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# Soil Stabilization using Rice Husk

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## ABSTRACT

India has a total road network of about 4.7million kilometres. 53 percent of the total road network is paved. The budgeted amount spent over roads is Rs.14, 90,925 Croce. The durability and serviceability of pavements depend mainly on strength of sub grade, which can be enhanced by ground improvement techniques. The field of ground improvement by the use of waste rice husk ash for this purpose. India is one of the world's largest producers of rice. This paper therefore takes the review of the effect of rice husk ash on the properties of soil related to pavement such as Optimum Moisture Content (OMC), Maximum Dry Density (MDD) and California Bearing Ratio (CBR).

In India the soil mostly present is Clay, in which the construction of sub grade is problematic. In recent times the demands for sub grade materials has increased due to increased constructional activities in the road sector and due to paucity of available nearby lands to allow excavate fill materials for making sub grade. In this situation, a means to overcome this problem is to utilize the different alternative generated waste materials, which cause not only environmental hazards and also the depositional problems. Keeping this in view stabilization of weak soil in situ may be done with suitable admixtures to save the construction cost considerably. The present investigation has therefore been carried out with agricultural waste materials like Rice Husk Ash (RHA) which was mixed with soil to study improvement of weak sub grade in terms of compaction and strength characteristics. Silica produced from rice husk ashes have investigated successfully as a pozolanic material in soil stabilization.

Due to various construction development projects undertaken all over the world there is a substantial increase in the production of waste materials rice husk. Which create disposal problems. Rice husk waste is produced in large quantity in rice husk mills and is disposed in open land. Therefore use of rice husk in foundation of buildings and in road constructions to improve bearing capacity of soil and to reduce the area of open land needed for its disposal and to preserve environment through resource conservation.

## I. 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.

## III. 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. 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.

## IV. TYPES OF SOIL STABLIZATION

The Types can be achieved in two ways, namely;

1. Mechanical stabilization
2. Chemical stabilization

**Mechanical stabilization**

Under this category, soil stabilization can be achieved through physical process by altering the physical nature of native soil particles by either induced vibration or compaction or by incorporating other physical properties such as barriers and nailing. Mechanical stabilization is not the main subject.

**Chemical stabilization**

Under this category, soil stabilization depends mainly on chemical reactions between stabilizer (cementations material) and soil minerals (pozzolanic materials) to achieve the desired effect. A chemical stabilization method is the fundamental of this review and, therefore, throughout the rest of this report, the term soil stabilization will mean chemical stabilization.

Through soil stabilization, unbound materials can be stabilized with cementations materials (cement, lime, fly ash, bitumen rice husk ash or combination of these). The stabilized soil materials have a higher strength, lower permeability and lower compressibility than the native soil.

## V. STABILIZATION METHODS

The method can be achieved in two ways, namely;

(1) In situ stabilization and

(2) ex-situ stabilization.

### In–Situ Stabilization

The method involves on site soil improvement by applying stabilizing agent without removing the bulk soil. This technology offer benefit of improving soils for deep foundations, shallow foundations and contaminated sites. Planning of the design mix involves the selection and assessment of engineering properties of stabilized soil and improved ground. The purpose is to determine the dimensions of improved ground on the basis of appropriate stability and settlement analyses to satisfy the functional requirements of the supported structure (Keller Inc.). The technology can be accomplished by injection into soils a cementations material such cement and lime in dry or wet forms. The choice to either use dry or wet deep mixing methods depend among other things; the in-situ soil conditions, in situ moisture contents, effectiveness of binders to be used, and the nature of construction to be founded. Depending on the depth of treatment, the in situ stabilization may be regarded as either deep mixing method or mass stabilization.

**Parts of wet mixing tool showing injection of slurry into the soil**

### Ex-Situ Stabilization

The technology involves dislodging of the soils and or sediments from the original position and moves to other place for the purpose of amendment. These can be encountered in dredging of river channel and Ports. The main objectives of dredging can be either for amending the contaminated sediments to reduce toxicity and mobility or

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to maintain or deepen navigation channels for the safe passage of ships and boats (US EPA, 2004). Offsite treatment of the sediment can be done in confined disposal facilities (CDF) and then be used or disposed at designated site. Method of removal, means of transportation, availability of treatment location, disposal site or demand for reuse is key factors to consider when planning for ex-situ stabilization (Miller and Miller, 2007; PIANC, 2009). Treatment of sediments in CDF falls under ex-situ mass stabilization method, which can be accomplished in several ways depending on natural of sediments and water contents.

