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EXPERIMENTAL INVESTIGATION OF SOIL STABILIZATION USING RICE HUSK ASH AND CEMENT

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ABSTRACT

The use of industrial wastes has been found to be helpful in stabilising soil, and study into this topic is expanding quickly in the field of construction engineering. The current experimental work provides a brief overview of the suitability of the locally accessible Rice Husk Ash (RHA) to be used in the local construction sector in a way that minimises the quantity of trash that must be disposed of to the environment, creating environmental contamination. Due to the increasing cost of stabilising materials like cement, lime, etc., standard soil stabilisation techniques are getting more and more expensive.

By substituting RHA for a significant amount of the stabilising agent, the cost of stabilisation may be reduced. Additionally, it will reduce environmental risks. Clay with high plasticity (CH), the soil sample used for the investigation, really needs to be strengthened. Different ratios of rice husk ash and a tiny amount of cement are used to stabilise the soil. The variations in soil parameters such as the California bearing ratio (CBR), maximum dry density (MDD), optimal moisture content (OMC), and unconfined compressive stress (UCS) are observed. According to the data, an increase in RHA content raises OMC while lowering MDD.

From the observation of maximum improvement in strength, 15% RHA content with 8% cement is recommended as optimum amount for practical purposes. Observing the tremendous improvement of CBR value of soil, the present soil stabilization technique may mostly be recommended for construction of pavement.

Keywords: Soil Stabilization, Rice Husk Ash (RHA), Cement, Optimum Moisture Content (OMC), California Bearing Ratio (CBR), Unconfined Compressive Stress (UCS).

INTRODUCTION

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, cement and lime are the two main materials used for stabilizing soils. These materials have rapidly increased in price due to the sharp increase in the cost of energy. 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 causes. Rice husk is an agricultural waste obtained from milling of rice. About 10^8 tons of rice husk is generated annually in the world. Hence, use of RHA for upgrading of soil should be encouraged.

Previous experiments with RHA showed that it has a promising potential for enhancing the engineering properties of soils for sub-grade purposes. Therefore, this work concentrated on determining the ideal RHA concentration for practical applications through the observation of the effect of RHA on some geotechnical properties of soft clayey soil that are important for assessing the performance of sub-grade soils. However, because it lacks the cementation properties necessary to bind the material to a satisfactory level of durability, the RHA can only be used as a partial replacement for the more expensive stabilising agents (cement/lime). Therefore, in the current study, a small amount of cement was combined with RHA and the impact of soil stabilisation on soil properties, such as optimal moisture content and maximum dry density, California bearing Ratio and unconfined compressive stress is observed and the optimum content is found out from the maximum improvement. By paying a small cost for cement, a tremendous improvement of CBR-value of soil is observed which indicates the cost-effectiveness of construction of pavement.

MATERIALS USED

1. Rice Husk Ash
2. Cement
3. Soil Sample

1. RICE HUSK ASH

Rice husk is a by-product of the rice milling. About 110 million tons of husk per year are produced across the world. Due to its abrasive character, it is not suitable as animal feed. High lignin and ash content make it unacceptable for paper manufacturing. During milling of paddy, around 75% is obtained as rice and bran and rest 25% as husk. The husk obtained is used as fuel for processing paddy in rice mills and for producing energy through direct combustion. Upon burning, 25% of husk gets converted into ash and remaining is volatile matter. This RHA is a great threat to the environment which can damage surrounding area and land where it is dumped. For its effective disposal it can be used as pozzolanic material in concrete production, absorbents for oils and chemicals and for soil stabilization.

Amorphous silica is present in rice husk in concentrations of 85 to 90 percent.

The RHA was collected from sharma Rice Mill at Mullana. The RHA was ground and sieved through 0.075mm aperture before use. The oxide composition of RHA is shown in Table.

Table: Oxide composition of RHA.

Constituent	Composition (%)
SiO2	75.2
Al2O3	5.2
Fe2O3	1.02
CaO	1.4
MgO	1.75
Loss on Ignition	15.43

Fig: - RICE HUSK ASH

2.SOIL

The soil sample used for this study is collected from local area at Hema Majra, India at a depth of 1.5m using the method of disturbed sampling. The properties of the soil used in the investigation are given in Table. The overall geotechnical properties of the soil classified as Clay with high plasticity (CH) in the IS Soil Classification System.

