EXPERIMENTAL STUDY ON SOIL STABILIZATION USING RICE HUSK ASH

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ABSTRACT

The rice husk ash is mixed with soil in various proportions like 5%, 10%, 20%, 30%, 40% & 50%. The different tests were conducted in order to determine the different characteristics and properties of the red soil and obtained with following results. The liquid limit of the soil with addition of rice husk ash was found to be decreasing when compared to liquid limit of soil alone. The plastic limit of the soil increased with the addition of rice husk ash. The MDD of the soil with addition of rice husk ash by weight of soil is found to be decreases and the corresponding OMC is increased with addition of rice husk ash.

Keywords: Liquid limit, Plastic limit, Standard Proctor Test, OMC(optimum moisture content), MDD(maximum dry density)

1. INTRODUCTION

1.1 General

Soil stabilization is showing the promising results to achieve the shear strength. It started in the year of 1970. In order to recover the soil properties to our specific needs, earth reinforcement is one of the important techniques. Stabilization of soil has been done through different methods depending upon our requirement and economy. Nowadays, with an increase in population and in demand of shelters, soil stabilization gives a solution to recover the poor-quality lands. In many parts of India soil consists of high finer fractions specially silt content, low strengths and minimum bearing capacity. The performance characteristics of these soils are analysed on the finer percentage in it. Soil is one of the most abundant and cheapest construction materials. The knowledge of the use of soil as the construction materials dates to prehistoric times, when man started constructing dwelling for living and roads for transportation. During the last century, the rapid growth of civilization and urbanization in many parts of the world has led to civil engineering projects in infrastructure and resource development.

1.2 Red soil

Red soils are formed due to the weathering of metamorphic parent rock located in the region of Deccan plateau. Organic layers which bound and provide the coating of brownish yellow color. Due to the presence of water content, limonite that shows the soil into yellow as dominancy. Generally, upper surface soils are red in color and the lower part of the soil stratum is yellow in color. While the horizon below gets yellow. Red soil has a nutrient which is not appropriate for plant growing conditions for

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specific species. Percolation of the soil is more, which could not hold the water in the root region. Red soil is the third predominant soil present in India covering more than 3.5 lakhs sq. km.

1.3 Rice husk ash

Rice husk can be burnt into ash that fulfills the physical characteristics and chemical composition of mineral admixtures. Pozzolanic activity of rice husk ash (RHA) depends on (i) silica content, (ii) silica crystallization phase, and (iii) size and surface area of ash particles. In addition, ash must contain only a small amount of carbon. The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete. Using it provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions.

Rice husk is an agricultural residue widely available in major rice producing countries. The husk surrounds the paddy grain. During milling process of paddy grains about 78 % of weight is obtained as rice, broken rice and bran. Remaining 22 % of the weight of paddy is obtained as husk. This husk is used as fuel in the various mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the rest 25 % of the weight of this husk is converted into ash during the firing process, this Ash is known as rice husk ash. This RHA contains around 85 % - 90% amorphous silica. Rice husk is generated from the rice processing industries as a major agricultural by product in many parts of the world especially in developing countries. About 500 million tons of paddies are produced in the world annually after incineration only about 20% of rice husk is transformed to RHA. Still now there is no useful application of RHA and is usually dumped into water streams or as landfills causing environmental pollution of air, water and soil. RHA consists of non-crystalline silicon dioxide with high specific Surface area and high pozzolanic reactivity, thus due to growing environmental concern and the need to conserve energy and resources, utilization of industrial and biogenic waste as supplementary cementing material has become an integral part of concrete construction. Pozzolana's improve strength because they are smaller than the cement particles, and can pack in between the cement particles and provide a finer pore structure. RHA has two roles in concrete manufacture, as a substitute for Portland cement, reducing the cost of concrete in the production of low-cost building blocks, and as an admixture in the production of high strength concrete.

