Compressibility Behaviour of Black Cotton Soil Admixed With Lime and Rice-Husk Ash

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Abstract: **Black cotton soil covers about one-fifth of the area of our country. Owing to its undesirable engineering properties such as high swelling and shrinkage, the soil is not good either as foundation or embankment material. To make the best use of black cotton soil, its properties are to be modified to suit the requirements in any specific case by means of stabilization. Therefore, it is necessary to properly choose the stabilizer through careful investigation to improve the strength, compressibility and permeability characteristics. At the same time, the economics of the process of the stabilization should also be considered. In this paper the results obtained by studying the compressibility behaviour of black cotton soil admixed with lime and rice-husk ash is presented. For the purpose of comparison similar studies have been carried out with admixtures such as lime and rice-husk separately.**

Keywords: **-Black Cotton Soil; Stabilization; Lime; Rice-Husk Ash.**

I.INTRODUCTION

Expansive soils, well-known as Black Cotton Soils in India, occupy about one-fifth of land area of the country. Black Cotton Soils are residual deposits formed from basalt or trap rocks. They contain significant amount of montmorillonite material. These soils are very hard in dry state but lose their load carrying capacity when once they are allowed to imbibe water. They have high shrinkage and swelling characteristics. In general, these expansive soils are very much sensitive to changes in environment. The environment includes the stress system, the chemistry of pore water in the system, the seasonal variations in ground water table with consequent changes in natural moisture content and temperature variations. These properties have made the soil unsuitable for civil engineering purposes either as foundation or embankment material. The engineering properties of soils, especially of clays, can be improved to a great extent by stabilizing with lime. Further, it has been found that, by increasing pozzolanic action, the stabilization by lime is highly effective. In rice-producing countries such as India, rice-husk ash for stabilization appears to be a successful solution since rise-husk ash, primarily being siliceous material, acts as a pozzolona. Hence, in this investigation, the compressibility behavior of Black Cotton Soil treated with lime and rice-husk ash has been studied. For the purpose of comparison, similar studies have been carried out with admixtures such as lime and rice-husk ash separately.

LITERATURE REVIEW

Ramaiah et al (1972) studied the behavior of Black cotton soil admixed with lime and rice-husk ash in various proportions. It was found that this admixture decreases the maximum dry unit weight, increases the optimum moisture content, decreases the flexibility as indicated by axial strain at failure and also increases the compressive strength of the stabilized soil.

Sivanna et al (1977) investigated consolidation characteristics of black cotton soil admixed with lime and rice-husk ash. It was shown that rice-husk ash with lime not only accelerates the settlement rate but also reduces the total settlement. Besides, the quantity of lime could be reduced 50% using rice-husk ash as admixture for almost the same characteristics as obtained for lime admixed soil. Jyothi and Ramana Sastry (1991) investigated the behavior of expansive soils treated with lime. It was observed that, in general, the coefficient of consolidation increases whereas both the compression index and swelling index decrease with increase in lime content.

Muntohar (2002) carried out a series of laboratory experiments individually and in combination of RHA and lime in stabilizing expansive soils in Indonesia. He found that the geotechnical properties of expansive soils improved with addition of RHA and lime. RHA and lime altered the texture of clay soil by reducing the fine particles. The admixtures also found to reduce the liquid limit, swelling potential of expansive soils and also the compressibility characteristics.

Ali et al (2004) carried out an investigation to study the influence of RHA and lime on Atterberg limits, strength, and compaction swell and consolidation properties of bentonite. The results indicated that the plasticity properties of bentonite were significantly modified upon the addition of RHA and lime. The RHA and lime have noticeable influence on compaction, swell and consolidation properties of bentonite soil particularly at 15% RHA and 8% lime contents individually and combinedly at 15% RHA +4% Lime.