Characteristics	Description
Natural Moisture content (%) Percent passing IS sieve 75 micron	21 86
Specific gravity Liquid limit (%)	2.34 51

METHODS OF TESTING

The laboratory tests carried out first was on the natural soil which include Particle size distribution CBR and UCS. The geotechnical properties of the soil are determined. Specimen for Unconfined compressive strength (UCS) and California bearing ratio (CBR) tests are prepared at the Optimum moisture contents (OMC) and Maximum dry densities (MDD). In the second phase of the study, three different percentages of RHA 15%,17% and 18% are mixed with soil in three different tests. In each case, 8% cement is mixed with the soil-RHA mix to get adequate cementation property to the mix. For the above three different proportions, tests are carried out to observe the changes in the properties of soil i.e., Maximum dry density, Optimum moisture content, CBR value and Unconfined compressive stress of soil.

CALIFORNIA BEARING RATIO

As an indicator of compacted soil strength and bearing capacity, it is widely used in the design of base and sub-base material for pavement. It is also one of the common tests used to evaluate the strength of stabilized soils. The variation of CBR with increase in RHA from 15%, 17% & 18% mixed with soil 8% cement and test is performed.

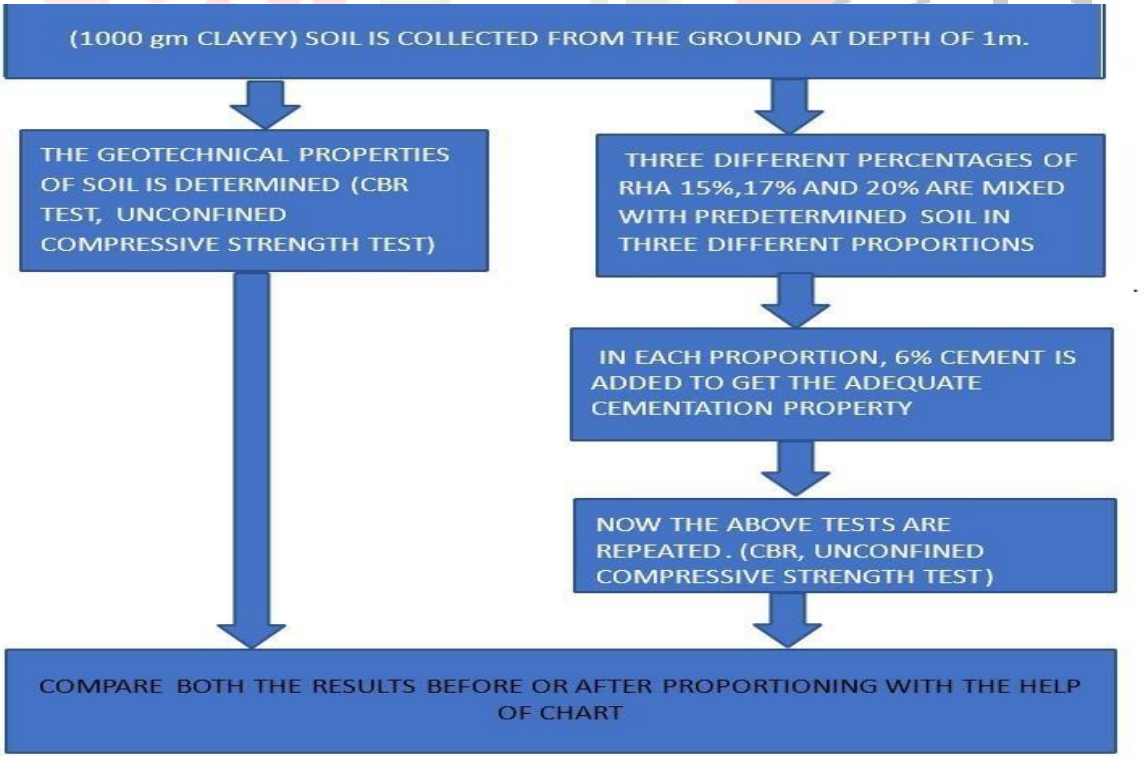
UNCONFINED COMPRESSIVE STRENGTH

Unconfined compressive strength (UCS) is the most common and adaptable method of evaluating the strength of stabilized soil. It is the main test recommended for the determination of the required amount of additive to be used in stabilization of soil. Variation of UCS with increase in RHA from 15% ,17% & 18% is investigated.