2. LITERATURE REVIEW

Rice husk is a by-product of the rice milling. About 100 million of tons of husk per year are produced worldwide [1]. The husk is not suitable as animal feed because of its abrasive character and almost negligible digestible protein content [2], its high ash and lignin contents make it unsuitable as a raw material for paper manufacturing [3].

In order to reduce such volume of waste, rice husk is burned either in open heaps or as a fuel in ovens for rice drying, power generation, etc. The burning volatilizes the

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organic compounds and water of the rice husk, and about 20% of the mass remains as rice husk ash (RHA) [2, 4–9]. If all rice husks had been burned, it would annually produce about 20 million of tons of RHA worldwide. To value this residue is an alternative to its final disposition with environmental benefit.

Pozzolanas are siliceous and/or aluminous materials, which in themselves possess little or no cementing properties, but chemically react with calcium hydroxide, such as lime, to form compounds possessing cementitious properties [10]. The RHA contains around 90% of silica [4, 5], which is the highest concentration of all plant residues [2]. Based upon this, RHA has been used to improve properties of soil either when added alone or when mixed with a hydraulic activator such as the cement and lime [1, 6–8, 11–16]. Soil stabilization by the addition of RHA and lime is particularly attractive for road pavements because it leads to cheaper construction and lesser disposal costs, reduces environmental damage and preserves the most highly qualified materials for priority uses [7, 8].

The effect of the addition of RHA alone on the plasticity, unconfined compression strength (UCS) and California Bearing Ratio (CBR) of a lateritic soil with 45% passing the #200 sieve (75 μm), was studied by Rahman [11]. Results showed increases of UCS and CBR in 1 day with increase in RHA up to 20 and 18%, respectively, after which they started to decrease. Similarly, Alhassan [14] observed increasing of CBR with 6-day and 1-day soaking and without soaking when a clayey soil was stabilized with RHA up to 6 and 12%, respectively.

Generally, RHA cannot be used alone in soil stabilization because of its lack of cementitious properties [7, 8]. Development of UCS has been observed when clayey, clayey sandy, silty clayey and silty sandy soils were treated with RHA and lime or cement [1, 7, 8, 12, 13]. In the case of cement, it was observed that little or insignificant increases of UCS in lateritic and clayey soils stabilized with RHA and cement with respect to its increase when they were treated with cement alone [6, 12]. For a given lime or cement content there is an optimum value of RHA content which corresponds to the maximum UCS, which varies depending on the type of soil, ash characteristics, hydraulic activator and curing time [1, 7, 8]. Alhassan [15] attributes the UCS decreasing after this optimum value to the excess RHA that could not be utilized for the alkaline reactions. Also, he shows that addition of RHA in clayey soil-lime specimens further increased the UCS at specified lime content. This increment was rapid between 0 and 4% RHA content but decreased in rate from 6 to 8% RHA content at specified curing period.

Basha et al. [8] found that a lesser amount of cement is required to achieve a given strength as compared to cement-stabilized silty sandy soil when RHA is added. Since cement is more costly than RHA, this results in lower construction cost. Ali et al. [7], evaluating the effectiveness in the improvement of a clayey sandy soil with RHA, showing that lime is a more effective stabilizing agent than cement.

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3. OBJECTIVE AND METHODOLOGY

3.1 Objective of the study

1. To analyze the characteristics of Red soil for different concentrations of 0%, 10%, 20%, 30%, 40%, 50% Rice husk mixed with it.
2. To study the effect of solid wastes namely Rice husk ash in red soil on the variation of index properties and compaction characteristics.
3. To study the outcome of Rice husk in soil stabilization, in the way to decrease the waste disposal problem, environmental pollution.

3.2 Objective of the study

4.EXPERIMENTAL INVESTIGATIONS

4.1 General

The detailed experimental programme of the present study was undertaken to investigate the changed behaviour of the available red soil when mixed with easily available local stabilizing admixtures like rice husk ash in different proportions individually or in combinations. This will enable to examine not only suitability of these composite materials in the construction of sub-grade for flexible pavement, but also to decide the optimum mixing proportion for cost effective construction.

