Influence of Rice Husk Ash on Geotechnical Properties of Soft Clay

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ABSTRACT— ***This paper studies the influence of rice husk ash as soil stabilizing agent. A series of laboratory test was carried out for different percentage of soil-rice husk ash mix. The various test conducted was standard proctor compaction test, consistency limit, and unconfined compressive strength test. A significant change in the index properties of soil was found out. The strength of soil increases, optimum moisture content increases and maximum dry density decreases. The test results reveals that the rice husk ash can be used as a soil stabilization material.***

Keywords— Compaction characteristics, Consistency limit, Rice husk ash, Unconfined compressive strength

1. INTRODUCTION

Soil stabilization means modifying the soil properties to improve its engineering performance. Strength of soil is important for the long life of structure. Soft clay has very low shear strength value, and it changes volume when water content changes. So clay soil should be stabilized before it is used for construction. Now a day's use of waste material for soil stabilization has been practiced all over the world.

Rice husk is an agricultural waste obtained from milling of rice. Every year approximately 120 million tones of paddy is produced in India. This gives around 24 million tones of rice husk that is about 20% of paddy produced. On burning 17-25 percentage of rice husk is converted into ash. That is more than 4.4 million tones of rice husk ash (RHA) is produced in every year in India. RHA consist of 80-90% of silica, and the silica content will be more if it is burned under high temperature. The high percentage of silica present in the rice husk ash makes it a good soil stabilization agent

2. MATERIAL USED

2.1 Soil

The soil sample was collected from Ernakulam, Kerala, India. The depth of soil collected was 5-6 meter from ground surface. The soil was black in color. The properties of soil are given in table 1.

2.2 Rice husk ash

Rice husk ash is a waste by product of paddy, obtained from rice mills. Large silica content in rice husk ash makes it a good pozzolanic material and can be used for soil stabilization. Rice husk ash for the proposed work was collected from Pranamya Biofuels, Udupi, Karnataka, India. Uncontrolled burning was done on rice husk to make it ash. Color of ash after burning was whitish grey. The rise husk ash was sieved through ASTM sieve size #40 (0.425 mm) to perform various tests.

Table 1: Properties of Soil

Properties	Results
Specific gravity	2.63
Particle size distribution	
Clay (%)	52
Silt (%)	44
Sand (%)	4
Liquid limit (%)	76
Plastic limit (%)	27.6
Shrinkage limit (%)	22.5
Optimum moisture content (%)	24.3
Maximum dry density (KN/m^3)	14.94
UCS (KN/m^2)	31.3
Free swell index	25
CBR (%)	1.47

3. METHODOLOGY

The soil collected was air dried, pulverized and sieved through different sieves to perform various laboratory tests. The percentage of RHA used was 5%, 10%, 15%, and 20%. The soil was replaced by the percentage weight of RHA. The test conducted was standard proctor compaction test, liquid limit, plastic limit, shrinkage limit, and unconfined compressive strength (UCS) test. All test was carried out accordance with IS 2720.

4. RESULTS AND DISCUSSIONS

4.1 Compaction characteristics

The test was conducted accordance with IS 2720 Part 7 (1974). The result of compaction test is summarized in table 2. Optimum moisture content (OMC) increases and maximum dry density (MDD) decreases with increase in percentage of RHA. The increase in OMC may be due more absorption of water by the additive to carry out chemical reaction, and the decrease in MDD may be due to the lower specific gravity of additive compared to soil. Figure 1 represents the variation of OMC with different percentage of RHA, and fig. 2 represents the variation of MDD with different percentage of RHA

Table 2: Compaction Characteristics

Percentage of rice husk ash (%)	Maximum dry density (KN/m3)	Optimum moisture content (%)
Untreated soil	14.94	24.3
5	14.14	29.4
10	13.41	32.2
15	12.68	35.7
20	12.08	39.4