Adrian (2011) conducted one dimensional laboratory consolidation tests on compacted lateritic soils treated with up to 16% Rice-Husk Ash (RHA), to assess its consolidation properties. Specimens were prepared at three different moulding water contents (2% dry of optimum, optimum moisture content and 2% wet of optimum) and compacted using the British Standard Light compactive effort. Pre-consolidation pressure increased with RHA content, it also decreased before increasing with increased moulding water content. Reductions in compression index (Cc) and Swell Index (Cs) with increased RHA content were recorded. Cc and Cs generally decreased before increasing with increased moulding water content. The coefficient of volume compressibility (Mv) decreased and increased with higher RHA content; they were also affected by the soil particle state with increasing pressure. The co-efficient of consolidation (Cv) showed no observable trend with increased RHA content but generally increased with higher consolidation pressure on the dry and wet side of optimum compacted states.

Ashwani Jain (2013) have been conducted One-dimensional consolidation tests to study the effect of addition of various percentages of rice husk ash on compressibility characteristics of highly plastic clay soil. It has been observed due to the addition of rice husk ash to the parent clay, Compression index (Cc) has been found to decrease significantly with increase in percentage of rice husk ash, hence decreasing consolidation settlement of parent material. It has also been observed that the time required for achieving a given degree of consolidation decreases with increase in the percentage of rice husk ash at a particular effective stress. Overall, it has been observed that rice husk ash effectively increase one-dimensional stiffness and therefore, reduce settlement.

MATERIALS AND METHODS

A series of laboratory tests were conducted on 0.5%lime mixed BC Soil blended with RHA in various percentages i.e. 10%, 20% and 30 %.by weight of dry soil. The following tests were conducted on 0.5%lime mixed BC soil and Rice mixes; as per relevant IS Code. The tests are

1. Compaction Test
2. Shrinkage limit
3. Unconfined Compressive Strength
4. Plastic limit of soil
5. Direct Shear Test

BLACK COTTON SOIL

The black cotton soil used in this study was collected from The Chhattisgarh is located in the central part of India, between the latitudes of 17°46–24°8 N and the longitudes of 80°15–84°24 E.

RICE HUSK ASH

The stabilizer materials used in this study was Rice Husk Ash. Rice Husk Ash used in this study collected from Rice Mill, Dist. Durg (C.G..) The property of RHA is presented in Table 1. The black cotton soil was mixed with 0.5%lime and soaked for four days. After oven drying, the following samples are prepared by mixing different percentage of rice husk ash to it.

Table 1. Chemical& Physical properties of RHA

Oxide composition % by mass	**RHA**
Sio2	88.32
Al2O3	0.46
Fe2O3	0.67
CaO	0.67
MgO	0.44
Na2O3	0.12
K2O	2.91
LOI	5.81
Specific gravity	2.11

RESULTS AND DISCUSSION: The tests results are summarized in Table 3. The variation in the shrinkage limit and liquid limit are shown in Figures 1 to 2.

