INFLUENCE OF RICE HUSK ASH ON ENGINEERING PROPERTIES OF EXPANSIVE SOILS

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ABSTRACT

Due to increase in the demand of soil stabilization with the waste by-products from the industry and as well as from the municipal waste, the stabilization of soil has become more economical for the purpose of construction. Therefore, in this paper an attempt has been made to study the effect of Rice husk ash (RHA) on strength characteristics of black cotton soil. The treated samples are prepared by mixing various proportions of rice husk ash (i.e. 2%, 5%, 7.5%, 10%, 15% and 20%). The basic tests like specific gravity (G), Hydrometer test, Atterberg's limit and compaction test have been conducted to classification the soil and to study the behaviour of soil with the addition of RHA. The results showed that the Optimum moisture content increases with the addition of RHA and the drop in the Liquid limit, plastic limit, plasticity Index and maximum dry density have been observed with the increase in the percentages of RHA. The strength of the natural soil have been obtained as 0.62 Kg/cm2 and with the increase in RHA as an additive the maximum strength have been obtained at 15% RHA of 1.26 kg/cm2, but further increase shows a decreasing trend of strength with 1.18 kg/cm2 for 20 % RHA.

Keywords: Soil Stabilization, RHA and Strength.

INTRODUCTION

In India soils are encountered in various engineering projects, therefore the load bearing capacity, settlement of foundations [15 & 16] and stability analysis of black fill retaining wall structures became an important criterion for the stability of the soil. In, which for improving the properties of the soil, the stabilization became a necessary situation for the site, which we are using for the construction purpose [14].

Rice husk is an agricultural waste [11] obtained from the milling of rice, about 109 tonnes of rice husk are generated annually in the world. Approximately 120-125 million tonnes of paddy are produced in India. This gives around 25 million tonnes of rice husk per every year. In the RHA the silica content depends upon the variety of rice, type of soil, type of climate and agriculture practise ranging from application of fertilizers and insecticides [7]. Rice husk ash has been so much being utilized in the past for upgrading of soils in the most cases the rice husk ash was used as stabilizing agent and admixture [10].

Field Applications of RHA

1. For the purpose of sub grade strength improvement of payments.

2. For reduction of horizontal thrust on the retaining wall (i.e. as the MDD decreases wit addition of RHA) to make the structure safe against earth pressures.

3. Other uses of rice husk ash are green concrete, high performance concrete and crack restriction. etc.

Aim of the study

The aim of the study is to find out the behaviour and strength characteristics of Black cotton soil using Rice husk

ash which were added in different percentages such as 2%, 5%, 7.5%, 10%, 15% and 20% under Optimum Moisture Content and Maximum dry density.

Objective of the study

To evaluate the properties such as Atterberg's limits, Grain size distribution for classification of soil.

To study the behaviour of soil, Compaction test have been conducted for black cotton soil and RHA treated black cotton soil in different proportions (i.e., 2%, 5%, 7.5%, 10%, 15% and 20%).

To evaluate the unconfined compressive strength of Black cotton soil and various proportions (i.e., 2%, 5%, 7.5%, 10%, 15% and 20%) of RHA treated Black cotton soil.

Material

Black cotton soil

The Black cotton soil was brought from Sangareddy village, Medak district, Telangana state, India. The top soil at a depth of 25 cm was removed and the disturbed soil samples which were collected from the site have been packed in bags to prevent the loss of moisture and the tests, which are used for classification of soil and to predicting the behaviour of the soil like compaction and unconfined compressive strength (UCC) test are conducted according to IS code of practice.

Rice Husk ash

It was collected from brick kilns near to the Sathupalli, Khammam District, Telangana, India. For the purpose of experimental work the sample, which is sieved through 2.36mm sieve size was adopted and it has a specific gravity of 2.05.

