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SOIL STABILIZATION USING RICE HUSK

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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

INTRODUCTION

Civil engineering projects located in areas with soft or weak soils have traditionally incorporated improvement of soil properties by using various methods. Soil Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Over the times, rice husk ash is the materials used for stabilizing soils. Thus the use of Agricultural waste (such as rice husk ash -RHA) will considerably reduce the cost of Construction and as well reducing the environmental hazards they cause. Rice husk is an agricultural waste obtained from milling of rice. About 108 tons of rice husk is Generated annually in the world. Hence, use of RHA for upgrading of soil should be encouraged. Because expansive clays are characterized by excessive compression, dispersion, collapse, low shear strength, low bearing capacity, and high swell potential, such soils are unsuitable for road sub grade layer construction. Expansive clays usually experience large volume changes depending on the amount of water contained in the soil voids. Such soils can form deep cracks in drier seasons and expand dramatically when wet. Such instability affects the strength performance of soil as a construction material. Volume changes involving shrinkage and swelling cause deformation of the road surface, whereas increased moisture content in 0expansive clay soils significantly reduces soil bearing strength. Soils with low-bearing capacity can be strengthened economically for building purposes through the process of “soil stabilization” using different types of stabilizers.

SOIL STABILIZATION

Soil stabilization is the process of improving its geotechnical properties of soil. Soil stabilization involves the use of stabilizing agents (binder materials) in weak soils to improve its geotechnical properties such as compressibility, strength, permeability and durability.

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The components of stabilization technology include soils and or soil minerals and stabilizing agent or binders, soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together.

TYPES OF SOIL STABLIZATION

The Types can be achieved in two ways, namely;

1. Mechanical stabilization
2. Chemical stabilization

1. LITERATURE REVIEW

Koteswara et al. (2011) used rice husk ash, lime and gypsum as additives to the expansive soil which resulted in considerable improvement in the strength characteristics of the expansive soil. It was found that rice husk ash can potentially stabilize the expansive soil solely (or) mixed with lime and gypsum. The utilization of industrial wastes like RHA, lime and gypsum is an alternative to reduce the construction cost of roads particularly in the rural areas. It was observed that the liquid limit of the expansive soil has been decreased by 22% with the addition of 20% RHA+5% lime. It was noticed that the free swell index of the expansive soil has been reduced by 88% with the addition of 20% RHA + 5% lime. The unconfined compressive strength of the expansive soil has been increased by 548% with addition of 20% RHA+5% lime + 3% gypsum after 28 days curing.

Mtallib and Bankole (2011) carried out experimental study on lime stabilized lateritic soils using rice husk ash as admixture. The index property tests classified the soils as (A-7-6) under the AASHTO soil classification scheme. Index and geotechnical properties tests conducted on the soil containing lime and rice husk ash combinations showed significant improvement in properties. The Atterberg limits were significantly altered with lime and rice husk ash combination; the plasticity of the soils were significantly reduced from 18.10 to 6.70 for sample A and 26.6 to 5.92 for sample B at 6 % lime and 12.5% RHA combination. In terms of compaction characteristics, addition of lime and rice husk ash decreased the maximum dry density and increased the optimum moisture content. At 8% lime and 12.5% RHA, the values of MDD for samples A and B were 1.27 and 1.22 Mg/m3 respectively. The California bearing ratio values peaked at 50% unsoaked values for 8 % lime and 10 % RHA combinations for sample A while that of sample B was 30% at 6% lime and 12.5% RHA combinations. This paper presents the results of experimental study carried out on three different soils improved with different percents of rice husk ash.

Brooks (2009) made a trial to upgrade expansive soil as a construction material using rice husk ash and fly ash, which are waste materials. Remolded expansive clay was blended with RHA and fly ash and strength tests were conducted.

METHODOLOGY METHODS FOR MEASURING SHEAR STRENGTH:

• **DIRECT SHEAR TEST (DST)**

A direct shear test is generally conducted on cohesion less soils as CD test. It is convenient to perform and gives good results for the strength parameters. This is the most common test used to determine the shear strength of the soil. In this experiment the soil is put inside a shear box closed from all sides and force is applied from one side until the soil fails. The shear stress is calculated by dividing this force with the area of the soil mass. This test can be performed in three conditions- untrained, drained and consolidated untrained depending upon the setup of the experiment.

• **CALIFORNIA BEARING RATIO (CBR)**

California Bearing Ratio is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.

