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Experimental Investigation for Stabilizing Soil using Rice Husk Ash

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***Abstract*— Many State of India and A portion part of Karnataka is covered with Laterite soils. It is characterized by its distinctive reddish-brown to yellow-brown color and its high clay content. Laterite soils are High water-holding capacity, Resilience to erosion, Iron and aluminum content, Nutrient availability challenges, and Adaptation to specific crops.**

Laterite soil is known for its high clay content, and plasticity and demonstrates significant shrinkage and swelling characteristics. The shearing strength and bearing capacity of the soils are very low. The high clay content and low permeability of laterite soil hinder water infiltration and lead to waterlogging, affecting plant growth and construction activities. To avoid this circumstance, soil must be stabilized, and strength should be high. RHA is a fibrous residue of the rice that remains after the incineration of rice husk gives the ash.

Rice husk Ash acts as a binding agent, forming cementitious compounds with the soil particles and enhancing their cohesion and stability. The chemical analysis of rice husk ash revealed significant concentrations of silica, potassium, iron, calcium, magnesium, and aluminum. When RHA mix with Laterite soil by mass in proportions of 5%, 10%, 15%, 20%. And then geotechnical properties are evaluated.

RHA's chemical ingredients improve Nutrient sources, Soil pH adjustment, Soil structure enhancement, Soil amendment for heavy clay soils, Pest and disease management, and Sustainable waste utilization.

***Keywords*— Laterite soils, Rice husk ash, California Bearing Ratio (CBR), Atterbag Limits, Soil stabilization**

I. INTRODUCTION

Laterite soil is a distinct soil type that is formed through a process known as lateralization. It is mostly found in tropical and subtropical regions with high temperatures and heavy rainfall. Laterite soil is characterized by its unique properties, composition, and formation process, making it a subject of interest for various scientific studies and applications.

The formation of laterite soil involves the weathering of parent materials, such as basalt or other volcanic rocks, over long periods of time. The intense heat, high humidity, and prolonged exposure to rainfall accelerate the weathering process, leading to the development of laterite soil. This soil type is typically reddish-brown to yellowish-brown in color, owing to the presence of iron and aluminum oxides.

Laterite soil is also called "expansive soil because of its low fertility, drainage issues, erosion susceptibility, and difficulty in excavation and construction. Expansive soil is very difficult to be used in construction.

Laterite soil is called also Expansive soil because of Low fertility, Drainage issues, Erosion susceptibility, and Difficulty in excavation and construction. Expansive soil is very difficult to be used in construction. While laterite soil has good water-holding capacity, it can also experience rapid moisture loss due to its permeability and susceptibility to drying and shrinkage. This can result in challenges for moisture-sensitive crops and may require supplemental irrigation to maintain adequate soil moisture levels.

The hot climate and inadequate drainage conditions prevalent in these soil formations contribute to their moisture-related challenges. During the monsoon and summer seasons, evaporation hampers surface moisture retention. Consequently, these soils exhibit a cyclic swell-shrink behavior, low strength, high moisture content, volume changes, and differential settlement. Such soil vulnerabilities can lead to pavement cracking, surface distress, rutting, and foundation instability. To address these issues effectively, proper treatment and stabilization techniques are crucial to mitigate these soil-related challenges.

Rice Husk Ash (RHA) is an agricultural waste generated during the rice milling process in our country. Globally, approximately 120 million tons[1] of rice husk are generated annually. Rice husk contains a significant amount of silica, ranging from 85% to 98% [2] of its composition. The silica present in rice husk is in an amorphous form, making it a valuable pozzolanic material. Silica is naturally found in rice husk in an amorphous form, rendering it a valuable pozzolanic material. On average, it has been estimated that 1000 kg of rice yields 150 kg of rice husk, ash, and about 82% silica content. The ash is obtained by subjecting the rice husk to a temperature of approximately 600°C for 24 hours through combustion. Because of its amorphous structure, the silica in rice husk ash combines with calcium hydroxide (CaOH). This reaction generates heat and leads to the formation of cementitious compounds.

II. MATERIALS USED

The materials used in this investigation are laterite soil and rice husk ash.

Laterite soil:

The laterite soil sample used for this study was collected from a local area at Harholli, Banglore, in Karnataka, India, at a depth of 1.5m to 2.5m using the method of disturbed sampling.
The overall geotechnical properties of the soil are classified as clay with high plasticity (CH) in the Indian Standard Soil Classification System (IS) Soil Classification System.
The properties of laterite soil are shown in the table below.

Table -1: Properties of Laterite Soil

Properties	Value
Specific gravity	2.57
Liquid Limit	53 %
Plasticity Index	21.76%
Plastic Limit	31.52%
Maximum Dry Density	1.75g/cc
Optimum Moisture Content	19%

2. Rice husk ash: -

Rice husk ash is obtained from the burning of rice husk. The husk is a by-product of the rice milling industry. The RHA used in this study is collected from the Kanakapur rice mill in Bengaluru, Karnataka.

