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Soil Stabilization Using Rice Husk Ash and Sugarcane Bagasse Ash

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Abstract: ***Soil stabilization has become a major issue in construction engineering and the researches regarding the effectiveness of using industrial wastes are rapidly increasing. The present experimental work briefly describes the suitability of the locally available Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SCBA) to be used in the local construction industry in a way to minimize the amount of waste to be disposed to the environment causing environmental pollution. The common soil stabilization techniques are becoming costly day by day due to the rise of cost of the stabilizing agents like, cement, lime, etc. The cost of stabilization may be minimized by replacing a good proportion of stabilizing agent using RHA. It will minimize the environmental hazards also. Addition of rice husk ash and cement decreases the maximum dry density and increases the optimum moisture content.***

Keywords: Black cotton soil, Rice husk ash, Sugarcane bagasse ash, OMC, MDD, CBR.

I. INTRODUCTION

Rice husk is a by-product of the rice milling. About 100 millions of tons of husk per year are produced worldwide. The husk is not suitable as animal feed because of its abrasive character and almost negligible digestible protein content , its high ash and lignin contents make it unsuitable as a raw material for paper manufacturing. In order to reduce such volume of waste, rice husk is burned either in open heaps or as a fuel in ovens for rice drying, power generation, etc. The burning volatilizes the organic com- pounds and water of the rice husk, and about 20% of the mass remains as rice husk ash (RHA)If all rice husks had been burned, it would annually produce about 20 millions of tons of RHA worldwide. To value this residue is an alternative to its final disposition with environmental benefit. Soil stabilization is the process of increasing or maintaining the stability of a soil mass which results in improving the engineering properties of soil. One of the methods of stabilizing soil is the use of special stabilizers such as lime, cement, bitumen and other chemicals. Soils which are free from organic matter usually show a significant improvement on stabilization with cement. This stabilization with cement is used where great strength is not needed. The most important property required is durability, which is the resistance to cycles of wetting and drying. Strength and durability has been found to go together. It is therefore much simpler to test specimens for compressive strength rather than durability.

II. MATERIALS

A. Black Cotton Soil

The Black Cotton Soil used in experimental work was brought form countryside field of Hingna Nagpur. The Properties of Black Cotton Soil are as shown in table below.

Table1 - Properties of Black Cotton Soil

Properties	Value
Specific gravity	2.35
Liquid limit	50%
Plastic Limit	28.67%
Plasticity Index	21.53%
Maximum Dry Density	1.71g/cc
Optimum Moisture Content	18.9%

The oxide composition of RHA is shown in Table:

Table2-Oxide composition of RHA

Constituent	Compositon%
Silicon Oxide(SiO2)	75.2
Aluminium Oxide(Al2O3)	5.2
Iron Oxide(Fe2O3)	1.02
Calcium Oxide(Cao)	1.4
Magnesium Oxide(MgO)	1.75
Loss on Ignition	15.43

Fig:Rice Husk Ash

The oxide composition of SCBA is shown in Table:

Table3: Oxide composition of SCBA

Constituent	Compositon%
Silicon Oxide(SiO2)	70.87
Aluminium Oxide(Al2O3)	9.12
Iron Oxide(Fe2O3)	4.87
Calcium Oxide(Cao)	8.84
Magnesium Oxide(MgO)	3.25
Potassium(K2O)	3.05

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III. LITERATURE REVIEW

1) Sonoo Kumar, RP Singh, SK Paswan(2022)

There are about 20% black cotton soil areas in India. It is one of the most problematic soils with a high tendency to shrink or swell due to water content changes. When it comes into contact with water, the volume of the soil increases and decreases when water evaporates or loses its touch. Because of the unpredictable nature of this soil, it is not easy to construct or use such land properly without proper treatment because it provides different settlements that pose risks to constructed structures.

2) F Hidalgo, J Saavedra, C Fernandez, G Duran(2020)

This document studies the stabilization of the soil used as a subgrade, by adding locally available materials such as rice husk ash (RHA) and sugarcane bagasse ash (SCBA). These aggregates were added to the soil in substitution by weight between 5%, 7.5% and 10%. By adding these, the expansiveness is reduced while the maximum dry density increases, in addition the tendency of CBR is increasing and then tends to decrease proportionally to the addition of the aforementioned aggregates. This indicates a peak in CBR and expandability. The best result obtained from CBR was 33.75% with the 5% replacement mixtures.