Experimental methodology

Index properties

The Specific gravity of the Black cotton soil has been conducted as per [1] by using a density bottle. The particle size distribution curve of the soil in Figure 1 was plotted as per the guidelines given in [2] and classification of the soil can be done according to [3]. The liquid limit (LL) and Plastic limit (PL) of the soil are determined according to [4] and the plasticity index values was found by using LL and PL values. The physical properties of black cotton soil, which

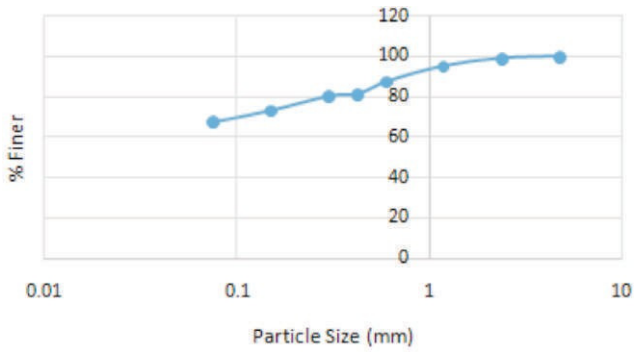

Figure 1. Grain size distribution curve for Black cotton soil (Wet sieve Analysis)

were shown in Table 1 are determined according to [1, 2, 3, 4 & 5].

Standard proctor test

The standard proctor test was conducted to determine the Optimum moisture content and maximum dry density of untreated and RHA treated soil samples according to [5] and the values are presented in the Table 2.

Specimen Preparation

The soil sample was mixed with various percentages of Rice husk ash and the consequent mixture was then compacted in the compaction mould. The Specimen was extracted carefully and checked for dimensions as per

Physical properties	Materials	
	Black cotton soil	Rice husk ash
Gravel (%)	0	0
Sand (%)	26.85	24.7
Clay + Silt (%)	73.15	76.3
Specific gravity	2.6	2.05
Liquid limit (%)	50	
Plastic limit (%)	26	Non Plastic (NP)
Plasticity Index (%)	24	
IS Classification	High Compressible Clay (CH)	Low Compressible Silt (ML)
OMC (%)	14	–
Maximum dry density (g/cc)	1.7	–

Table 1. Physical properties of Black cotton soil and Rice husk ash

	SOIL	2%RHA	5%RHA	7.5%RHA	10%RHA	15%RHA	20%RHA
OMC (%)	14	16	18	18	20	26	30
MDD (g/cc)	1.7	1.66	1.51	1.52	1.49	1.45	1.34

Table 2. OMC and MDD for Black cotton soil treated with RHA

standards (3.8 cm diameter and 7.6 cm length). For each untreated and treated soilsamples 3 set of specimens have been equipped for one soil sample and Average of the 3 sets of samples has been obtained.

Unconfined compressive strength (UCS)

The cylindrical specimen, which are obtained during the exaction process was placed at the centre of the base plate without any stress application upon the specimen. The dial gauge and proving ring readings are adjusted to zero and the axial load was applied at a strain rate of 1.25 mm/min. Later, the unconfined compressive strength was determined as per [6] for both the natural soil and artificially stabilized Black cotton soil.

Results and Discussion

Atterberg's Limits

With the increase in RHA content, From Figure 2 and Table 3 it is clearly observed that Liquid Limit of the black cotton soil decreases from of 50% to 40% and Plastic limit from 26% to 18.5%, similar to [9]. Based on Liquid and plastic limits, the Plastic Index have been decreased from 24% to 21.5 % with the addition of 20% RHA.

Compaction characteristics

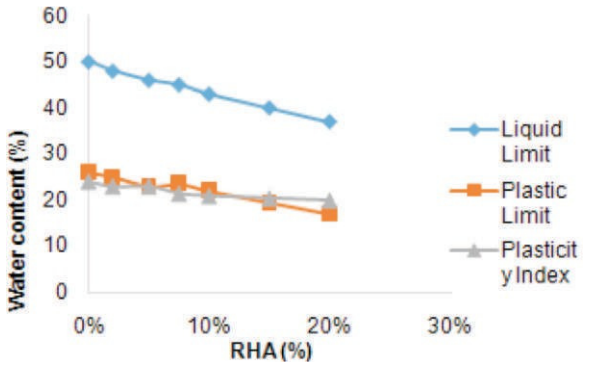

Figure 2. Liquid Limit, Plastic Limit and Plasticity Index for RHA treated Black cotton soil

	Soil	2% RHA	5% RHA	7.5% RHA	10% RHA	15% RHA	20% RHA
Liquid limit (%)	50	48	46	45	43	40	37
Plastic limit (%)	26	25	23	23.5	22	19.5	17
Plasticity Index (%)	24	23	23	21.5	21	20.5	20

Table 3. Atterberg's Limit for RHA treated Black cotton soil

From the Figure 3 it is observed that with the increase in RHA up to the point of 20%, there is a decrease in its maximum dry density (MDD) of 1.7 g/cc to 1.34 g/cc and there is an increase in its optimum moisture content (OMC) of 14% to 30%.The increase in OMC With the increase in RHA Content was due the absorption of water and decrease in MDD due to increase in fine material [8, 12, 13 & 17].

