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Stabilization of Soil Using Rice Husk Ash

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ABSTRACT: Chemical stabilization of soil using cement, lime, etc. is costly. In order to introduce new material which can reduce the cost of chemical stabilization a review is made on rice husk ash. Rice husk is a waste material from paddy crop. After burning it gives the rich amount of silica which may be used as chemical stabilizer for soil stabilization. The rice husk ash is mixed in various proportions with soil like 5%, 10%, 15% and 20%. Various tests were also conducted on these mixes in order to find optimum proportion.

KEYWORDS: Rice husk ash, Soil stabilization, Chemical stabilizer, Index properties, California bearing ratio, Cation Exchange Capacity(CEC), Clay

I. INTRODUCTION

Stabilization of soil is a method to improve the index and Engineering properties of soil. There are certain method of soil stabilization such as mechanical stabilization, chemical stabilization and bio- enzymatic soil stabilization. RHA may be used as chemical stabilizer as it contains high silica content.

If soil contain medium or coarse sandy particles then mixing of RHA will occupy the void created by coarser particles, further leads to increase in shearing and bearing capacity due to increase in chemical bonding other than gravitation force. If major particle of soil contain clay minerals like montmorillonite then RHA which is having high silica content, replace exchangeable ion further leads to decrease in cation exchange capacity(CEC). CEC decrease due to decrease in -ve ion as Si replace other metallic ion such as Na, Mg etc. Exchangeable ion present in the soil water leads to swelling of soil if it contain clay minerals like montmorillonite as they form weak bond between clay particles. As clay surface is negatively charged Si make stronger bond then other metallic ion present in clay minerals.

II. LITERATURE SURVEY

Rice husk ash containing about 60 to 90% silica, which is highly chemically reactive. Several experiments and review studies is already documented by various different authors on rice husk ash as a soil stabilizer with and without other stabilizing materials.

Bhasin et al. (1988), [1] made a laboratory study on the stabilization of black cotton soil as a pavement material using RHA, along with other industrial wastes like fly ash, bagasse ash, lime sludge, black sulphite liquor independently with and without lime. The RHA causes greater improvement than that caused by other wastes due to presence of higher percentage of reactive silica in it. In combination with lime, RHA improved the properties of black cotton soil significantly.

Muntohar and Hantoro (2000), [2] had studied the stabilizing effects of RHA and lime on engineering properties of expansive soil and had found improvement in engineering properties like IP, CBR, shear strength parameters etc.

Basha et al. (2003), [3] had studied the effects of RHA and cement on plasticity and compaction properties of expansive soil (bentonite) and had recommended that 10-15% of RHA and 6-8% of cement as optimum percentages for stabilization.

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Chandra et al.(2005), [4] had stabilized a non-expansive clayey soil with RHA and lime sludge. RHA added to soil was from 5 to 20% in steps of 5% and lime sludge from 4 to 16% in steps of 4%. Properties of the stabilized soil studied were, Atterberg's limits, maximum dry density (MDD), optimum moisture content (OMC), unconfined compressive strength (UCS) and soaked California bearing ratio (CBR) of soil.

Ramakrishna and Pradeep Kumar (2006), [5] had studied combined effects of RHA and cement on engineering properties of black cotton soil. From strength characteristics point of view they had recommended 8% cement and 10% RHA as optimum dose for stabilization.

Rao et al. (2011), [6] had studied the effects of RHA, lime and gypsum on engineering properties of expansive soil and found that UCS increased by 548% at 28 days of curing and CBR increased by 1350% at 14 days curing at RHA- 20%, lime -5% and gypsum -3%.

Sabat (2012), [7] had studied the effects of polypropylene fibre on engineering properties of RHA-lime stabilized expansive soil. Polypropylene fibre added were 0.5 to 2% at an increment of 0.5%. The properties determined were compaction, UCS, soaked CBR, hydraulic conductivity and Ps. The effect of 0,7 and 28 days of curing were also studied on UCS, soaked CBR, hydraulic conductivity and Ps. The optimum proportion of soil: RHA: lime: fibre was found to be 84.5:10:4:1.5.

Sabat (2013), [8] had studied the effect of lime sludge (from paper manufacturing industry) on compaction, CBR, shear strength parameters, coefficient of compression, Ps and durability of an expansive soil stabilized with optimum percentage of RHA after 7 days of curing. The optimum proportion soil: RHA: lime sludge was found to be 75:10:15.

Ms. Aparna (2014), [9] Roy has presented a study which gives details about soil which is stabilized with different percentages of Rice Husk Ash and a small amount of cement. The results obtained show that the increase in RHA content increases the Optimum Moisture Content but decreases the Maximum Dry Density. Also, the CBR value and Unconfined Compressive Strength of soil are considerably improved with the Rice Husk Ash content.