The California bearing ratio (CBR) test is a penetration test developed by California State Highway Department (U.S.A.) for evaluation of the mechanical strength of road subgrades and base courses. The CBR rating was developed for measuring the load-bearing capacity of soils used for building roads. We are determining the resistance of the subgrade, (i.e. the layer of naturally occurring material upon which the road is built), to deformation under the load from vehicle wheels. To check how strong the ground upon which we are going to build the road. The CBR test is a way of putting a figure on this inherent strength, the test is done in a standard manner so we are able to compare the strengths of different subgrade materials, and we are able to use these figures as a means of designing the road pavement required for a particular strength of subgrade.

b) **ATTERBERG'S LIMITS**

• **SHRINKAGE LIMIT**

This limit is achieved when further loss of water from the soil does not reduce the volume of the soil. It can be more accurately defined as the lowest water content at which the soil can still be completely saturated.

• **PLASTIC LIMIT**

This limit lies between the plastic and semi-solid state of the soil. It is determined by rolling out a thread of the soil on a flat surface which is non- porous. It is the minimum water content at which the soil just begins to crumble while rolling into a thread of approximately 3mm diameter.

• **LIQUID LIMIT**

It is the water content of the soil between the liquid state and plastic state of the soil. It can be defined as the minimum water content at which the soil, though in liquid state, shows small shearing strength against flowing. It is measured by the Casagrande's apparatus

c) **PARTICLE SIZE DISTRIBUTION**

Soil at any place is composed of particles of a variety of sizes and shapes, sizes ranging from a few microns to a few centimeters are present sometimes in the same soil sample. The distribution of particles of different sizes determines many physical properties of the soil such as its strength, permeability, density etc. Particle size distribution is found out by two methods, first is sieve analysis which is done for coarse grained soils only and the other method is sedimentation analysis used for fine grained soil sample. Both are followed by plotting the results on a semi-log graph. The percentage finer N as the ordinate and the particle diameter i.e. sieve size as the abscissa on a logarithmic scale. The curve generated from the result gives us an idea of the type and gradation of the soil. If the curve is higher up or is more towards the left, it means that the soil has more representation from the finer particles; if it is towards the right, we can deduce that the soil has more of the coarse grained particles.

d) **SPECIFIC GRAVITY** Specific gravity of a substance denotes the number of times that substance is heavier than water. In simpler words we can define it as the ratio between the mass of any substance of a definite volume divided by mass of equal volume of water. In case of soils, specific gravity is the number of times the soil solids are heavier than equal volume of water.

2. METERIAL PROPERTIES

OBJECTIVES

After reading this module, the reader should be able to:

- List basic soil properties and understand the relationships between properties
- Understand how soil texture affects water and plant relations
- Recognize how management practices influence soil structure, porosity and soil organisms
- Understand relationships between soil chemical properties to exchange capacity, pH and salt-affected soils
- Describe the relationship between soil organic matter and basic soil properties

SCOPE AND OBJECTIVES

This study was oriented towards improving the strength of soil by using locally available agricultural and cattle waste to reduce the construction cost. The different stabilizing agents are used Rice husk ash (RHA).The present study was undertaken with the following objectives:

1. To explore the possibility of using rural waste materials like RHA, in soil stabilization.
2. To investigate the chemical and physical properties of stabilizing agents and there suitability.
3. To investigate the physical and engineering properties of natural soil and stabilized soil by adding 2.5%,5%,7.5%,10% and 12.5% of ash in soil.
4. To compare the thickness of the pavement for maximum value of soaked CBR obtained for stabilized soil with soaked CBR value of natural soil.

SOIL PROPERTIES

Specific gravity	2.69
Water absorption	0.6%
Fineness modulus	8.26
Bulk density Compacted-	1.48 Kg/L
Loose-	1.4 Kg/L

Percentage Voids	44.98%

RICE HUSK PROPERTIES

Specific gravity	2.75
Water absorption	2.2%
Fineness modulus	3.34
Bulk density Compacted	-1.6 Kg/L
Loose	-1.21 Kg/L
Percentage Voids	41.81%

CBR Test Apparatus

Soil+10%RHA	46.08
Soil+15%RHA	42.95
Soil+20%RHA	39.60

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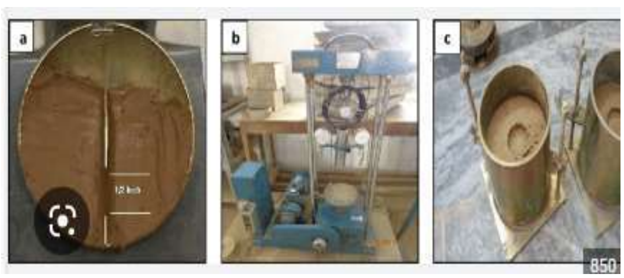

RESULTSANDDISCUSSIONS

Liquid Limit: This test is done by liquid limit apparatus designed by A. Casagrande. A soil sample which passing through 425micron 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 25 blows gives liquid limit.