3) Vishal Ghutke, Pranita Bhandari, Vikash Agrawal(2018)

A large part of central India and a portion of south India is covered with black cotton soils.
These soils are residual deposit formed from basalt and trap rocks. These soils quite suitable for growing cotton. Black cotton soils are clays of high plasticity. The soils have high shrinkage and swelling characteristics. The shearing strength and bearing capacity of the soils is extremely low. To avoid these circumstance, soil must be stabilized, and strength should be high. RHA is a fibrous residue of the rice that remains after incineration of rice husk gives the ash. The chemical analysis on rice ash was found to contain mainly silica, potassium, iron, calcium, magnesium, aluminum. when RHA mix with black cotton soil by mass in proportion of 4%, 8%, 12%, 16%. And then geotechnical properties are evaluated.

4) BHJ Pushpakumara, WSW Mendis(2022)

Soils containing significant levels of silt or clay generally exhibit unacceptable engineering properties (i.e. low strength, high compressibility and high level of volumetric changes) when exposed to variation in moisture content. Chemical stabilizers such as cement and lime which are currently practiced, are often high-priced and unhygienic in terms of environmental sustainability. The prevailing study intended to explore the potential of the local Rice Husk Ash (RHA) which is an agricultural waste, with lime as a soil stabilizer.

5) Mubashir Aziz, Masood Saleem, Muhammad Irfan(2015)

The rapid urbanization in Pakistan is creating a shortage of sustainable construction sites with good soil conditions. Attempts have been made to use rice husk ash (RHA) in concrete industry of Pakistan, however, limited literature is available on its potential to improve local soils. This paper presents an experimental study on engineering properties of low and high plastic cohesive soils blended with 0-20% RHA by dry weight of soil.

6) Bello Afeez Adefemi, Awogboro Samuel Olufemi(2014)

The results of a laboratory investigation on the influence of four compactive efforts namely Reduced British Standard Light (RBSL), British Standard Light (BSL), West African Standard (WAS) and British Standard Heavy (BSH) on the engineering properties of Lateritic soil stabilized with rice husk ash (RHA) derived from Osun State University main campus, Osogbo, Osun State, Southwestern Nigeria has been presented

7) AJ Choobbasti, H Ghodrat, MJ Vahdatirad, S Firouzian, Amin Barari, M Torabi, A Bagherian(2010)

This paper aims to investigate the influence of adding rice husk ash on the reaction between soil and lime and lime reaction and determine soil physical and mechanical characteristics. Therefore, sufficient laboratory soil tests, such as Atterberg limits, compaction, California bearing ratio (CBR), and direct shear test are carried out, and the results are analyzed

IV. METHOD OF TESTING

The laboratory tests carried out first was on the natural soil which include Particle size distribution, Atterberg limits, Compaction, CBR. The geotechnical properties of the soil are determined in accordance with Indian Standard [8].

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 and SCBA, 10%, 15% and 20% are mixed with soil in three different tests. 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 of soil.

1) The pulverized soil sample was first sieved through the required sieve for a particular test.
2) The required quantum soil was weighed out for the test.
3) The material to be added to the soil was also sieved through the required sieve, for the particular test and then the required quantum was weighed out on the weight basis as per the percentage to be added to the soil for test.
4) Then, black cotton soil was kept in oven for removing moisture content and drying at 110°C temperature for 24hrs is done. Then the agricultural waste ash is also kept in oven for maintaining the dry form of the ash.

V. RESULT AND DISCUSSION

Specific gravity

Soil+%RHA,SCBA	Specific gravity
5	2.26
10	2.24
15	2.22

Liquid Limit

Soil+%RHA,SCBA	Liquid Limit
5	70.1
10	68.63
15	66.67

Plastic Limit

Soil+%RHA,SCBA	Plastic Limit
5	42.45
10	41.52
15	40

Standard Proctor test

Soil+%RHA,SCBA	MDD
5	1.65
10	1.63
15	1.64

CBR Test

Soil+%RHA,SCBA	CBR value
5	1.40
10	2.01
15	2.32

Fig: CBR Apparatus

VI. CONCLUSION

1) The Specific Gravity of soil is decreases with increase in RHA and SCBA .
2) Liquid limit in soil First increases up to 5% and then decreases with increase in proportion of RH and SCBA.
3) Plastic limit in soil first increases up to 5% RHA and then decreases with increase in proportion of RHA and SCBA.
4) MDD Decreases with increase in proportion of RHA and SCBA.
5) CBR Value Increases up to 15% RHA and SCBA and then decreases hence at mixing 15% RHA and SCBA strength is maximum.