Initially the geotechnical property like Atterberg limit of the soil and stabilized soil had been determined. The necessary experiment on made to determine the compaction characteristics i.e. optimum moisture content (OMC) and maximum dry density (MDD) by conducting Standard Proctor Compaction tests of those soils. There after the effect of strength characteristics of the original soil and stabilized soils had been made by conducting California Bearing Ratio (CBR) test on the stabilized soil.

The different tests were conducted in order to determine the different characteristics and properties of the soil. The procedure of each of the tests have been explained below.

5. RESULTS AND DISCUSSIONS

5.1 Soil stabilization with adding rice husk

5.1.1 Grain size analysis

Table. 1: Grain size analysis of soil-RHA mixes.

S.No	Soil(%)	RHA (%)	GRAIN SIZE		
			SAND (%)	SILT (%)	CLAY (%)
1	100	0	7	88	5
2	90	10	7	85	8

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3	80	20	8	82	10
4	70	30	7	86	7
5	60	40	7	89	4
6	50	50	7	89	4

5.1.2 Atterberg Limit (Casagrande Method)

Table. 2: Atterberg Limits of Soil - RHA Mixes

S. No	RHA(%)	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Group
1	0	48	29.4	18.6	MI
2	10	45	31	14	MI
3	20	42	32	10	MI
4	30	39	32.6	6.4	MI
5	40	38	33	5	MI
6	50	37.8	33.7	4.1	MI

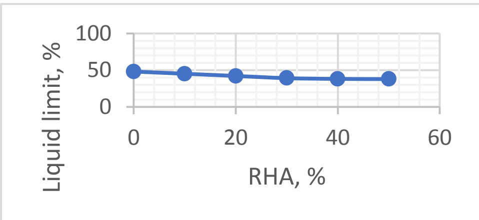

Fig. 1: Liquid limit test results.

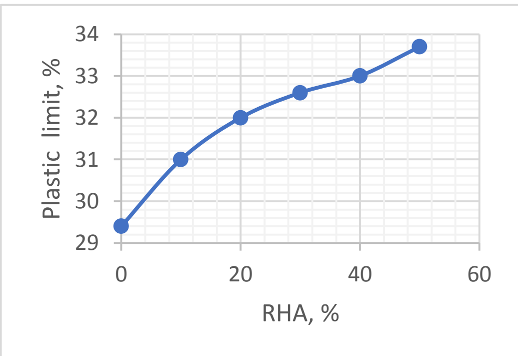

Fig. 2: Plastic limit test results.

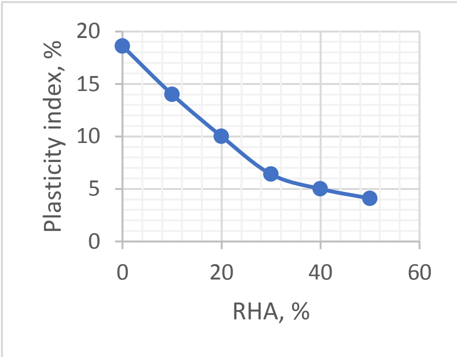

Fig. 3: Plasticity limit test results.

5.1.3 Compaction test (Standard proctor method)

Table. 3: Compaction characteristics of Soil-RHA mixes.