OBJECTIVE

1. Stabilization of Soil with the use of Rice husk ash and Cement.
2. To enhance the physical properties of Soil (optimum moisture content).

METHODOLOGY



LITERATURE REVIEW

S.NO	AUTHOR	TITLE	CONCLUSION
1	Shrivastava et al. (2014)	The effect of adding lime and RHA on various geotechnical properties of Black cotton soil.	The test results indicate significant improvement in California bearing ratio (CBR) and Unconfined compressive strength (UCS), whereas differential free swell decreases with increase in RHA content. Maximum improvement of 287.5% and 30% in CBR and UCS, respectively, was reported corresponding to 20% RHA content. It was concluded that silica present in RHA reacts with lime to form a binding material and enhances the soil properties considerably
2.	Aparna Roy	Soil Stabilization using Rice Husk Ash and Cement	Treatment with RHA and a small percentage of cement shows a general decrease in the MDD and increase in OMC with increase in the RHA content. There is also an improvement in the unsoaked CBR (106% at 10% RHA content) compared with the CBR of the natural soil.
3.	Ayush Mittal, Sonu Verma	Review on Suitability of Rice Husk Ash as Soil Stabilizer	10% RHA with 6% cement gives maximum improvement in CBR and UCS values of soil. 10% RHA with 6% Lime results in maximum increase in CBR and shearing properties of the soil. 20% RHA and 10% stone dust results maximum improvement in the strength characteristics in soil. 8% RHA and 1% core fibre results in maximum improvement in shearing characteristics of soil

4.	B. H. J. Pushpa kumara and W. S. W. Mendis	suitability of Rice Husk Ash (RHA) with lime as a soil stabilizer in geotechnical applications	The optimum dosage for the treatment is 10% of RHA and 20% of lime by weight of dry soil. Properties of stabilized soil are obviously dependent on the type of soil to be treated. Therefore, for soil with clay/ fine content > 90%, LL around 60% and PI around 30, dosage of 10% of RHA and 20% of lime can be recommended to be used for soil stabilization.
5.	Ghutkeetal. (2018)	the effect of RHA addition on index and strength properties of black cotton soil	It was found that liquid and plastic limit first increases up to 4% RHA addition and then start decreasing. Specific Gravity and MDD decreases as the percentage of RHA increases. CBR value increase up to 12% RHA content and beyond that it decreases. It was concluded that optimum ash content in soil was 12% where maximum improvement in properties are occurring.

RESULTS AND DISCUSSION:

Soil Stabilization using Rice Husk Ash and Cement:

Plastic limit (%)	26.8 20.1
Plasticity index (%)	1.64
Maximum dry density(gm/cc)	21.5
Optimum moisture content (%)	1.54
California bearing ratio, unsoaked (%)	72KN/m^2
Unconfined compressive strength (KN/m2)	

Compaction Characteristics

The variations of MDD and OMC with RHA contents mixed with soil and 8% cement are shown in Figure 1 and Figure 2, respectively. The Maximum Dry Density (MDD) is decreased while the Optimum Moisture Content (OMC) is increased 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. There is increase in OMC with increase RHA contents. 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.