Strength Characteristics

The strength parameters of soil were obtained from UCS test. From the below Figure 4 it is observed that the natural soil has a strain of 0.53 at the point of failure stress of 0.62 kg/cm^2. Further, with the addition of admixtures of 2%, 5%, 7.5%, 10%, 15% and 20% is shown in below Figures 5, 6, 7, 8, 9 & 10 respectively. The addition of additives shows a trend of increasing in the stress value up to the point of 15% RHA with a strength of 1.26 kg/cm^2 but further increase leads decrease in its strength of 1.18 kg/cm^2 for 20% RHA. Similarly trend of increase in strength was observed with the increase in % RHA in [18 & 19]

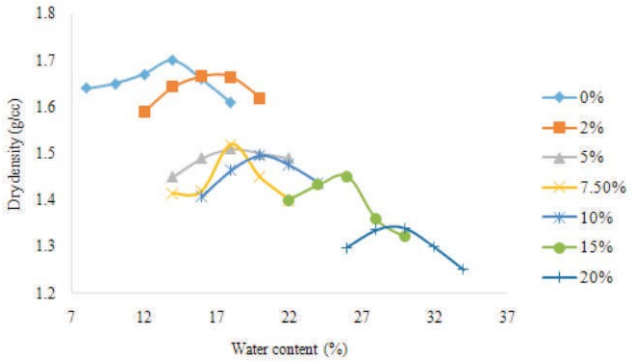

Figure 3. compaction curves for RHA treated with Black cotton soil

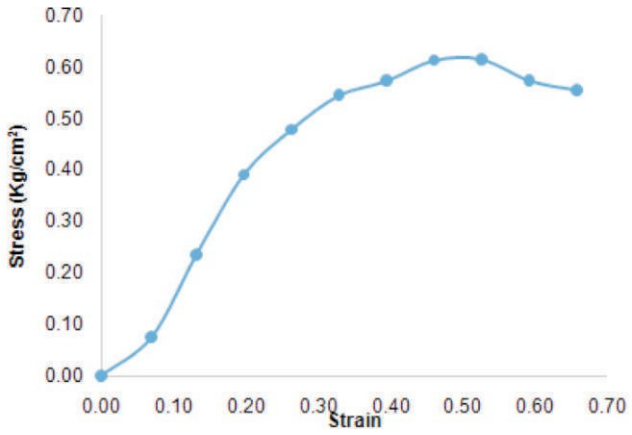

Figure 4. Stress- strain curve for Black cotton soil

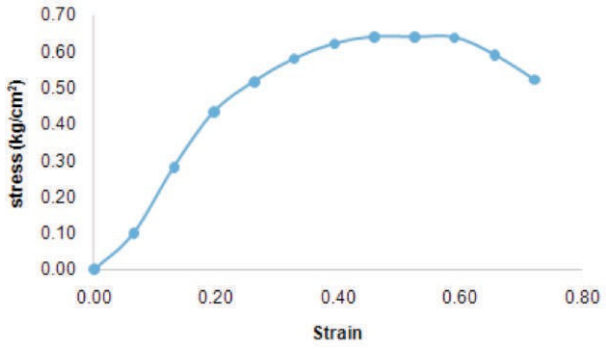

Figure 5. Stress- strain curve for 2% RHA

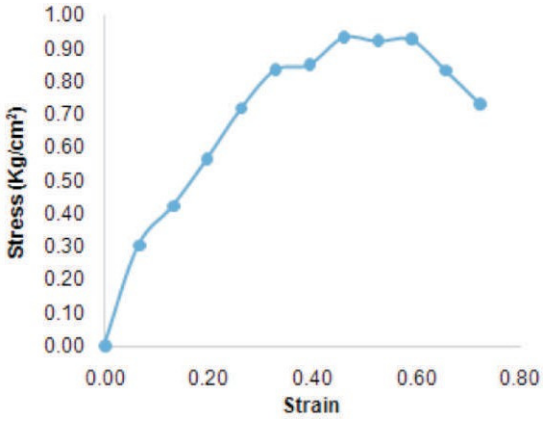

Figure 6. Stress- strain curve for 5% RHA

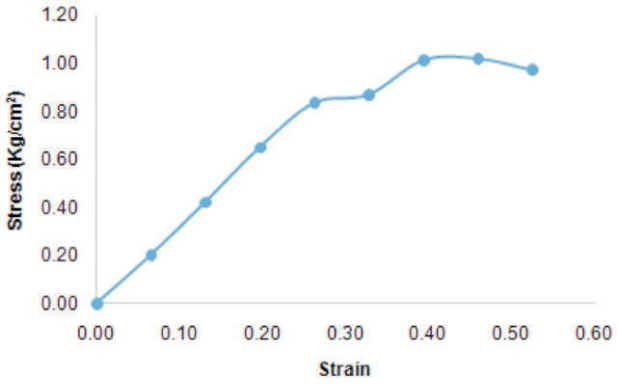

Figure 7. Stress - strain curve for 7.5% RHA

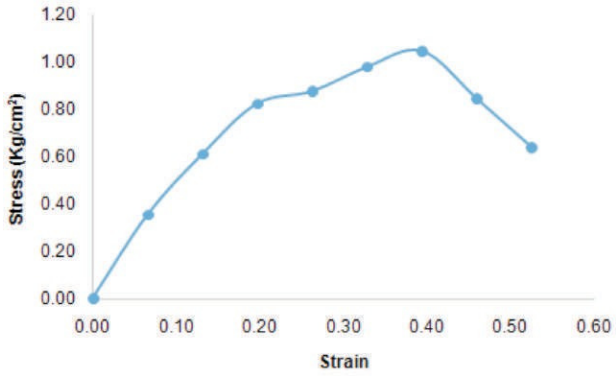

