STABILIZATION OF BLACK COTTON SOIL USING RICE HUSK ASH AND GROUND GRANULATED BLAST FURNACE SLAG

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Abstract : The objective of stabilization used is to increase the strength and stiffness, improve workability and constructability of the soil and reduce the plasticity index. In the present work, an attempt was made to study the effect of Ground Granulated Blast furnace Slag [GGBS] and Rice Husk Ash [RHA] on properties of Black Cotton Soil. GGBS is heavier than most natural aggregates. It has higher stability and high angle of internal friction. RHA is an inorganic, natural soil stabilizer which is said to improve the index and engineering properties of poor soils. GGBS and RHA are powder additives which act on soil to reduce voids between soil particles and minimize absorbed water in the soil to achieve maximum compaction. The effect of 5%, 10% & 15% of GGBS and RHA on properties of soil such as Liquid Limit, Plastic Limit, California Bearing Ratio and Unconfined Compressive Strength for different curing periods were studied. A comprehensive experimental investigation shows that there is an increase in strength with increase in percentage additives. A comparison of strength with respect to GGBS and RHA show higher strength in GGBS as compared to RHA**.**

***IndexTerms* -** GGBS, RHA, Stabilization, Liquid Limit, Plastic Limit, California Bearing Ratio and Unconfined Compressive Strength**.**

I. INTRODUCTION

Engineers are often face the problem of constructing facilities on or with soils, which do not possess sufficient strength to support the loads imposed upon them either during construction or during the service life of the structure. The black cotton soil generally rich in silt, indicates low strength and poor bearing capacity. For better performance of structures built on such soils, the performance characteristics of such soils need to be improved. The poor engineering performance of such soils has forced engineers to attempt to improve the engineering properties of such soils. Thus in the present study, an attempt has been made to investigate the engineering properties of black cotton soils treated with RHA and GGBS Stabilizer, the influence of applying this stabilizer has been examined via various laboratory tests. The RHA is an inorganic, natural soil stabilizer which is said to improve the engineering properties of poor soil as well as enhancing that of good soils to meet the specified requirements. The RHA Stabilizer is convenient to use safe, effective and improves the quality of soil.

Ground-granulated blast-furnace slag is obtained by quenching molten iron slag from a blast-furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS enhance better workability, making placing and compaction easier. Hence improve the engineering properties of poor quality soil.

II. LITERATURE REVIEW

Brooks (2009) has carried out a study to screen a suite of traditional and non-traditional stabilizers against soils that have caused problems during construction or resulted in poor performance in service. The selected stabilizers were: RHA and fly ash, where in the author has conducted different laboratory studies on Black cotton soils and arrived at the following conclusions: When the RHA content was increased from 0 to 12%, Unconfined Compressive Stress increased by 97%. The RHA content is increased from 0 to 12%, CBR improved by 47%. The optimum RHA content was found at 12% for both UCS and CBR tests. The swelling potential of expansive soil decreases with increasing swell reduction layer thickness ratio. The vertical movement of clay soils with cushioning material stabilizes after 3 cycles of swelling and shrinkage. RHA content of 12% are recommended for strengthening the expansive sub grade soil.

Manjunath, et,al(2012), carried out a study to screen a suite of traditional and non-traditional stabilizers against three Virginia soils that have caused problems during construction or resulted in poor performance in service. The selected stabilizers were: GGBS, They conducted different laboratory studies on Black cotton soils and arrived at the conclusions: The primary benefits of using these additives for soil stabilization are Cost Savings: because slag is typically cheaper than cement and lime; and Availability*:* because slag sources are easily available across the country from nearby steel plants. Waste management one of the industrial wastes can be done economically. Use of slag as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor soil. It is observed that with increase of slag, more stability of soil is achieved as compared to using lime alone. UCC strength of Ordinary Black Cotton Soil which was found out to be 188.5 KN/m², increased to 3429.37 KN/m². Finally, this study concluded that For the proportion of (BC soil + 30% slag) + 4% lime at OMC on 28th day with proper curing, UCC strength has increased up to 18 times that of ordinary Black Cotton Soil i.e. (3429.37 KN/m²).

III. METHODOLOGY

The samples of Black Cotton soil were collected for the investigation. The samples of soils were taken from 2m depth below the ground surface. The collected samples were treated with RHA and GGBS for various mix ratios. The Stabilizer/Additive is applied to the natural soil by loose volume and dry mass of the soil respectively. Subsequently, the treated soil samples were cured for different periods ranging from one day to twenty eight days. Soil samples collected from site are tested for their geotechnical properties and strength characteristics. The various tests conducted to obtain geotechnical parameters are referred in Punmia (2005). The tests conducted are Atterberg's limits, Compaction test, California Bearing Ratio test and Unconfined Compressive Strength test. The effects of RHA and GGBS on Black cotton soil will be discussed in detail below.