The method described herein is based upon

IS2720- 5:Methods of test for soils, Part5, [10]

Table1.EffectofRHAonLiquidLimitbehavior

DESCRIPTION	LIQUID LIMIT(%)
Soil alone	50.20
Soil+5%RHA	47.60

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Table 1 shows the effect of Liquid Limit behavior 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%to39.60%.

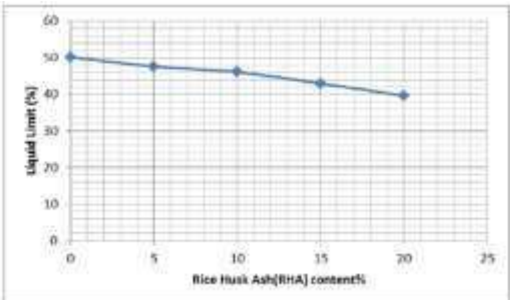

Figure1. Effect of RHA on liquid limit behaviour of Natural soil

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 his 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 944 cc 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:27 20(Part7)-1980-Methodsoftestforsoils, [11].

Table2Effect of RHA for Natural soil on OMC and MDD

DESCRIPTION	OMC(%)	MDD(ing/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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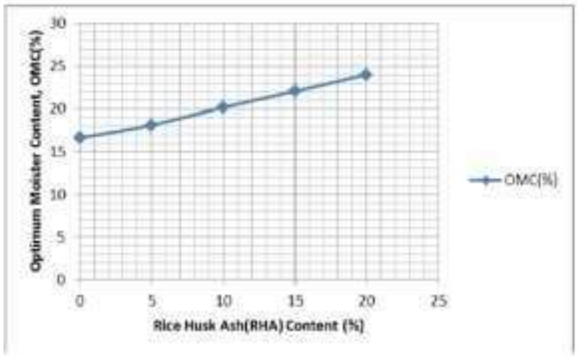

Figure2.Optimum Moisture content (%)

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.

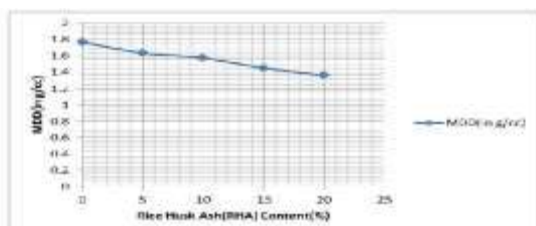

Figure3.Maximum dry density, MDD (g/cc)

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.

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 (Part16) -1973- Methods of test for soils.[12]

Table3 Effect of RHA for Natural soil on CBR values

DESCRIPTION	CBRVALUEAT2.5 MMPENETRATION (%)	CBRVALUEAT5 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

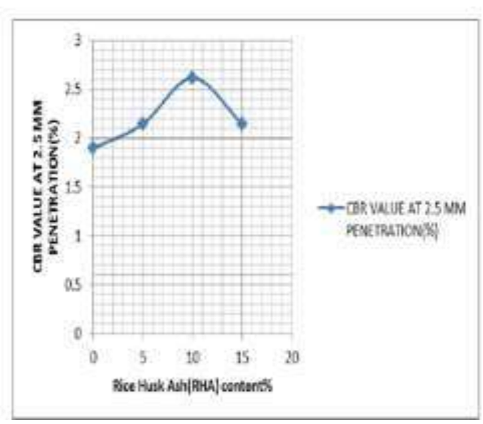

Figure4.CBR values at 2.5mmpenetration

Figure4: show that the comparison of CBR Values on different percentage of RHA. Ingraph, up to 10% there is increase in CBR values, beyond 10% it start decreasing.

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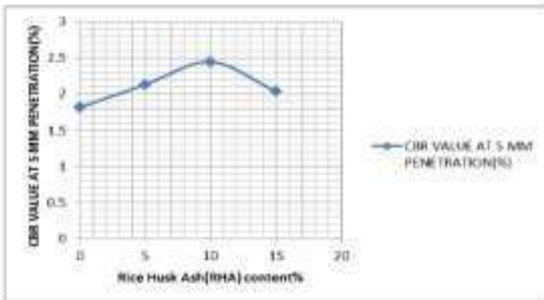

Figure4.CBR values at 2.5mmpenetration

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, beyond10% it start decreasing.

CONCLUSION

The main objective of this research work was to study the effect of adding RICE HUSKASH 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 RICEHUSK ASH.

Summary:

SL NO	SOIL+% OFRHA	OMC(In %)	MDD (mg/cc)	LIQUID LIMIT(%)	CBR	
					AT2.5MM PENETRATION(%)	AT5MM 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 is, the following conclusions can bed rawn.

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.
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 there after it decreases towards the end.

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