III. EXPERIMENTAL WORK

To study the effect of rice husk ash on soil as a soil stabilizer it mixed in various proportions with soil. These mixers are further tested to find index properties (specific gravity, liquid limit test, plastic limit test and standard Procter compaction test) and Engineering properties (California bearing ratio test).

IV. RESULTS AND DISCUSSIONS

Liquid Limit: This test is done by liquid limit apparatus designed by A. Casagrande. A soil sample which passing through 425 micron and air dried mixed with water to form paste. 1cm thick layer is levelled in cup. Then groove is cut in the soil in the cup and the handle is rotated at the rate of 2 blows per sec. Water content just sufficient to close the groove for 13mm length at 25blows gives liquid limit. The method described herein is based upon IS 2720-5: **Methods of test for soils, Part 5, [10]**

Table 1. Effect of RHA on Liquid Limit behaviour

DESCRIPTION	LIQUID LIMIT (%)
Soil alone	50.20
Soil + 5% RHA	47.60
Soil + 10% RHA	46.08
Soil + 15% RHA	42.95
Soil + 20% RHA	39.60

Table 1 shows the effect of Liquid Limit behaviour on different percentage of RHA. It can be seen that with addition of RHA, the liquid limit continuously decreases from a water content of 50.20% to 39.60%.

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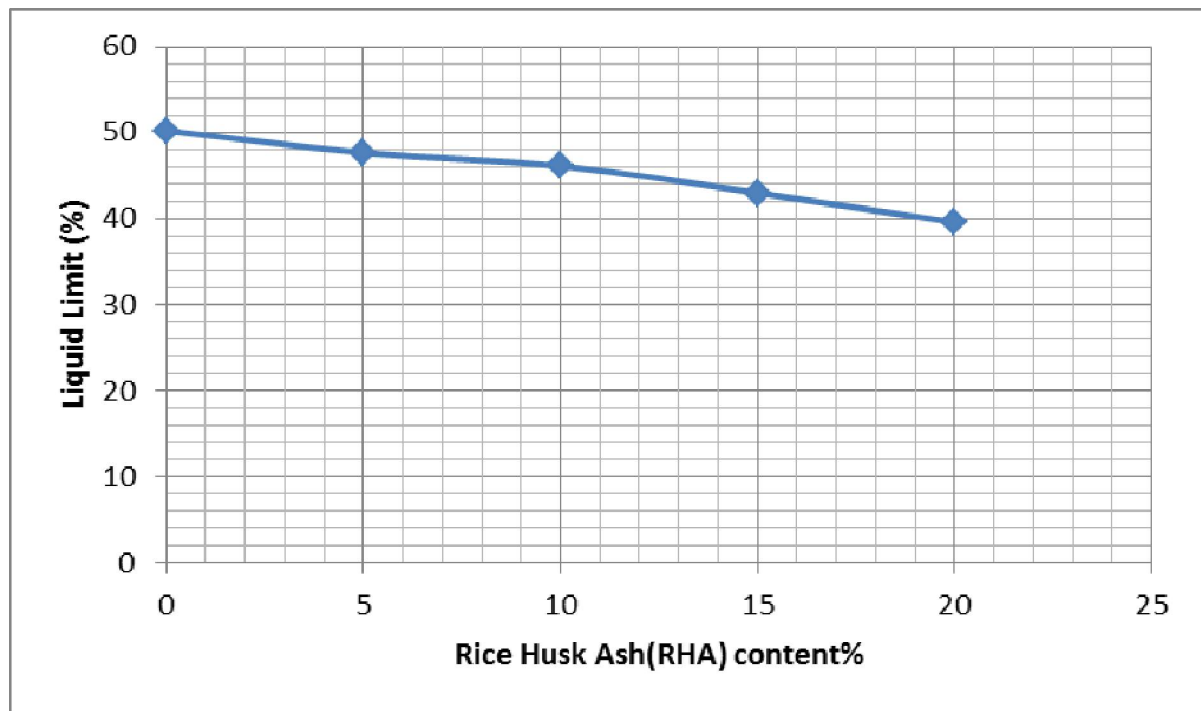


Figure 1. Effect of RHA on liquid limit behaviour of Natural soil

Figure 1 Show the variation of liquid limit of a soil with increasing percentage of RHA. Increase or decrease in liquid limit highly effect the compressibility and swelling characteristics of soil. Generally reduction in the liquid limit means reduction in the compressibility and swelling characteristics which is beneficiary for sub grade soil. Increase or decrease in liquid limit mainly depends on clay minerals present in soil.