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[7] Maninder Singh, R Sharma, A AbhishekInternational Research Journal of Engineering and Technology 4 (9), 589-596, 2017The safe disposal of both hazardous and nonhazardous waste becomes a problematic for the civil engineers. This is because only few states are able to dump these wastes emanate from industries safely.
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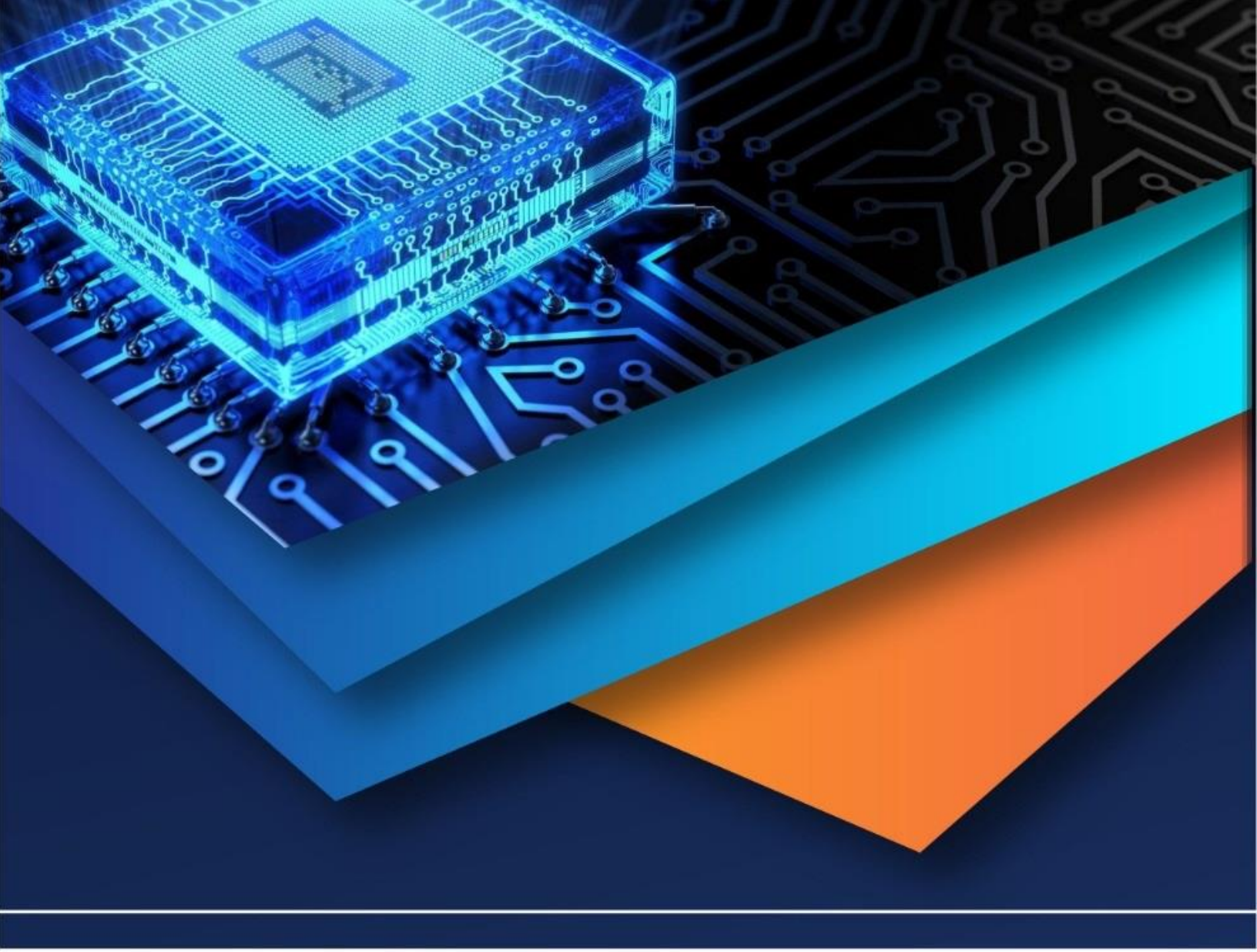

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