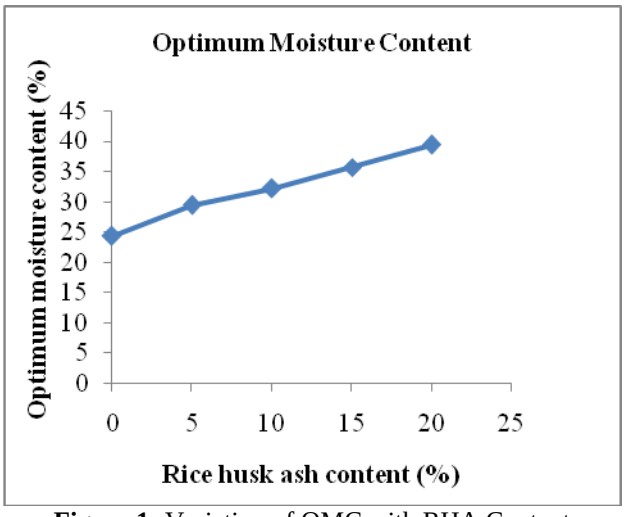

Figure 1: Variation of OMC with RHA Content

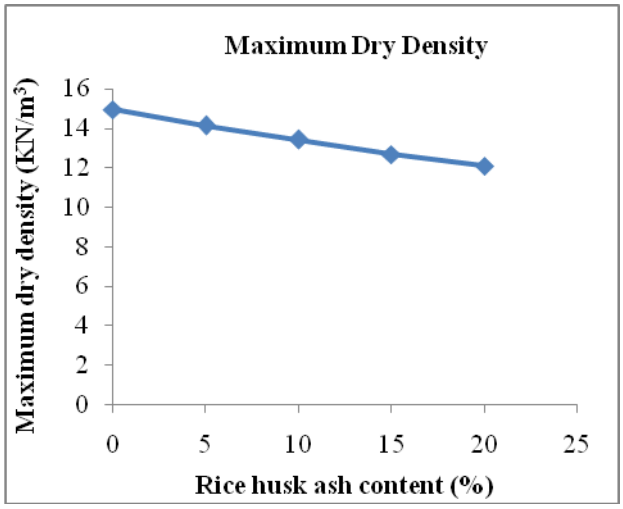

Figure 2: Variation of MDD with RHA Content

4.2 Consistency limit test

The index properties include liquid limit, plastic limit, plasticity index and shrinkage limit were tested for clay treated with different percentage of RHA. The test was carried out accordance with IS 2720 part 5 (1970) and IS 2720 part 6 (1972).

For 5% of RHA, the liquid limit value decreases from 76% to 49.21%, further addition of RHA increases the liquid limit value. For 5% of RHA plasticity index decreases, and for 10% of RHA its value slightly increases. From 10-20% RHA, plasticity index increases with increase in percentage of RHA. The plastic limit and shrinkage limit increases with increase in percentage of RHA. The variation of liquid limit, plastic limit, plasticity index and shrinkage limit are shown in fig. 3, 4, 5 and 6.

Table 3: Atterberg Test Result

Percentage of rice husk ash (%)	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Shrinkage limit (%)
Untreated soil	76	27.6	48.4	22.5
5	49.2	29.2	19.3	26.9
10	53.6	31.6	21.9	29.1
15	56.1	35.5	20.6	32.8
20	57.72	38.9	18.74	36.6