Figure 8. Stress- strain curve for 10% RHA

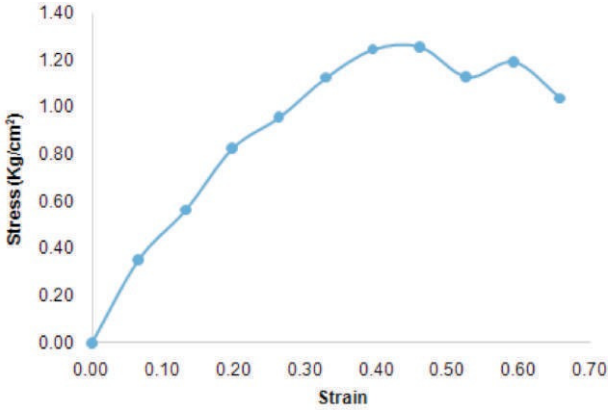

Figure 9. Stress - strain curve for 15% RHA

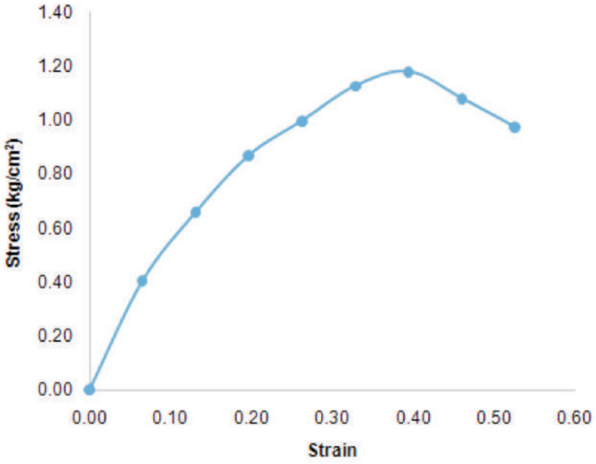

Figure 10. Stress- strain curve for 20% RHA

Conclusions

The following conclusions are drawn from the results of obtained.

1. The addition of RHA content decreases the Atterberg' s Limits (i.e. LL, PL & PI) and MDD but on the other hand, the increase in the OMC has been observed with the addition of RHA content.

2. The UCS value of Black cotton soil was obtained as 0.62 kg/cm2 and with the increase in the % of RHA its value increases to 1.26 kg/cm2 for 15% RHA.

3. From the results, we can say that the optimum RHA percentage for attaining the maximum strength is 15% for improving the black cotton soil.

Recommendation of the study

From the results of the study, we can know that RHA can be useful for soil improvement. Therefore, it is recommended

to stabilise the soil with some more additives like cement and lime to produce a secondary cementitious compounds, which are formed during the hydration process.

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