Standard Proctor Compaction Test:A mould of volume 944cc is filled in three layer with soil compacted with standard hammer by 25 blows falling through standard height. The method described herein is based upon **IS: 2720(Part 7)-1980- Methods of test for soils, [11]**.

Table 2 Effect of RHA for Natural soil on OMC and MDD

DESCRIPTION	OMC(%)	MDD(in g/cc)
Soil alone	16.61	1.766
Soil + 5% RHA	18.12	1.633
Soil + 10% RHA	20.18	1.573
Soil + 15% RHA	22.05	1.45
Soil + 20% RHA	24.02	1.36

Table 2 shows Effect of RHA for Natural soil on OMC and MDD. Standard proctor compaction test has been conducted in order to study the effect of solid waste on the compaction characteristics of soil with increasing percentage of RHA by weight basis. The results were obtained for soil with 0, 10, 15and 20% of RHA along with soil and listed in Table 2.

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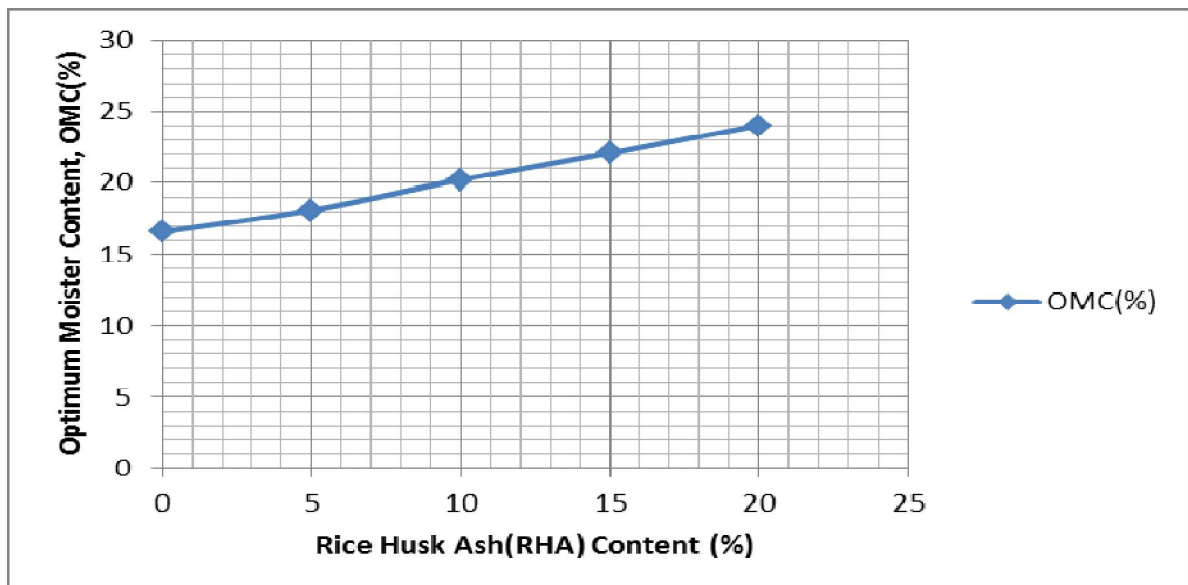


Figure 2. Optimum Moisture content (%)

Figure 2 shows the variation in OMC on adding RHA in different proportion. OMC is increased with increase in the RHA content. The increase is due to the addition of RHA, which decreases the quantity of free silt and clay fraction and coarser materials with larger surface areas are formed. These processes need water to take place. This implies also that more water is needed in order to compact the soil-RHA mixtures.