Table 2. Summary Of Result

MIX	SHRINKAGE LIMIT	LIQUID LIMIT
BCS	29.67%	0.136
RHA 10	22.35%	0.15
RHA 20	28.14%	0.08
RHA 30	27.03%	0.07

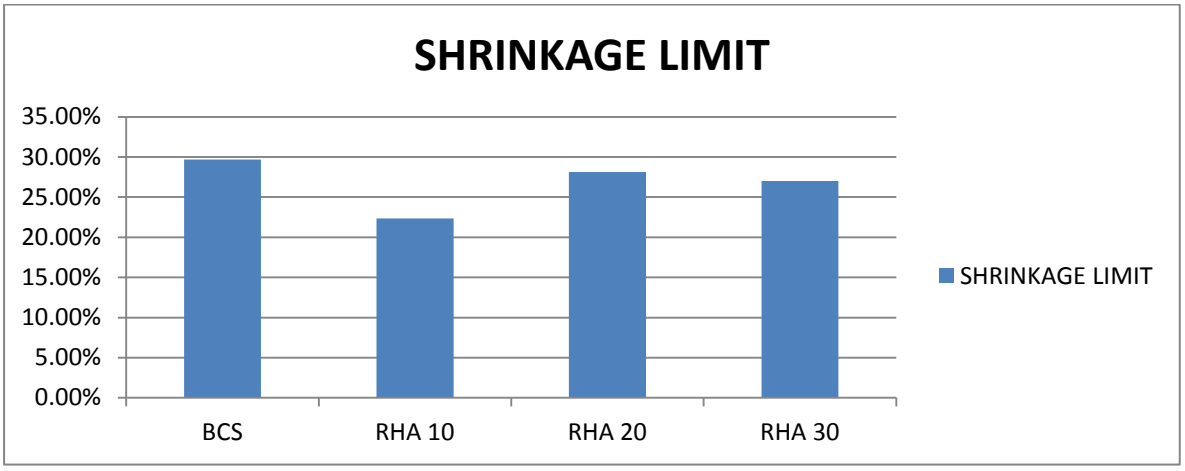

Figure No. 1 Shrinkage Limit

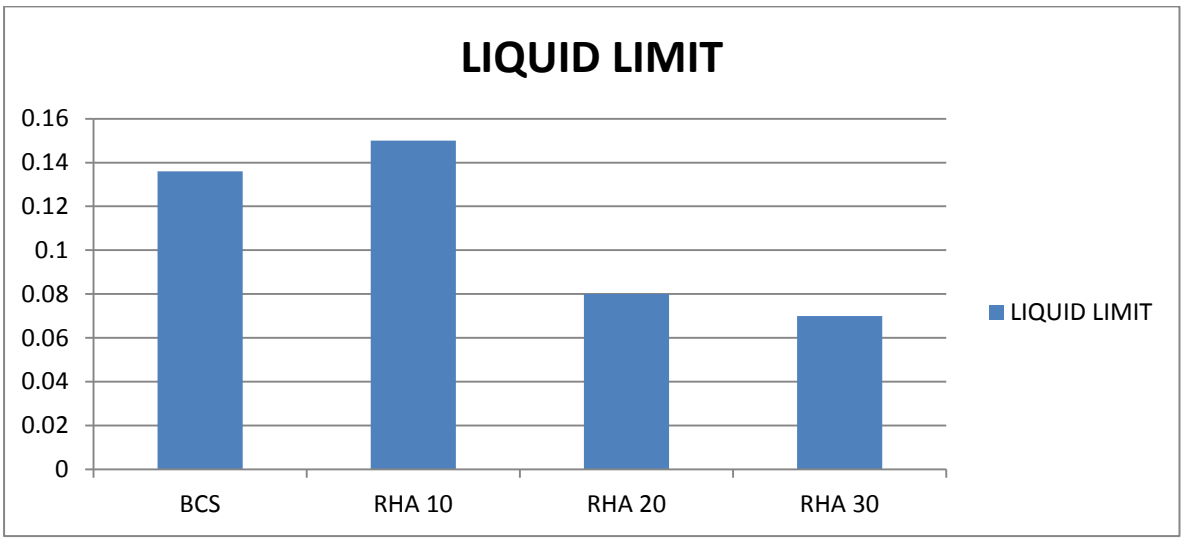

Figure No. 2 Liquid Limit

CONCLUSION

From the results of the investigation carried out within the scope of the study the following conclusion can be drawn

- Based on Specific gravity of a soil- With mixing of RHA, specific gravity of the soil increases by 0.3%. Strength of the soil is directly proportional to specific gravity, more is the specific gravity more will be the strength of soil.
- Based on liquid limit of a soil - Soil without RHA and with RHA have liquid limit difference of 16.46%.
- Based on plastic limit of a soil - As similar to liquid limit the plastic limit of soil is also reduces. It reduces from 29.35% to 27.03%. % decrease in plastic limit is 2.32%, This result shows increase in shear strength Cohesiveness and consistency of soil mass.
- Based on liquid limit of a soil - The value of the shrinkage limit in black cotton soil is greater than that of soil with RHA. Hence with the use of RHA shrinkage increases.
- The differential free swells decreases, showing appreciable decrease in swelling behavior.
- Thus the improvement in index properties of soil reveals that rice husk ash is an important material to stabilize the black cotton soil & make suitable for construction purpose.
- It is observed that addition of RHA enhances not only the strength development but also the durability of lime stabilized soil.

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