**Ex-situ for on-site use stabilization (mixing in place of contaminated dredged materials)**

## VI. 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.

## VII. 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. The potential of RHA-fly ash blend as a swell reduction layer between the footing of a foundation and subgrade was studied. In order to examine the importance of the study, a cost comparison was made for the preparation of the sub-base of a highway project with and without the admixture stabilizations. Stress-strain behavior of unconfined compressive strength showed that failure stress and strains increased by 106% and 50% respectively when the fly ash content was increased from 0 to 25%. When the RHA content was increased from 0 to 12%, unconfined compressive stress increased by 97% while CBR improved by 47%. Therefore, an RHA content of 12% and a fly ash content of 25% were recommended for strengthening the expansive sub grade soil. A fly ash content of 15% was recommended for blending into RHA for forming a swell reduction layer because of its satisfactory performance in the laboratory tests.

Yadu et al. (2011) presented the laboratory study of black cotton soil stabilized with fly ash (FA) and rice husk ash (RHA). The samples of these soils were collected from a rural road located in Raipur of Chhattisgarh state. The soil was stabilized with different percentages of FA (i.e., 5, 8, 10, 12, and 15%) and RHA (i.e., 3, 6, 9 11, 13, and 15%). The Atterberg limits, specific gravity, California bearing ratio (CBR), and unconfined compressive strength (UCS) tests were performed on raw and stabilized soils. Results indicated that addition of FA and RHA reduces the plasticity index (PI) and specific gravity of the soil.

Rao., Pranav , Anusha et.al (2012) has conducted a detailed study on expansive soils with the addition of RHA, lime and gypsum on properties of expansive soil such as Atterberg's limits, compaction, strength, CBR and free swell index. It was observed that the liquid limit of the expansive soil has been decreased by 22% and Free Swell Index by 88% with the addition of 20% RHA+5% Lime. The improvement of 548% in UCS and remarkable increase in CBR value was also observed on addition of 20% RHA+5% lime + 3% Gypsum. Roy et.al (2014) has studied the effect of blended mixture of cement & RHA on properties of soil such as optimum moisture content, maximum dry density, California bearing Ratio (CBR) and Unconfined Compressive Strength (UCS). The paper studied the soft soil which was identified as clay of high plasticity (CH) according to IS Soil Classification System. It had very low CBR value (1.46) and UCS was found to be 70 KN/m2. The soil was required to be stabilized before doing any construction work. After the study it was revealed that, treatment with RHA and a small percentage of cement showed a general decrease in the Maximum Dry Density (MDD) by 10% and increase in Optimum Moisture Content (OMC) by 15% with increase in the RHA content. There was also an improvement in the un-soaked CBR (106% at 10% RHA content) compared with the CBR of the natural soil. A similar trend was obtained for UCS. The UCS value was at its peak at 10% RHA (90.6% improved). For maximum improvement in strength, soil stabilization using 10% RHA content with 6% cement is recommended as optimum amount for practical purposes.

## VIII. METHODOLOGY

The laboratory tests were carried out first on the natural soil which include liquid limit, plastic limit, plasticity index, specific gravity, compaction and UCS. Specimens for Unconfined compressive strength (UCS) tests are prepared at the Optimum moisture contents (OMC) and Maximum dry densities (MDD). Further a series of laboratory tests were conducted on BC Soil mixed with Rice Husk Ash in various percentages i.e.5% 10% 15%, 20%, 25% and 30% by weight of dry soil. For the above different proportions, tests are carried out to observe the changes in the properties of soil i.e. maximum dry density, optimum moisture content, and unconfined compressive strength of soil.

**Sample for CBR Test**

**CBR Test Apparatus**

## IX. RESULTS AND DISCUSSION

The effect of solid wastes namely Rice husk ash in alluvial soil and clay soil on the variation of index properties, compaction characteristics, shear strength and CBR values were analyzed. From the results the following conclusion may be drawn.

1. The liquid limit and the FSI of the soil decreased steeply with the increase in the % of RHA .In case of alluvial soil the liquid limit decreased from a value of 59% to 19.2% for the same quantum of addition of RHA. The decrease in the free swell Index was from 59% to 13.6%. The shrinkage limit of soil increased to 23.7 and 24.2% respectively for alluvial soil and clay soil from 12% initially for virgin soil.

2. The Maximum dry density increased from 16.39KN/m3 to 20.95kN/m3 in case of addition of 80% RHA to alluvial soil the soil. The maximum and minimum dry density of alluvial soil is 21.8kN/m3 and 18.4kN/m3 respectively. The Optimum moisture content decreased steeply with % RHA 17.8% to 13.25%. The Optimum moisture content decreased steeply with 80% RHA for clay soil from 17.89% to 13.25% and maximum dry density increased from 16.39kN/m3 to 19.5kN/m3.