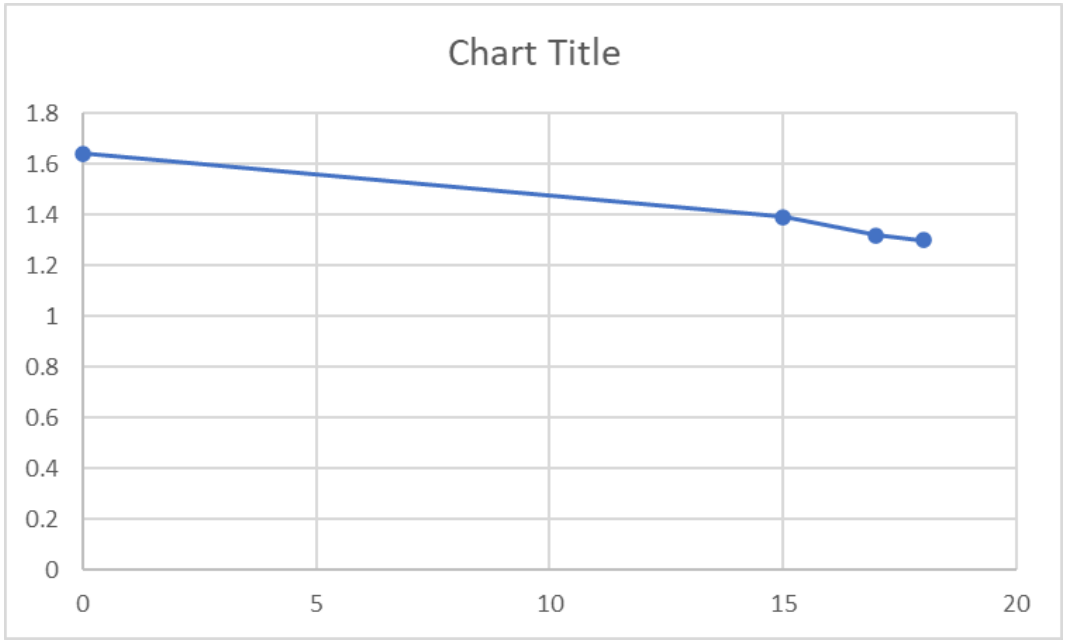


Figure 1: Variation of MDD with RHA Content

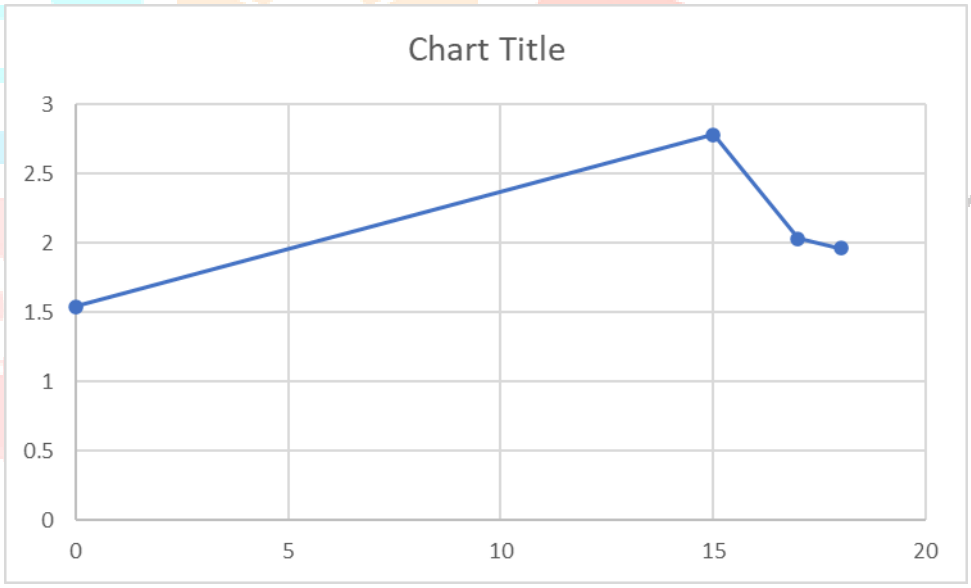
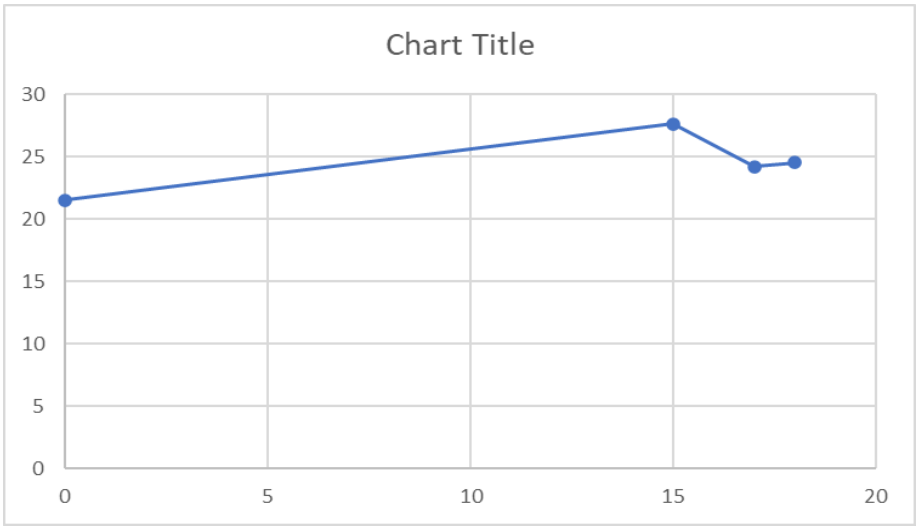


