"POTENTIALS OF RICE HUSK ASH FOR SOIL STABILIZATION"

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ABSTRACT:

Due to the large production of agricultural wastes, the world is facing a serious problem of its handling and disposal. The disposal of agricultural wastes has a potential negative impact on the environment causing air pollution, water pollution and finally affecting the local ecosystems. So it is mandatory to make these agricultural wastes eco- friendly. By using them as soil stabilizers, these agricultural wastes improves the strength of soil and its characteristics without causing any harm to the environment.

The objective of this paper is to upgrade soil as a construction material using rice husk ash (RHA) which is a waste material. The cost of construction of stabilized road have been keeping financially high due to the over dependency on the utilization of industrially manufactured soil improving additives (cement, lime etc.). By using the agricultural waste (such as rice husk ash - RHA) the cost of construction will be considerably reduced as well reducing the environmental hazards they cause.

The performance of the soil-RHA was investigated with respect to compaction characteristics, unconfined compressive strength (UCS) and California bearing ratio (CBR) tests. The results obtained, indicates a considerable decrease in the maximum dry density (MDD), an increase in optimum moisture content (OMC) and a superficial improvement in the CBR and UCS values with the increase in the RHA content. The peak UCS values were recorded at between 6-8% RHA, which indicated that a little potential of using 6-8% RHA shows a considerable improvement in the strength characteristics of the soil.

INTRODUCTION:

According to Geo technology, soil improvement can either be by modification or by stabilization, or by both. Soil modification is the process of addition of a modifier (cement, lime, etc.) to the soil to change its index properties, while soil stabilization is the treatment of soils to increase their strength and durability so that they are suitable for construction beyond their original classification.
In most of the situations, soils in natural state do not possess proper geotechnical properties to be used as road service layers, foundation layers and as a construction material. In order to make them useful and meet the requirements of geotechnical engineering design, researchers have concentrated more on the use of cost effective materials that are available locally from industrial and agricultural wastes in order to increase the properties of deficient soils and also to reduce the cost of construction. Due to the large production of agricultural wastes, the world is facing a serious problem of its

handling and disposal. The disposal of agricultural wastes has a potential negative impact on the environment causing air pollution, water pollution and finally affecting the local ecosystems. Hence the secure disposition of agricultural wastes has become a challenging task for engineers. The main aim of the paper is to investigate the use of Rice husk ash (RHA) which is an agricultural waste to stabilize the weak sub grade soil. This hitherto have continued to impede the poor and under developed nations of the world from providing accessible roads to their rural inhabitants who contribute to the major percentage of their population and are mostly, agriculturally dependent. Thus by using the agricultural waste (such as rice husk ash - RHA) the cost of construction will be considerably reduced as well reducing the environmental hazards they cause. It has been identified by Sear (2005) that Portland cement, with respect to its chemistry, produces large amounts of CO_2 for each ton of its final product. Hence by replacing proportions of the Portland cement with a secondary cementitious material like RHA in soil stabilization will reduce the overall negative environmental impact of the stabilization process.

RICE HUSK ASH:

Rice husk ash is a primary agricultural product obtained from paddy. Rice milling produces a by-product known as husk which is surrounded by the paddy grain. At the time of milling of paddy about 78% of weight constitutes rice, broken rice, bran and the remaining 22% of the weight of paddy is received as husk. For every 40 KN of rice 10kN of husk is produced. The husk is disposed off by dumping it heap in an open area near the mill or on the sides of the road to be burnt later. Burning the rice husk produces about 15-20% weight of ash. As the ash is very light, it is easily carried away by wind and water causing air pollution and water pollution. The large quantity of ash produced requires maximum areas for disposal. The husk is converted to ash by the process of incineration. The husk is generally used as fuel in the rice mills to produce steam for boiling. It contains about 75% of organic volatile matter and the rest 25% of the weight of the husk is converted into ash known as Rice Husk Ash (RHA) during the burning process. This RHA in turn contains about 85% - 90% of amorphous silica. The maximum percentage of siliceous material contained in rice husk ash showed that it has pozzolanic properties. Hence for every 2200 lbs of paddy milled, about 480 lbs (22%) of husk is produced, and when it is fired in the boilers, about 120 lbs (25%) of RHA is generated. This RHA is a great environmental hazard causing a negative impact on the land and the surrounding area in which it is dumped. There are many ways that are being thought for disposing it by making a commercial use with RHA.