3. The undrained cohesion value of soil mixed with alluvial soil decreased from 60kN/m2 to 20 kN/m2 and angle of internal fraction value increased from 17°5' to 39°. The undrained cohesion value of the soil mixed with RHA for clay soil decreased from 60 kN/m2 to 30 kN/m2 and angle of internal friction value increased from 17°5' to 38°.

4. The unsoaked CBR value of the soil increased from 3.2% to 12% whereas soaked CBR value from 2.4% to 6.4% only in the case of addition of RHA to alluvial soil. The unsoaked CBR value in the case of addition of RHA to clay soil increased from 3.2% to 9.3% and the soaked CBR value 2.4% to 4.4%.

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| Table 4. Effect of RHA on Liquid Limit behavior DESCRIPTION | ALLUVIAL SOIL (%) | CLAY SOIL (%) |
|---|---|---|
| Soil alone | 54.00 | 57.00 |
| Soil + 5% | 51.25 | 54.80 |
| Soil + 10% | 48.50 | 51.30 |
| Soil + 20% | 44.30 | 48.20 |
| Soil + 30% | 43.00 | 47.50 |
| Soil + 40% | 38.54 | 44.00 |
| Soil + 50% | 36.00 | 37.50 |
| Soil + 80% | 30.50 | 26.5 |

| Table 5. Effect of RHA for Natural soil on CBR values DESCRIPTION | ALLUVIAL SOIL | | CLAY SOIL | |
|---|---|---|---|---|
| | UNSOAKED CBR VALUE | SOAKED CBR VALUE | UNSOAKED CBR VALUE | SOAKED CBR VALUE |
| **Soil alone** | 3.27 | 2.42 | 3.60 | 2.80 |
| **Soil + 10%** | 6.27 | 2.58 | 6.01 | 2.58 |
| **Soil + 20%** | 6.69 | 2.67 | 6.47 | 2.70 |
| **Soil + 30%** | 7.30 | 3.40 | 6.73 | 3.28 |
| **Soil + 50%** | 8.80 | 4.22 | 7.50 | 3.58 |
| **Soil + 80%** | 12.19 | 6.40 | 9.30 | 4.35 |

## CONCLUSIONS

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 (1.46) and unconfined compressive stress (70 KN/m2). The soil is required to be stabilized before doing any construction work.

ii. Treatment with RHA 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 (106% at 10% RHA content) compared with the CBR of the natural soil.

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iv. A similar trend is obtained for UCS. The UCS value is at its peak at 10% RHA (90.6% improved).

v. For maximum improvement in strength, soil stabilization using 10% RHA content with 6% cement is recommended as optimum amount for practical purposes.

**BIOGRAPHAICAL DATA:**

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|---|---|
|  | **Prof. Mahadeva M** is working as assistant professor in civil engineering department in SPCE form last 2 years and he also worked as assistant professor in K S institute of technology. He received is **B E** in **civil engineering** and **M.Tech** with specialization in **CAD structures** from Visvesvaraya technological university. He is member of MISTE, MNG and MIRED. He is national advisory board member for international conference and he secured "***Active Young Research Award"*** in international journals for his continuous contribution in research field And He is Conference Convener for international conference and journals. His research interest is in the field of soil structure interaction, structural engineering, earth quake engineering and water resources and construction technology. |
|  | **Dr. D L VENKATESH BABU, Prof and HOD Dept of Civil/ ACSCE, Bangalore,** B.E (Civil)-Graduated from Bangalore University, in the year 1984 with **First Class With Distinction.** M.E (WRE)- Graduated from Bangalore University, in 1990 in the year with **First Class With Distinction.** Ph.D (Structural Engineering) degree from P.S.G. College of Technology, Coimbatore, Bharthiar University, in the year 2006 with **Highly Commended** for the research work (Sponsored by BRNS, AERB, Mumbai)**Certificate of Merit** was awarded during Nov 1984 for having stood First in batch in B.E Civil Engineering Department. Thirty years of teaching, research and consultancy experience for undergraduate and post graduate students.Ten years of research and consultancy in the areas of civil engineering field. Guided **30 B.E**, **20 M.E** .Project works. **Six PhD (degree awarded)** , **ONE PhD (thesis submitted)**-Anna University, Chennai. |
|  | **Sharmila H C** working as assistant professor in Dr. Sri Shivakumara maha swamy college of engineering from last 5 months, She received is **B E** in **civil engineering** and **M.Tech** with specialization in **CAD structures** from Visvesvaraya technological university. Her research interest is in the field of structural engineering, earth quake engineering construction technology. |