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Experimental Investigation on Black cotton soil By using lime and Rice Husk ASH

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Abstract: In India, most of the land is covered by black cotton soil. Black cotton soil is also called as expansive soil. These soils are not good for construction as this soil causes severe damage to the stru cture. Black cotton soils exhibit high swelling and shrinkage, when gettting contact with the moisture content. To avoid these failures in engineering field soil must be stabilized. A suitable ground before constructions a real challenging issue for Geotechnical Engineers. The Soil is improved using many methods and materials in geotechnical engineering. In this thesis, black cotton soil is stabilized using waste materials like rice husk ash and lime. As rice husk ash and lime are available at low cost. The strength parameters are conducted to the stabilized soil and results are compared. The hydrated lime reacts with the clay particles and transforms them permanently into strong cementations matrix. To know Soil properties, tests such as Atterberg's limit, Compaction Test, Swell Index, CBR, UCS Test are carried out. These tests were conducted on proportions, and optimized proportion is arrived. A laboratory investigation is carried on 5% lime mixed with black cotton soil blended with and small proportions of rice husk ash 5%,10% and 15% by weight of dry soil. From this investigation, it can be concluded that the Rice Husk Ash has a potential to improve the characteristics of a black cotton soil.

Keywords: Black Cotton soil, Lime ,Rice Husk Ash, Soil Stabilization

INTRODUCTION

In India, almost 20 per cent of the soils are expansive in nature spreading mainly in central and Deccan plateau including some parts of Telangana state. Expansive soils are those which swells in contact with moisture and shrinks on drying which leads to failure of structures. They create numerous problems in the field of civil engineering while designing, construction and during the maintenance of various Civil Engineering projects like Building foundations, Roads, Railways, Runways for Airways. The swelling soils are commonly known by the name of Black Cotton Soils. They are called as black cotton soils for being black in colour and are more suitable for growing cotton and gives high yield of cotton compared to other type and colour of soils. The presence of montmorillonite clay in these soils imparts them high swell–shrink potentials. The Malwa region occupies a plateau in western Madhya Pradesh and south-eastern Rajasthan, with Gujarat in the west. To the south and east is the Vindhya Range and to the north is the Bundelkhand upland. The plateau is an extension of the Deccan Traps, formed between 60 and 68 million years ago at the end of the Cretaceous period. In this region the main classes of soil are black, brown and bhatori (stony) soil. The volcanic, clay-like soil of the region owes its black colour to the high iron content of the basalt from which it formed. The other two soil types are lighter and have a higher proportion of sand.

Problems with black cotton soil

Due to variation of moisture content in black cotton soil, it undergoes mainly two types of problems In any civil engineering structure they are Swelling – due to increase in moisture content, a volume of the soil increases and it is referred as swelling.ex- formation of heave
shrinkage – due to decreasing moisture content decreasing the volume of soil is called as shrinkage ex- settlement in the foundation

OBJECTIVE

1. To determine the properties of Black cotton Soil and soil stabilized with different percentage of Rice husk ash, Fly Ash and Lime individually.
2. Improvement of bearing capacity of Black Cotton Soil on addition of lime and rice husk ash.
3. To evaluate the effect on the properties of Black Cotton soil stabilized with mixture of Rice husk ash, Fly ash and Lime.
4. To find the optimum value of RHA and Lime

This experimental study focused on the effect of RHA and lime on index and geotechnical properties of

the soil and its performance. Rice Husk Ash is added as partial replacement material with variation of percentage as 5%, 10%, 15% in steps and the lime is added as a binding material at constant percentage of 5% to enhance the strength and stability of the soil. The laboratory tests are carried out and the effect on soil properties such as Particle size distribution, Atterberg limits, field density, optimum moisture content, Maximum dry density, California Bearing ratio, Unconfined compressive strength is determined in both natural soil and soil mixed with RHA and soil mixed with RHA and lime .From the above experimental investigations, optimum value of percentage addition of RHA with black cotton soil is evaluated.