S. No	RHA %	Moisture content (%)	Dry density (gm/cc)
1	0	7	1.51
2		12.5	1.59
3		16	1.65
4		19	1.62
5		21.2	1.61
6	10	9.1	1.35
7		14	1.43
8		17	1.51
9		21.2	1.54
10		25	1.48
11	20	7	1.28
12		15	1.37
13		18	1.42
14		22	1.47
15		26	1.40
16		27	1.38
17	30	12.5	1.25
18		16.8	1.385
19		24.1	1.44
20		27.3	1.41
21		30.2	1.34

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22	40	11.5	1.23
23		17.5	1.25
24		23	1.3
25		26	1.38
26		28	1.35
27		31	1.29
28	50	12	1.21
29		17	1.25
30		22	1.28
31		26	1.23
32		29	1.18

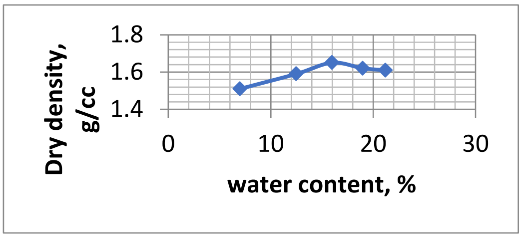

Fig. 4: Compaction curve for soil + 0% RHA.

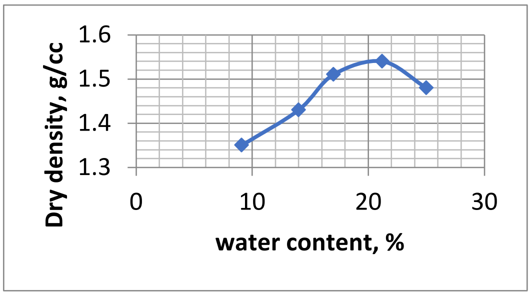

Fig. 5: Compaction curve for soil + 10% RHA.

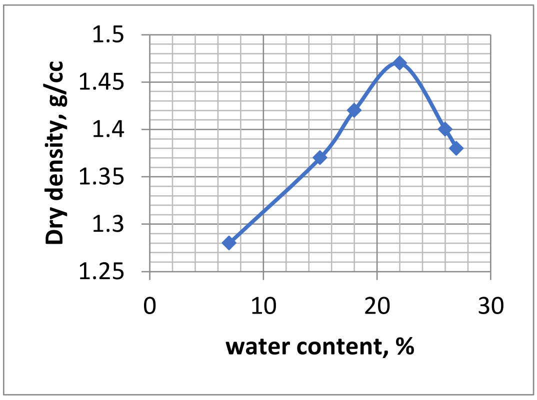

Fig. 6: Compaction Curve for Soil + 20% RHA

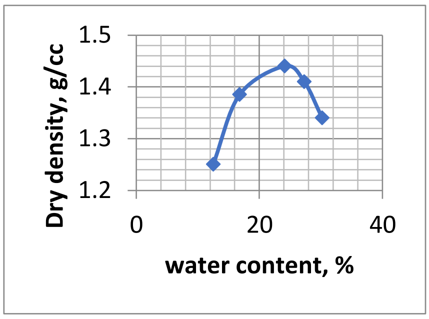

Fig. 7: Compaction curve for soil + 30% RHA.

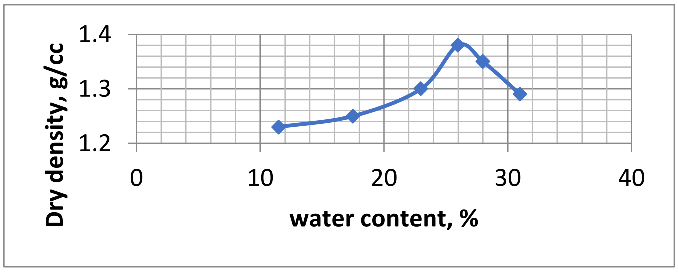

Fig. 8: Compaction curve for soil + 40% RHA.

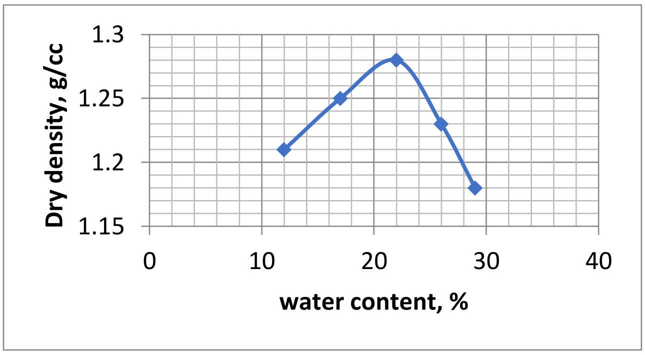

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Fig. 9: Compaction curve for soil + 50% RHA.