Chemical composition of rice husk ash

SiO_2	**86%**
Al_2O_3	**2.6%**
Fe_2O_3	**1.8%**
CaO	**3.6%**
MgO	**0.27%**
Loss of Ignition	**4.2%**

Physical properties of rice husk ash

S.No	PROPERTY		VALUE
1	**Grain size distribution (percent finer than)**	**4.75 mm**	**100**
		2.0 mm	**96**
		0.6 mm	**80**
		0.425 mm	**50**
		0.21 mm	**29**
		0.075 mm	**8**
2	**Specific Gravity**		**2.01**

USES OF RICE HUSK ASH:

As a stabilizer: Though Rice Husk Ash acts as inert material with the silica in the crystalline with respect to the structure of particles, it is unbelievable that it reacts with lime to produce calcium silicates. It is also unbelievable that RHA is as reactive as fly ash, which is more finely divided. So Rice Husk Ash would give great results when it is used as a stabilizing material. It is observed that RHA is likely to stabilize the soil solely or when mixed with lime, gypsum. The application of industrial wastes such as RHA, lime and gypsum is a substitute to minimize the cost of construction of roads especially in the rural areas.

In lightweight fill: The ash appears to be a very suitable material for light weight fill and it would not produce any difficulties in compaction, provided its initial moisture content is maintained within reasonable limits (less than 50%). It has a very high angle of internal friction which indicates that the material has a very high stability. On the other hand, lack of cohesion may cause problems in construction due to shearing and erosion under heavy rollers. These problems can be overcome by placing a 3 to 6 inch thick layer of cohesive material for every 2 to 3 ft.

Other uses: The compacted rice husk ash is a very suitable material as a final filter for water supply over a wide range of moisture contents, because of its small pore size and high permeability. Un-burnt rice husk may be employed as a first stage filter. As it is cheaper, it can be replaced often, if needed. The low compacted RHA might be used in light weight concrete.

METHODS OF TESTING:

The laboratory tests that are carried out on the natural soil include particle size distribution, compaction, California bearing ratio test, Atterberg limits, and unconfined compressive strength. The specimens required for California bearing ratio test and unconfined compressive strength tests will be prepared at the maximum dry densities and optimum moisture contents. The soil should be free from organic matter, pebbles and large stones. The dried and pulverized soil passing through I.S. 4.75 mm is taken for the test.

TEST RESULTS AND DISCUSSION:

Soil Identification: The geotechnical index properties of the natural soil before addition of stabilizers are shown in the table and overall properties of the soil are classified as A-7-6 in the AASHTO (1986) classification system. It indicates that the soil falls below the recommended standards for most geotechnical construction works and hence it needs stabilization.

Properties of the natural soil before stabilization

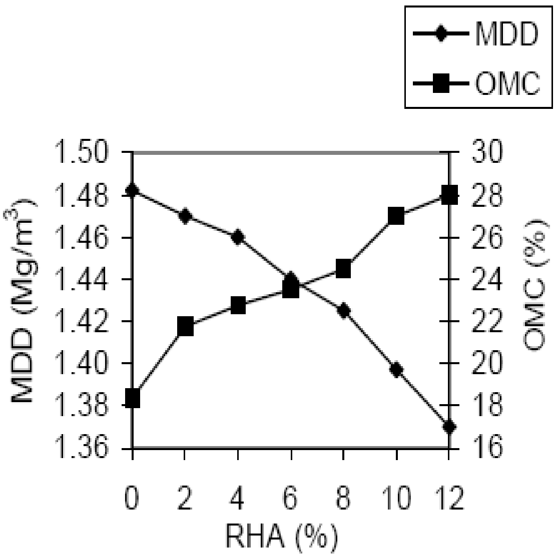
Characteristics	Description
Natural moisture content (%)	22.27
Percent passing B.S Sieve NO 200	77
Liquid Limit (%)	49.5
Plastic Limit (%)	24.4
Plasticity Index (%)	25.1
Group Index	20
AASHTO Classification	A-7-6
Maximum Dry Density (Mg/m^3)	1.482
Optimum Moisture Content (%)	18.38
Unconfined Compressive Strength (kN/m^2)	290
California Bearing Ratio (%) Unsoaked Soaked	 8.5 5.55
Specific Gravity	2.69
Color	Reddish-brown

EFFECT OF TREATMENT WITH RHA:

Compaction Characteristics:

The deviation of Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) with stabilizer contents are shown in figure. The MDD decreased while the OMC increased with increase in the RHA content. The decrease in the MDD can be explained as the replacement of soil by the RHA in the mixture which has a relatively low specific gravity (2.25) compared to that of the soil which has 2.69. It may also be explained as coating of the soil by the RHA which resulted in large size particles with big voids and low density. The decrease in the MDD is explained by considering the RHA as filler which has low specific gravity in the voids of the soil.

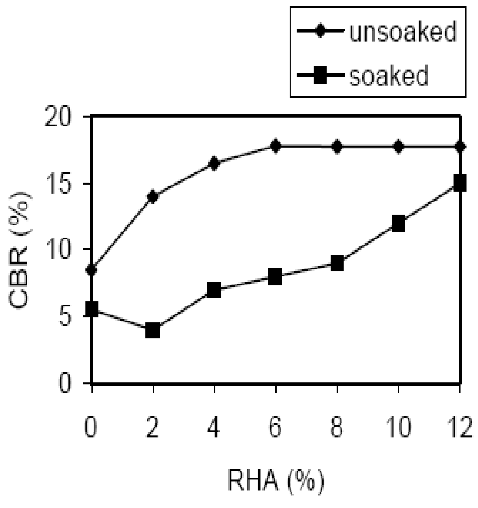
The increase in OMC with RHA content is due to the addition of RHA, which decreased the amount of free silt and clay fraction and in the process, coarser materials with larger surface areas are formed (these processes require water to take place). This also indicates that more water is required in order to compact the soil-RHA mixtures.