IV. RESULTS AND DISCUSSION

For soil treated with RHA and GGBS of 5%,10%,15% results are as follows

1. **Effect of RHA and GGBS on Atterberg's Limits**

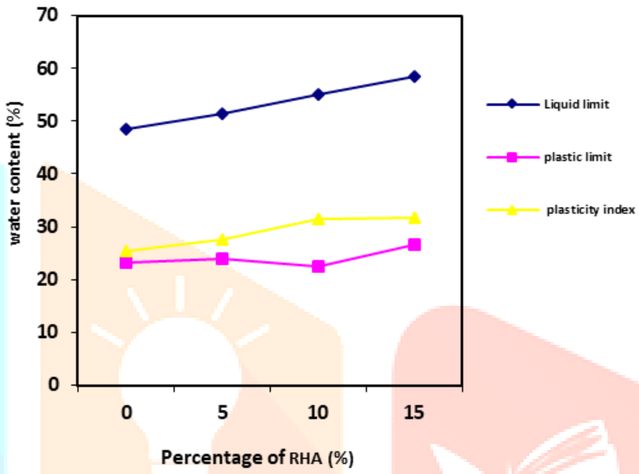

Figure 1 Effect of RHA on Atterberg's Limits

Figure 1 shows the variation of Atterberg's limits with different percent of RHA. It is observed from figure that the Liquid Limit increases with increase in percentage of RHA and there is no particular trend is observed in Plastic Limit and Plasticity Index.

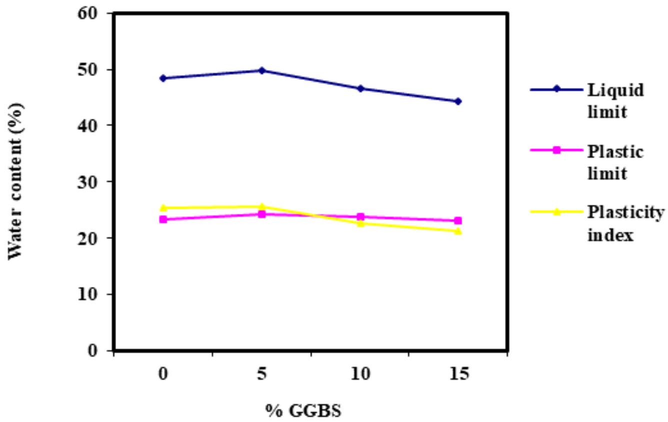

Figure 2 Effect of GGBS on Atterberg's Limits

Figure 2 shows the variation of Atterberg's limits with different percent of GGBS. It is observed from figure that the liquid limit and plasticity index decreases with increase in GGBS percent where as the plastic limit increases initially then decreases with increase in percent of GGBS.

2. Compaction Test

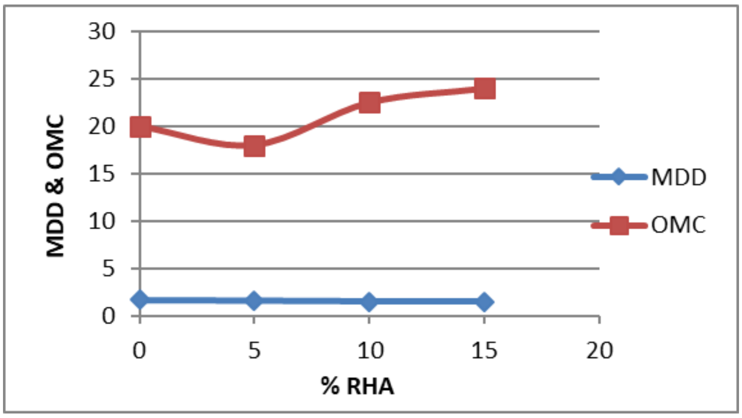

Figure 3 Soil treated with RHA of 5%,10%,15% results is as follows:

Figure 3 shows the compaction characteristics for black cotton soil with different percent of RHA. It is observed from figure that the Maximum Dry Density decreases with increase in percentage RHA and there is no particular trend was observed between the Optimum Moisture Content with increase in RHA percent

