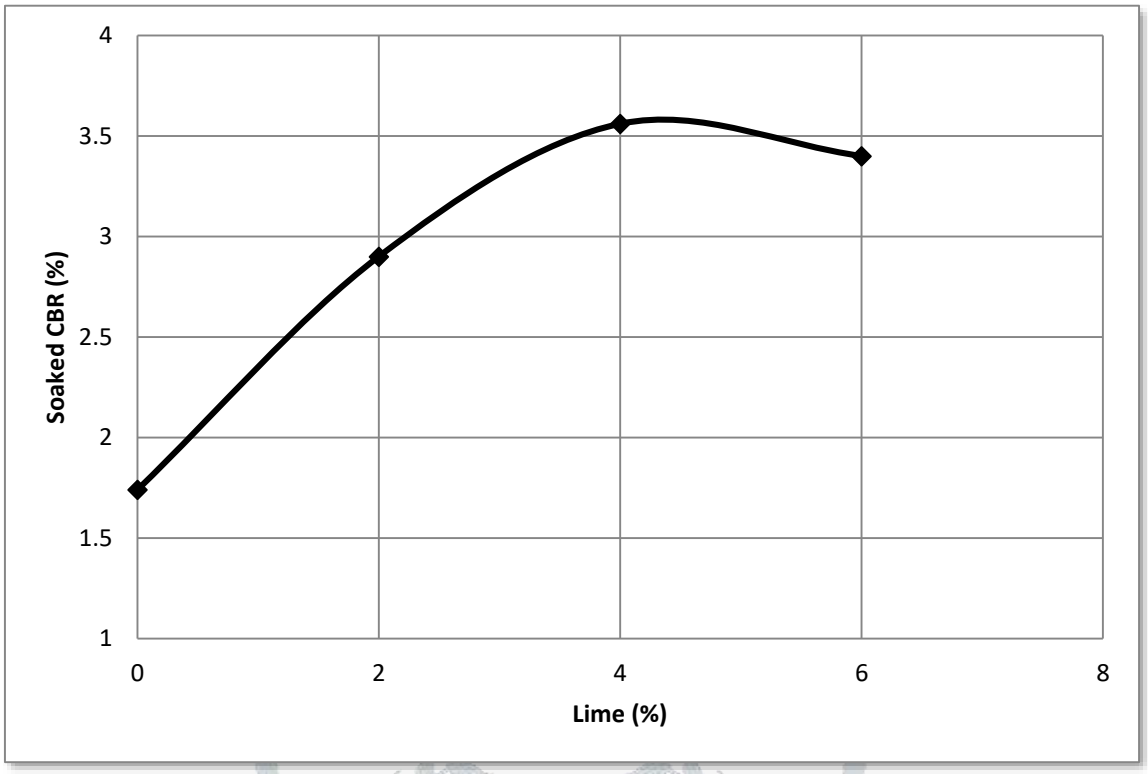

Figure 8: Effects of Lime on soaked CBR values

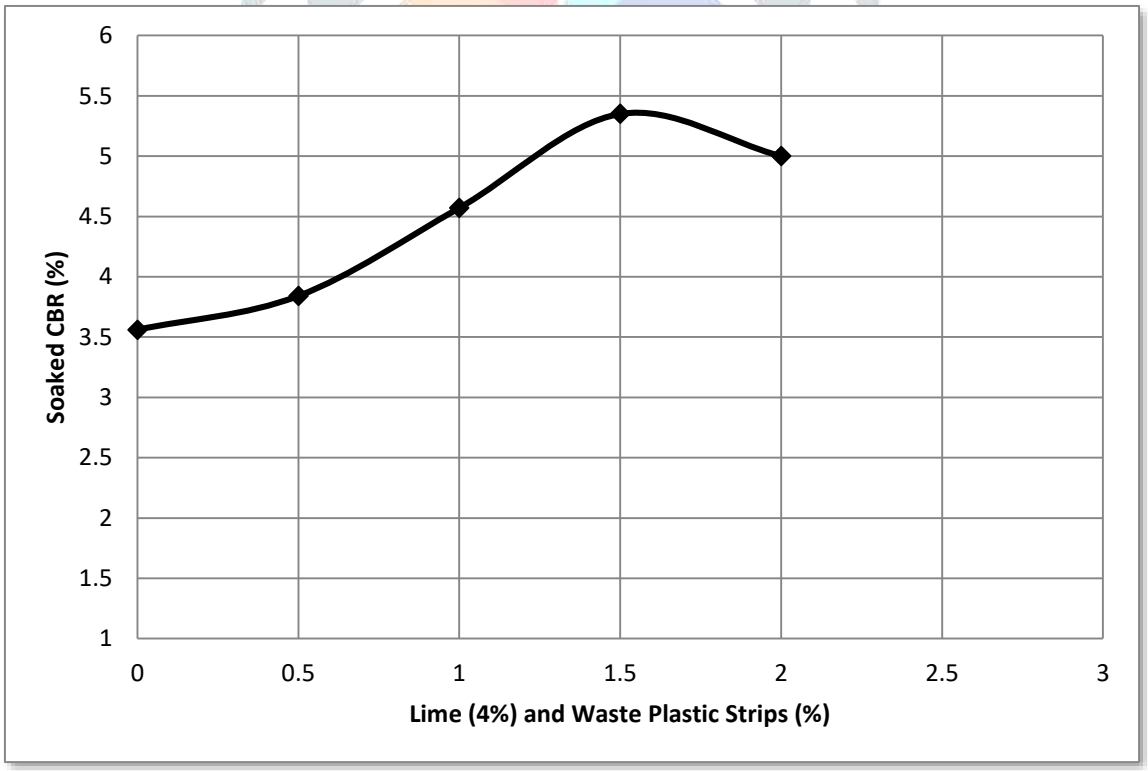

Figure 9: Effects of Waste Plastic Strips on soaked CBR values

IV. Result and Discussions

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

2. 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

3. 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.

4. 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.

5. 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.

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

7. 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.

V. Acknowledgment

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