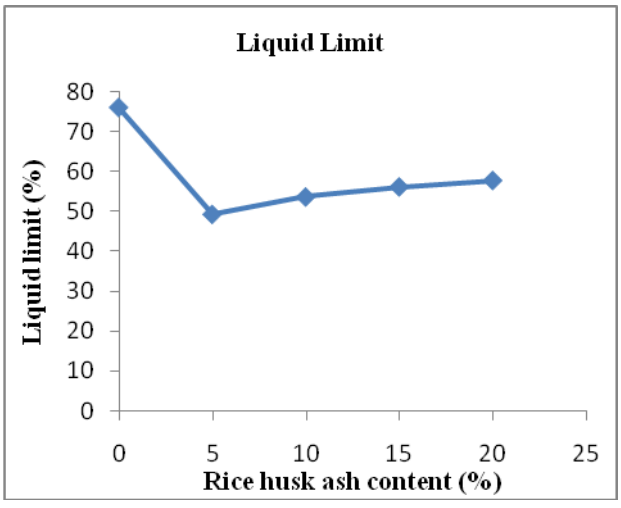

Figure 3: Variation of Liquid Limit with RHA Content

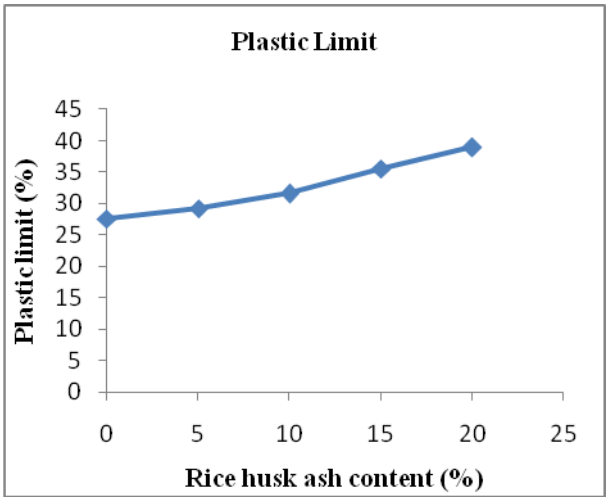

Figure 4: Variation of Plastic Limit with RHA Content

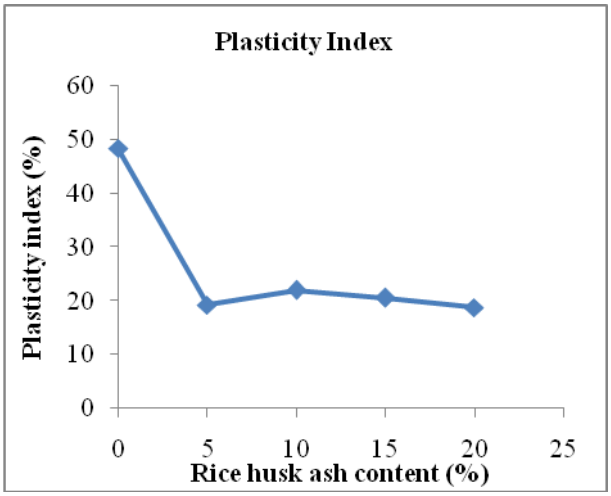

Figure 5: Variation of Plasticity Index with RHA Content

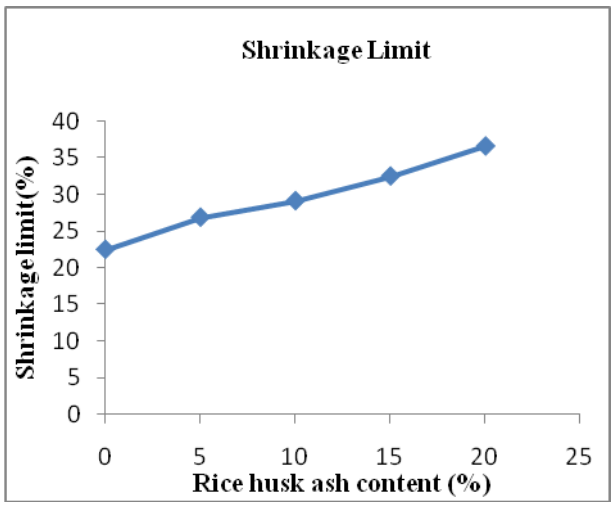

Figure 6: Variation of Shrinkage Limit with RHA Content

4.3 UCS test

Unconfined compressive strength (UCS) is the most common and adaptable method of evaluating the strength of soil. It is the main test recommended for the determination of the required amount of additive to be used in stabilization of soil (Singh and Singh, 1991). The test was conducted accordance with IS 2720 part 10, (1964). Sample was prepared at its OMC and maximum unit weight. The sample size was of 3.8 cm diameter and 7.6 cm length, and it was tested after one day.

The UCS test results are given in table 4, and fig. 7 represents the combined stress-strain curve of soil treated with different percentage of RHA. Initially the UCS value increases with increase in percentage of RHA, reaches a maximum, then it starts decreases. Maximum strength was obtained for soil treated with 10% of RHA, and the percentage improvement in strength was about 158%.

Table 4: UCS Test Result

Percentage of rice husk ash (%)	UCS (KN/m^2)	Improvement in strength (%)
Untreated soil	31.3	---
5	68.49	138
10	74.08	158
15	68.07	137
20	62.23	116

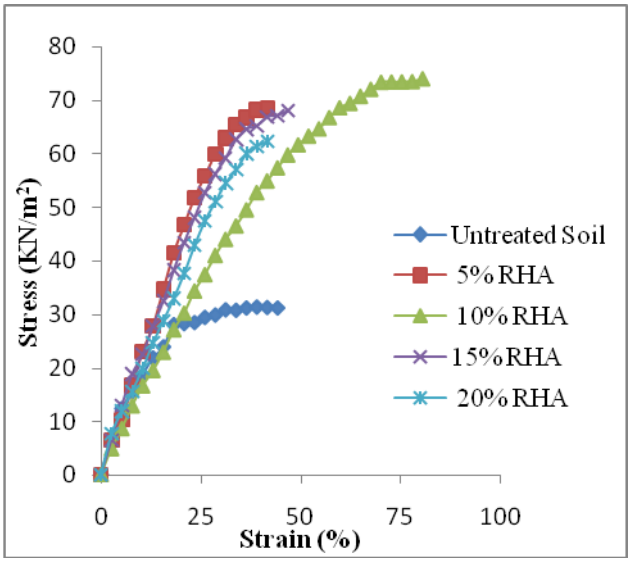

Figure 7: Stress Strain Curve for Different Percentage of RHA

5. CONCLUSION

Based on the laboratory test carried out on soil rice husk ash mix, following conclusion can be drawn. Based on the compaction characteristics it is found that, with increase in percentage of RHA, MDD decreases and OMC increases. For 5% of RHA, the liquid limit of soil decreases. Further addition of RHA increases the liquid limit. Plastic limit and shrinkage limit of soil increases with increase in percentage of RHA. Based on the UCS test, the optimum percentage of RHA obtained was 10%.The UCS value of the soil increased from 31.3KN/m^2 to74.08KN/m^2 for 10% RHA. The percentage improvement in strength was 158%. From test result it is clear that, RHA can be used as a soil stabilization material.

6. REFERENCES

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