MATERIALS USED

BLACK COTTON SOIL

For the experimental work, the soil sample is collected from Medak District, Telangana. About 50 kg of a sample is collected at a depth of 2.5 m and brought to the soil mechanics laboratory in our college for the project work. Standard test on the soil is carried out in our laboratory with the collected soil sample and properties of the soil are determined

LIME

Lime is an important cementing material use in engineering construction. A cement material may be defined as that material which has the capacity of holding the structural unit together with sufficient strength.

Lime or quick lime is – CaO

It is obtained by heating of naturally occurring calcium carbonate in the form of limestone, chalk or marble to about 900˚ in the presence of limited supply of air

$$CaCO_3 + heat \rightarrow CaO + CO_2$$

IMPORTANCE OF LIME

1. Workability of lime is high as lime reacts with CO2 slowly.
2. Lime is less brittle; therefore it is less prone to cracking.
3. Lime posses high permeability similar that of soil.
4. Environmental concern - While production of lime, CO2 is released into the atmosphere, but when mortar prepared with lime, it absorbs carbon dioxide from the atmosphere.

RICE HUSK ASH

Rice husk ash is an agricultural waste which is produced in a million in tons. Rice husk ash (RHA) is known as super pozzolanic in concrete at optimum replacement percentage. RHA is very rich in silicon dioxide which makes it very reactive with lime due to its not – crystalline silica content. Rice Husk Ash (RHA) is one of the agricultural wastes produced in our country when the rice is milled from paddy. About 108 tons of rice husk is produced in our world annually. Rice husk consists of about 67-90% of silica. The silica is present in this rice husk in amorphous form, and it is considered to be a pozzolanic material. It has been estimated that 1000 kg of rice produce 200 kg of rice husk from which 40 kg of rice husk ash would be generated. Rice husk is taken from Rice mill located at Yedapally, Nizamabad district.

Figure 1: Rice Husk Ash

Percentage	Particulars	
86.94	Silicon dioxide	1
0.2	Aluminum dioxide	2
0.1	Iron dioxide	3
0.3 – 2.2	Calcium dioxide	4
0.2 – 0.6	Magnesium dioxide	5
0.1 – 0.8	Sodium dioxide	6
2.15 – 2.3	Potassium dioxide	7

Table 1: Chemical property of RHA

PREPARATION OF SOIL SAMPLE

The soil sample which is to be stabilized is collected and sieved through 0.075mm aperture before use. Then, preliminary test is done on the soil to analyze the similarities in the geotechnical properties. The laboratory tests are done to determine the properties include Particle size distribution, Consistency Limits (Atterberg Limits), ex-situ soil tests, etc. The Standard Compaction test was done to find the optimum moisture content needed for the CBR test specimens

Mix proportions	S. No
BC= SOIL+0%L	1
BCL-0 = SOIL+5%LIME+0%RHA	2
BCL-5 =SOIL+5%LIME+5%RHA	3
BCL-10= SOIL+5%LIME+10%RHA	4
BCL-15= SOIL+5%LLIME+15%RHA	5