Figure 2: Variation of OMC with RHA Content

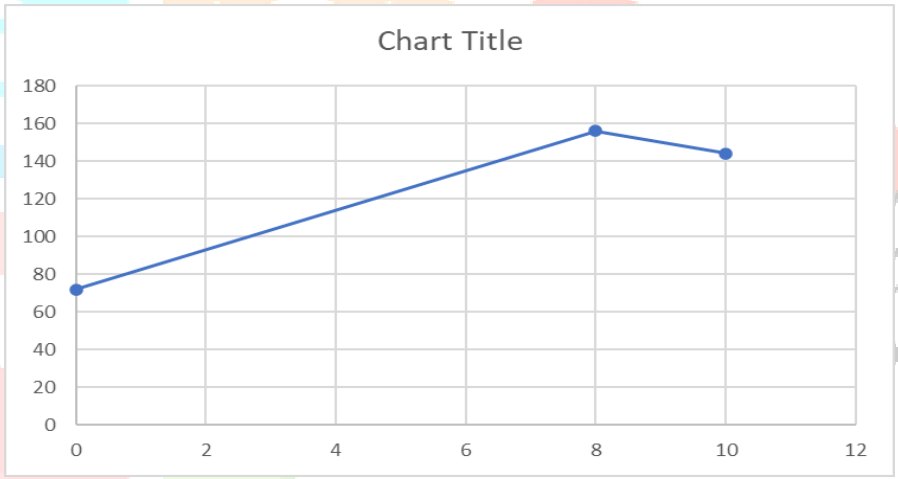
California Bearing Ratio

As an indicator of compacted soil strength and bearing capacity, it is widely used in the design of base and sub-base material for pavement. It is also one of the common tests used to evaluate the strength of stabilized soils. The variation of CBR with increase in RHA from 15 to 18% mixed with soil and 8% cement is shown in Figure. For unsoaked samples, the CBR value is increased by 109% for RHA content of 15%. Further the CBR value is slightly decreased for RHA content of 17%. The reason for increment in CBR may be because of the gradual formation of cementitious compounds in the soil by the reaction between the RHA and some amounts of CaOH present in the soil and cement present. The decrease in CBR at RHA content of 17% may be due to extra RHA that could not be mobilized for the reaction which consequently occupies spaces within the sample. This reduced the bond in the soil RHA mixture.



Unconfined Compressive Strength

Unconfined compressive strength (UCS) is the most common and adaptable method of evaluating the strength of stabilized soil. It is the main test recommended for the determination of the required amount of additive to be used in stabilization of soil. Variation of UCS with increase in RHA from 15% to 18% were investigated and the results are shown in Figure.



The UCS is increased by 85% for RHA content of 15%. Further the value of UCS is slightly decreased for RHA content of 17%. This decrease may be due to earlier reason given in the case of CBR. The UCS values increase with subsequent addition of RHA to its maximum at 15% RHA after which it dropped. The subsequent increase in the UCS is attributed to the formation of cementitious compounds between the CaOH present in the soil and RHA and the pozzolans present in the RHA.

SUMMARY AND CONCLUSION

CONCLUSION

From the results of this study, the following conclusions can be downed:

i. The soft soil is identified to be clay of high plasticity (CH) according to IS Soil Classification System. It has very low CBR-value (1.54) and Unconfined compressive stress (72 KN/m^2). The soil is required to be stabilized before doing any construction work.

ii. Treatment with RHA and a small percentage of cement shows a general decrease in the MDD and increase in OMC with increase in the RHA content.

iii. There is also an improvement in the unsoaked CBR (109% at 15% RHA content) compared with the CBR of the natural soil. iv. A similar trend is obtained for UCS. The UCS value is at its peak at 15% RHA (85% improved).

For maximum improvement in strength, soil stabilization using 15% RHA content with 8% cement is recommended as optimum amount for practical purposes.

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