Table. 4: OMC and MDD of soil-RHA mixes.

S.No	RHA %	OMC(%)	MDD(gm/cc)
1	0	16	1.65
2	10	21.2	1.54
3	20	22	1.47
4	30	24.1	1.44
5	40	26	1.38
6	50	22	1.28

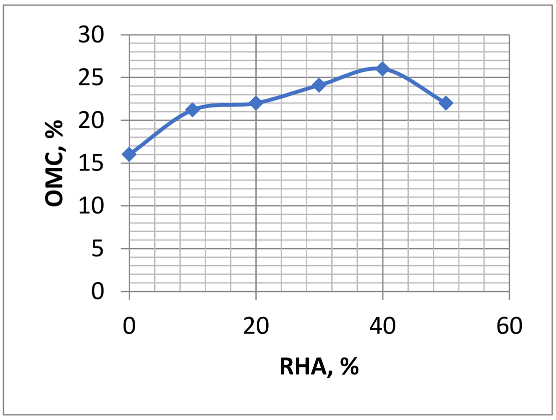

Fig. 10: OMC curve for soil + RHA.

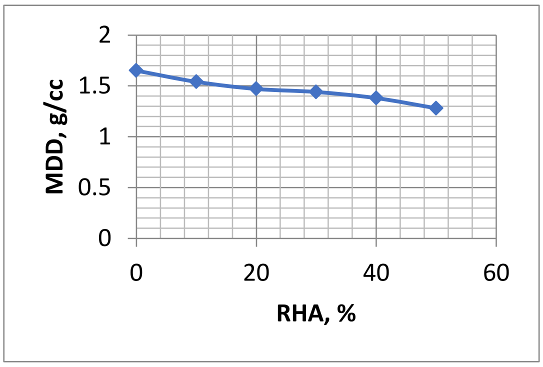

Fig. 11: MDD curve for soil + RHA.

5.2 Discussions

1. The liquid limit of the soil alone was found to be 48%. The liquid limit of the soil with addition of 50% RHA was found to be decreased by 21.25%, when compared to liquid limit of soil alone.
2. The plastic limit of the soil alone was found to be 29.4%. The plastic limit of the soil with addition of 50% RHA was found to be increases by 14.62%, when compared to plastic limit of soil alone.
3. The plasticity index of the soil alone was found to be 18.6%. The plasticity index of the soil with the addition of 50% RHA was found to be decreased by 77.95%, when compared to plasticity index of soil alone.
4. The optimum moisture content (OMC) and maximum dry density (MDD) of soil alone was found to be 16% and 1.65 g/cc respectively. The MDD of the soil with addition of 50% RHA by weight of soil is found to be decreases by 22.45% and the corresponding OMC is increased by 37.5%.

6. CONCLUSIONS

On the basis of present experimental study, the following conclusions are drawn

1. The red soil was identified As Intermediate compressible inorganic silt is designed (MI) on Indian Standard classification system. RHA was used to stabilize the soil for road construction in this study and a sufficient cementitious property was found in RHA.
2. On addition of different percentage of rice husk ash in the soil (0 to 50%), the plasticity index decreases with an increase in the proportion of

rice husk ash from 0% to 50%. The percentage decreases in plasticity index value of soil from 18.6 to 4.1, rha stabilized soil respectively.

3. The compaction characteristic of stabilized soil found to be dependent on the plastic nature of the soil. For medium plastic soil, addition of stabilizer to soil reduced the maximum dry density while increasing the optimum moisture content irrespective of stabilizer type.

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