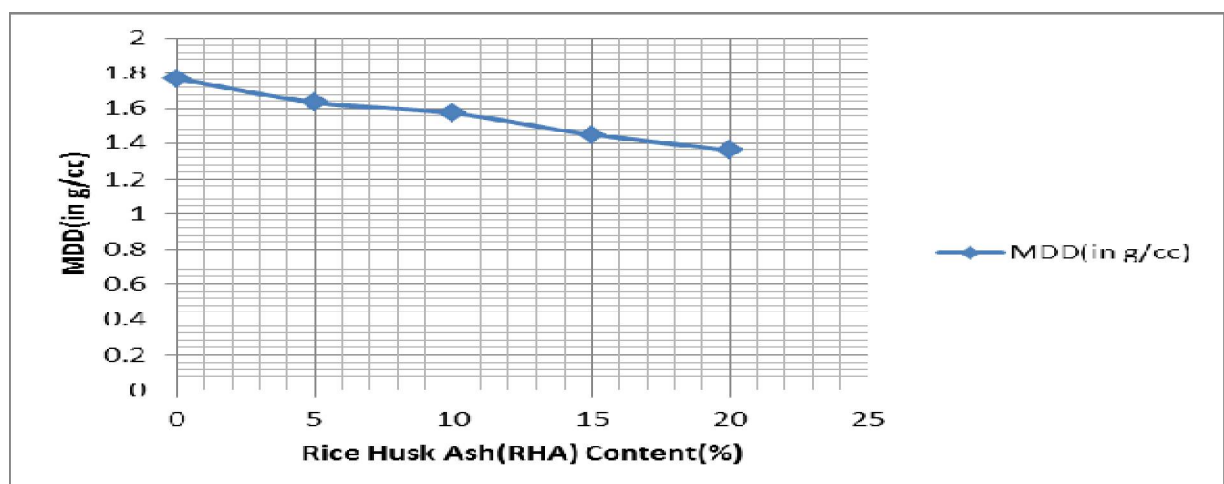


Figure 3. Maximum dry density, MDD(g/cc)

Figure 3 shows the variation in MDD on adding RHA in different proportion. The MDD is decreased with increase in the RHA content. The decrease in the MDD can be attributed to the replacement of soil and by the RHA in the mixture. The decrease in the MDD may also be explained by considering the RHA as filler (with lower specific gravity) in the soil voids.

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CBR Test: In CBR test soil sample passing through 4.75mm sieve mixed with water. Amount of water used is equal to OMC. After preparing soil sample it is filled in 2110cc mould in five layer and each layer is compacted by standard hammer. Finally the plunger of CBR test equipment penetrates the prepared soil specimen in the mould @ 1.25mm/minute. Analysis of the test result gives the CBR values. The method described herein is based upon IS: 2720(Part 16)-1973- Methods of test for soils. [12]

Table 3 Effect of RHA for Natural soil on CBR values

DESCRIPTION	CBR VALUE AT 2.5 MM PENETRATION (%)	CBR VALUE AT 5 MM PENETRATION (%)
Soil alone	1.896	1.814
Soil + 5% RHA	2.144	2.129
Soil + 10% RHA	2.617	2.445
Soil + 15% RHA	2.144	2.033

Table 3 shows The CBR value corresponding to 2.5mm and 5mm penetration. Sub grade of flexible pavement decide the thickness of flexible pavement. Higher the sub grade strength lesser will be the flexible thickness. On adding RHA we got some positive response upto certain point.

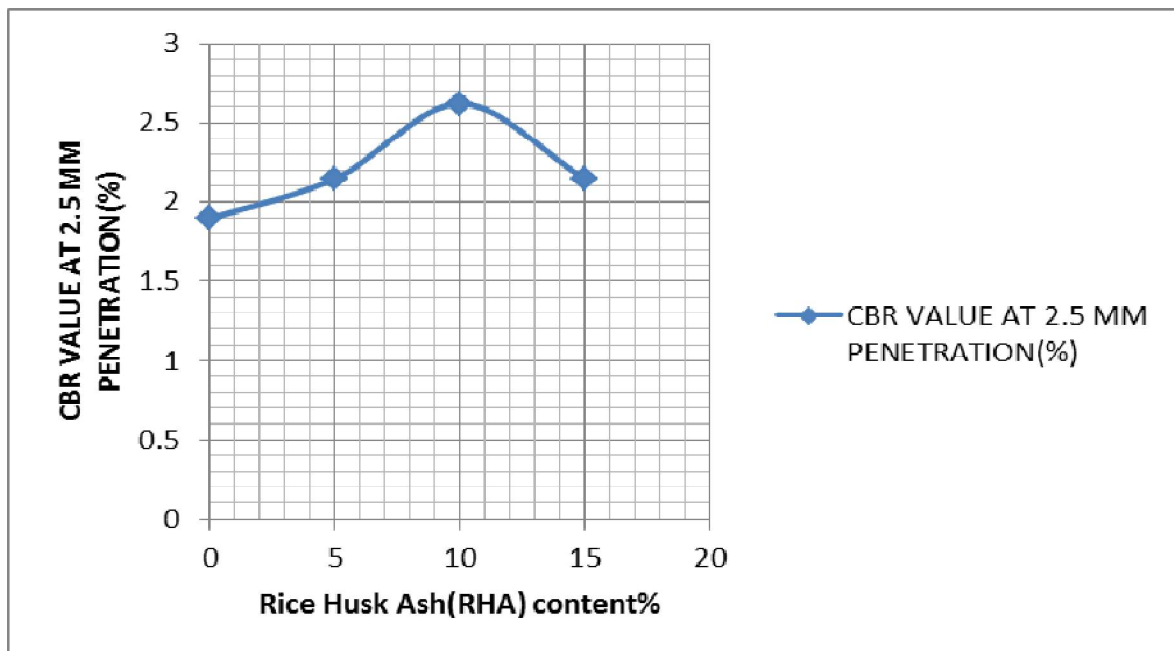


Figure 4. CBR values at 2.5mm penetration

Figure 4 shows that the comparison of CBR values on different percentage of RHA. In graph, up to 10% there is increase in CBR values, beyond 10% it starts decreasing.