Table 2: mix proportions of soil sample

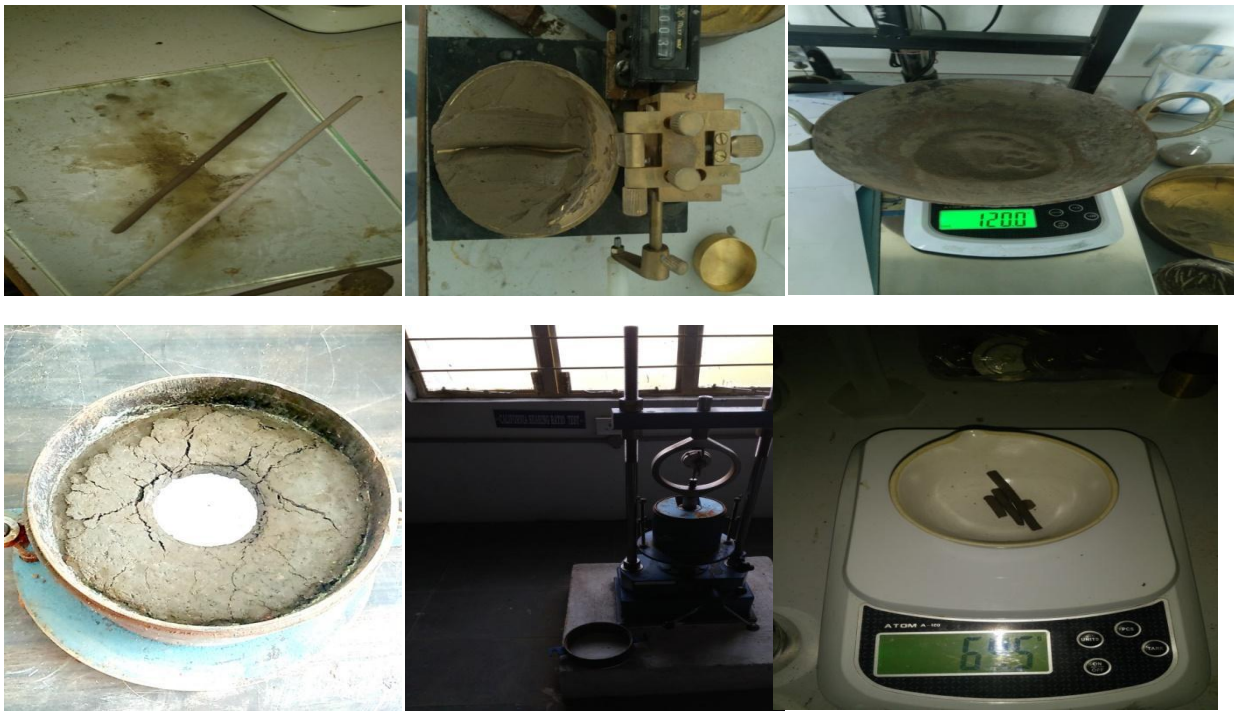
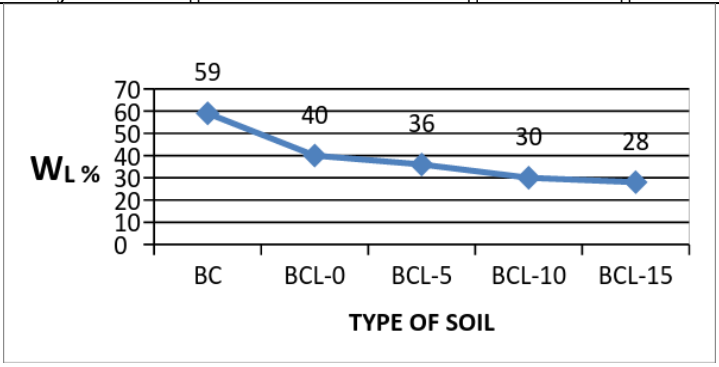


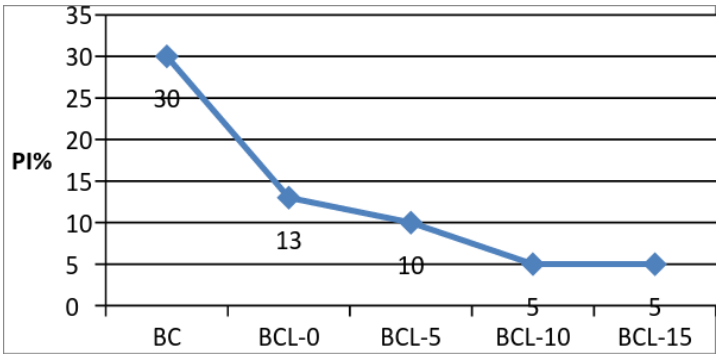
Figure 2: Experimental procedures



Graph1: Showing variation of liquid limit values

LIQUID LIMIT %	TYPE OF SOIL	S N O
59	BC	1
40	BCL-0	2
36	BCL-5	3
30	BCL-10	4
28	BCL-15	5

Table 3: variation of liquid limitvalues



Graph2: Showing variation of plastic index values

PI	PL	LL	Type of soil
30	29	59	BC
13	27	40	BC + 5% lime
10	26	36	BCL + 5%RHA
5	25	30	BCL + 10%RHA
6	22	28	BCL + 15%RHA