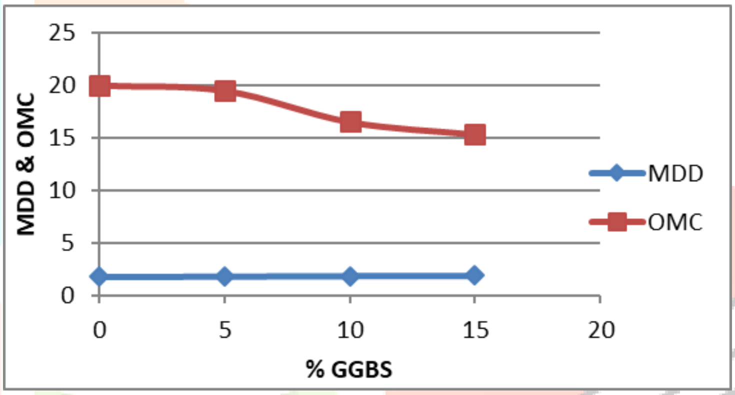

Figure 4 Soil treated with GGBS of 5%,10%,15% results is as follows

Figure 4 shows the compaction characteristics for black cotton soil with different percent of GGBS. It is observed from figure that optimum moisture content decreases and maximum dry density goes on increases with increase in percentage of GGBS.

3. Unconfined Compressive Strength Test

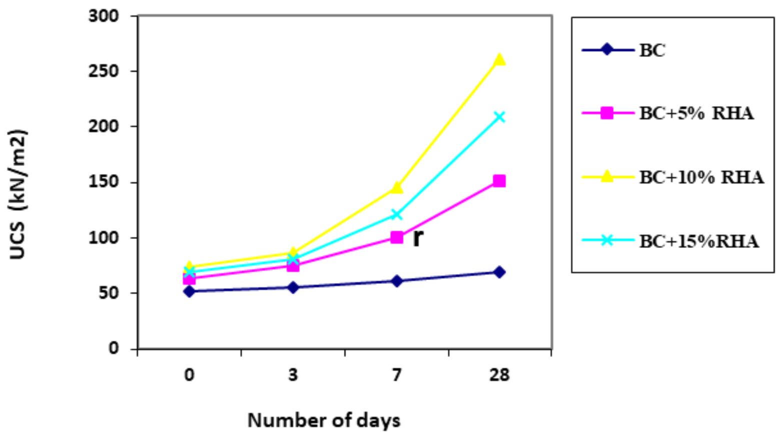

Figure 5 UCS for RHA in %

Figure 5 shows the unconfined compressive strength characteristics for various percentages of RHA for various curing periods. It is seen that the unconfined compressive strength increases with the increase of RHA percentage and it has increased for different curing periods for the same percentage of RHA.

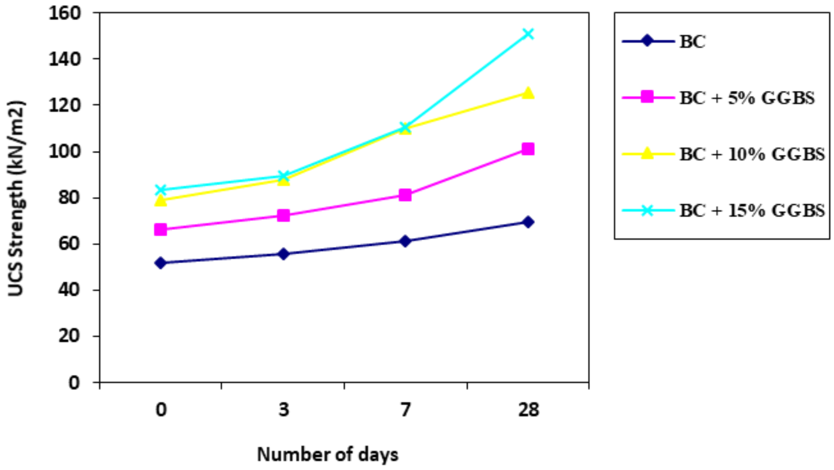

Figure 6 UCS for GGBS %

Figure 6 shows the unconfined compressive strength characteristics for various percentages of GGBS for various curing periods. It is seen that the unconfined compressive strength increases with the increase of GGBS percentage and it has increased for different curing periods for the same percentage of GGBS.