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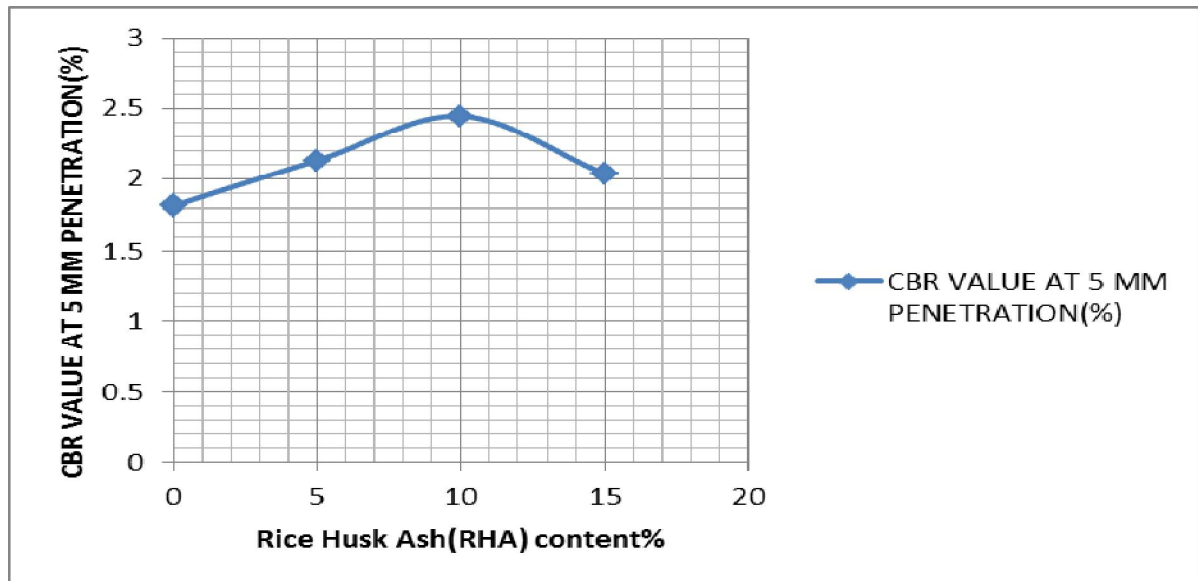


Figure 4. CBR values at 2.5mm penetration

Figure 5 also show that the comparison of CBR values on different percentage of RHA. In graph, up to 10% there is increase in CBR values, beyond 10% it start decreasing.

V. CONCLUSION

The main objective of this research work was to study the effect of adding RICE HUSK ASH on the engineering properties of soil sample. Extensive experimental work was carried out on the engineering properties of the test soil. Major changes were observed in some of the engineering properties of the test soil on the addition of RICE HUSK ASH.

Summary:

Sl. NO	SOIL+ % OF RHA	OMC (In %)	MDD (in g/cc)	LIQUID LIMIT (%)	CBR	
					AT 2.5 MM PENETRATION (%)	AT 5 MM PENETRATION (%)
1	0	16.61	1.766	50.20	1.896	1.814
2	5	18.12	1.633	47.60	2.144	2.129
3	10	20.18	1.573	46.08	2.617	2.445
4	15	22.05	1.45	42.95	2.144	2.033
5	20	24.02	1.36	39.60	-	-

Main Conclusion:

From the engineering analysis, the following conclusions can be drawn.

1. The addition of RICE HUSK ASH alone to the test soil resulted in decrease in the value of liquid limit.
2. The addition of RICE HUSK ASH alone to the test soil resulted in decrease in the value of MDD.

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3. The addition of RICE HUSK ASH alone to the test soil resulted in OMC increase.
4. Silica present in RHA is capable to replace the exchangeable ion present in clay mineral thus can reduce shrinkage and swelling property of clay minerals.

The addition of RICE HUSK ASH alone to the test soil resulted in first increase in CBR Value thereafter it decreases towards the end.

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