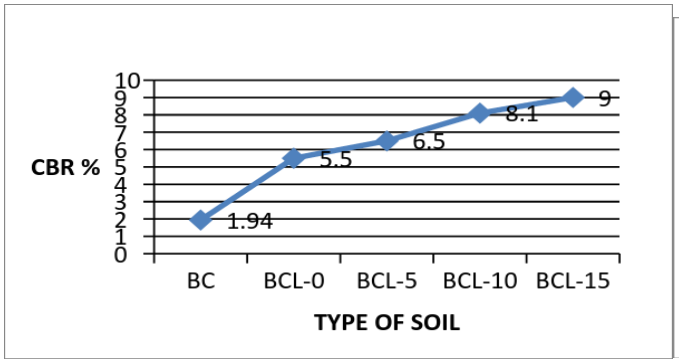
Table 4: variation of plastic limit values

CBR	Type of soil
1.94	BC
5.5	BC + 5% lime
6.5	BCL + 5%RHA
8.10	BCL + 10%RHA
9	BCL + 15%RHA

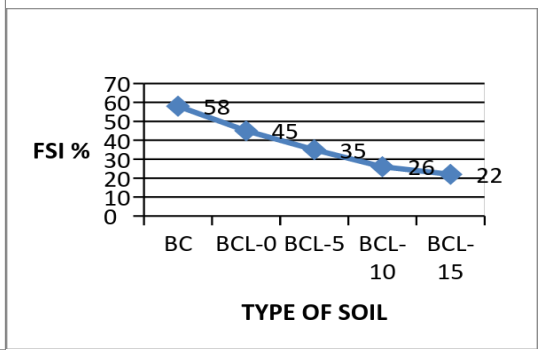
Table 6: CBR values for various proportions

MDD (g/cc)	OMC(%)	Type of soil
1.68	24	BC
1.72	20	BC + 5% lime
1.76	18	BCL + 5%RHA
1.8	15	BCL + 10%RHA
1.75	12	BCL + 15%RHA

Table 5: Compaction values for various proportions



Graph4: Showing variation of CBR values



Graph3: variation of free swell index

UCS	CBR% unsoaked	Compaction		Free swell Index	Atterberg's Limits				Soil type
kg/cm^2	%	ODD g/cc	OMC %	%	PI %	SL %	PL %	LL %	
1.15	1.94	1.68	24	58	30	14.5	29	59	BC
1.2	5.5	1.72	20	45	13	15	27	40	BCL-0%
1.25	6.5	1.76	18	35	10	15.2	26	36	BCL-5%
1.35	8.1	1.8	15	26	5	15.8	25	30	BCL-10%
1.38	9	1.75	12	22	5	16	22	28	BCL-15%

Table 7: Showing Final Experimental Values

CONCLUSION

1. On the basis of study and experimental investigations it was observed that the property of black cotton soil effectively improved by use of different percentage of lime with rice husk ash contents. In this research varying percentage (5%,10% and15% of RHA) with 5% lime was used to stabilize the black cotton soil. Points which were drawn from this study are listed below-
2. It was observed that Liquid limit values are decreases from 59% to 28% by adding of lime and rice husk ash that means soil property changes from highly compressible to low compressibility
3. Plastic index values are decreases from 30% to 5% on addition of lime with RHA that means highly plastic to low plastic
4. Free swell index values are decreased that means swelling of the soil also decreases.
5. The C.B.R. values of black cotton soil raised from 1.94 to 9% on addition of lime with RHA respectively

Hence, it can be concluded from this investigation that properties of black cotton soil can be improved by addition of 5 percent lime and 10 per cent Rice husk ash

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