4. California Bearing Ratio Test

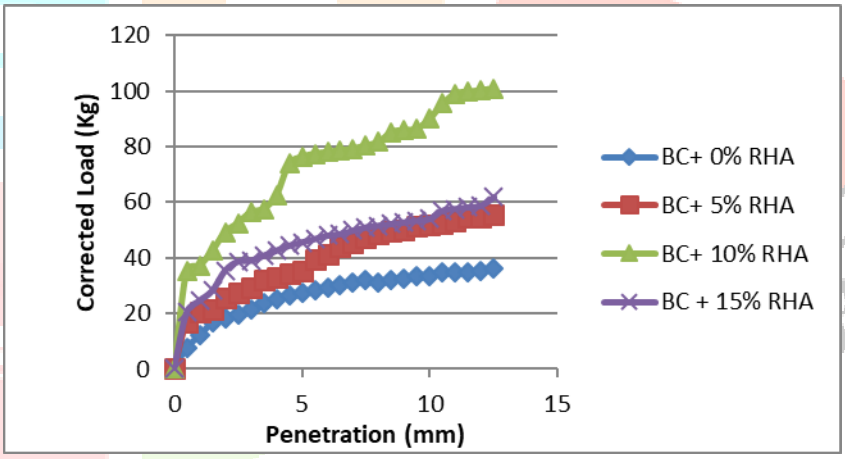

Figure 7 Penetration Vs Corrected Load

Figure 7 shows the compaction characteristics for black cotton soil with different percent of RHA. There is an increase in CBR results with increase in % of RHA up to 10%, but the CBR value decreases for 15% RHA.

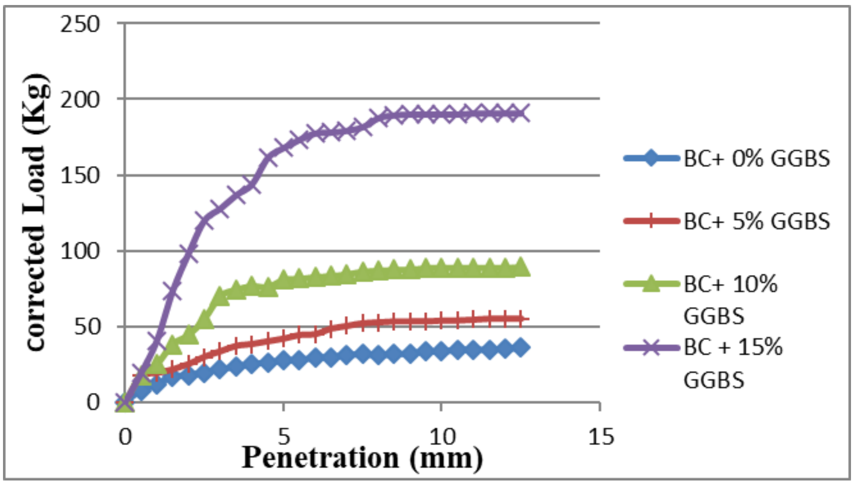

Figure 8 Penetration Vs Corrected Loads

Figure 8 shows the compaction characteristics for black cotton soil with different percent of GGBS. It is observed from figure increase in CBR value with increase in % of GGBS.

V. CONCLUSION

A comprehensive experimental investigation was carried out to stabilize black cotton soil using RHA and GGBS. The experiments conducted include Atterberg's limits, Compaction Test, California Bearing Ratio and Unconfined Compressive Strength. The percentage of additives used was 0, 5, 10 and 15. There is an increase in strength with increase in percentage additives but comparatively the strength of GGBS was more than the RHA.

Stabilization using RHA and GGBS gave the following changes in Black cotton soil

Since RHA is inert material, therefore it doesn't play any significant role in liquid limit and there is no definite trend observed in plasticity index with increase in RHA percent. MDD decreases for Stabilized soil due to relatively low specific gravity of RHA compared to soil. The increase in trend of OMC is due to water holding capacity of RHA. There is an increase in Unconfined Compressive Strength with increase in percentage of RHA up to 10% and the strength due to interlocking effect in stabilized soil and formation of weaker bond between particle and RHA developed for 15%. There is an increase in CBR results with increase in % of RHA up to 10%, but the CBR value decreases for 15% RHA.

The liquid limit and plasticity index decreases with increase in percentage of GGBS which makes the soil have less plastic and plasticity index reduces. With increase in percentage of GGBS, OMC decreases and MDD increases, hence the compact ability of soil increases making the soil denser a hard. There is an increase in Unconfined Compressive Strength and also it increases for increase in curing period. There is an increase in California Bearing Ratio results with increase in percentage of GGBS. Hence it can be good stabilizer to improve soil properties. The replacement of GGBS to BCS proved more effective than RHA as the strength increased by GGBS is comparatively high.

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