Variation of MDD and OMC with RHA content

California Bearing Ratio (CBR):

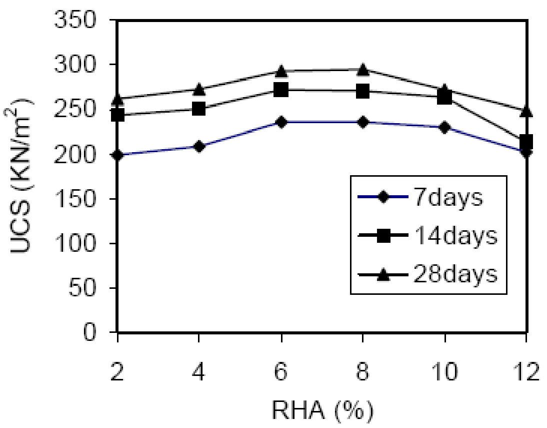
This test is widely used in the design of base and sub-base materials for pavement and it is a sign of compacted soil strength and bearing capacity. It is one of the most common tests used to determine the strength of stabilized soils. The deviation of CBR with increase in RHA content from 0 to 12% is shown in figure. For unsoaked samples, CBR values initially decreased with the addition of 2% RHA, after which the values increased to its peak at 6% RHA. Then it slightly decreased at 8% RHA and remains constant to 12% RHA. Initially the decrease in CBR is due to the decrement in the content of silt and clay in the soil, which minimizes the cohesion of the samples. The increase in the CBR after 2% RHA can be explained as the gradual formation of cementitious compounds between the RHA and CaOH contained in the soil. The gradual decrease in the CBR after 6% RHA is due to excess of RHA that was not mobilized in the reaction, and they occupy spaces within the sample, minimizing bond in the soil-RHA mixtures. The trend of the soaked CBR is similar to the unsoaked CBR, only after the addition of 6% RHA where the CBR kept increasing. This trend indicates that the presence of moisture helps further in the formation of the cementitious compounds between the soils's CaOH and the pozzolanic RHA.



Variation of CBR with RHA content

Unconfined Compressive Strength (UCS):

This test is the most common and flexible method for evaluating the strength of stabilized soil. It is an important test recommended to determine the required amount of additive to be used in stabilization of soil. The change in UCS with increase in RHA from 0% to 12% for 7 days, 14 days and 28 days curing period is shown in figure. The UCS value recorded for the natural soil is 290kN/m^2. Initially there was a sharp decrease in the UCS with addition of RHA to the natural soil. This decrease may be due to same reason given in the case of CBR. The UCS values increase with subsequent addition of RHA to its maximum value at between 6-8% RHA after which it decreased from 10-12% RHA. The subsequent increase in the UCS is explained as the formation of cementitious compounds between the CaOH present in the soil and RHA and the pozzolanos present in it. The drop in the UCS values after the addition of 8% RHA may be due to the excess RHA present in the soil which forms weak bonds between the soil and the cementitious compounds formed. The maximum UCS value recorded were 293 kN/m^2 at 6% RHA content and 295kN/m^2 at 8% RHA contents after 28 days curing period which are slightly higher than the UCS value of natural soil which is 290kN/m^2.



Variation of UCS with RHA content

RECOMMENDATION:

As the result of the study indicates little potentials of using RHA only for soil improvement, it is suggested that it should be combined more with cement or lime for the production of secondary cementitious compounds with the CaOH obtained from the hydration of cement or when used with lime (CaOH). Rice husk ash and lime/ cement changed the texture of clay soil by minimizing the fine particles. RHA and lime/cement improves plasticity index and swelling potential of expansive soils reduces with admixture addition.

CONCLUSION:

It can be concluded from the results of the study that:

- Treatment with RHA showed a gradual decrease in the MDD and increase in OMC with rise in the RHA content.
- There was also an improvement in the unsoaked CBR compared with the CBR of the natural soil. The soaked CBR also improved.
- A similar trend of the CBR was obtained for UCS. The values of UCS were at their peak at 6-8% RHA. The UCS of the mixes also increased with curing age.
- Rice husk ash and lime/ cement altered the texture of clay soil by reducing the fine particles.
- RHA and lime/cement improves plasticity index and swelling potential of soils reduces with admixture addition.
- Rice husk ash can potentially stabilize the soil solely or when mixed with lime, gypsum. The utilization of industrial wastes like RHA, lime and gypsum is an alternative to minimize the cost of construction of roads particularly in the rural areas of developing countries.

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