Table -2: The basic constituent of RHA

Constituents (%mass)	Percent Content
Fe2O3	0.23
SiO2	90.11
CaO	1.68
Al2O3	2.44
MgO	0.56
Carbon	2.19
KaO	0.41

III. METHODOLOGY

The laboratory tests were carried out first on the Laterite soil,which include liquid limit, plastic limit, plasticity index, specific gravity, and compaction.

A series of laboratory tests were conducted on natural soil mixed with Rice Husk Ash in various percentages. 5%, 10%, 15%, and 20% by weight of dry soil. For the above different proportions, tests are carried out to observe the changes in the properties of soil. maximum dry density and optimum moisture, plastic limit, and liquid limit.

For the determination of Atterberg's Limits, 120 grams of natural soil samples were weighed and passed through a 425 Micron sieve. Accordingly, the mixing proportion (RHA) was weighed using a weighing balance and mixed with natural soil. Similarly, for other proportions, the same procedure was followed. The weight of Natural Stabilization of soil by using rice husk ash Recent Innovation & Challenges in Civil Engineering.

Laterite soil was Soil weighed for determination of Liquid Limit. The same amount of natural Soil was taken for the determination of the Plastic Limit of our research.

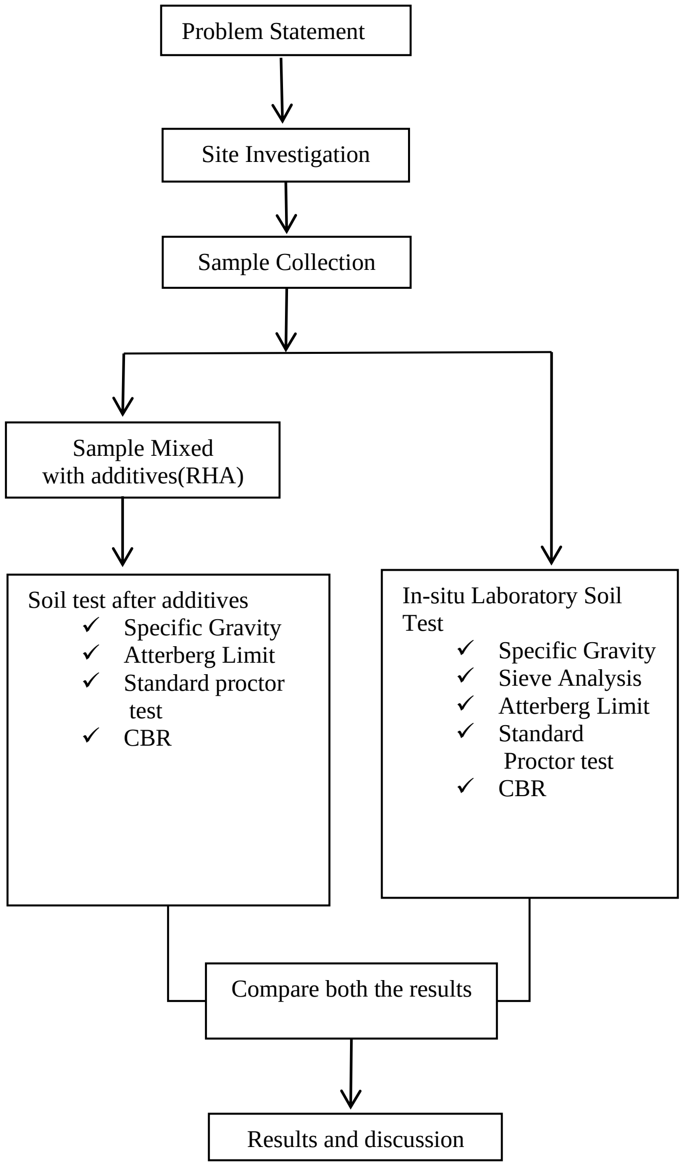

Fig : Flow chart Methodology

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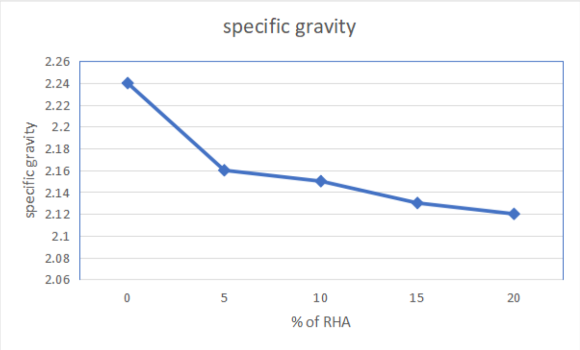
IV. RESULTS AND DISCUSSIONS :

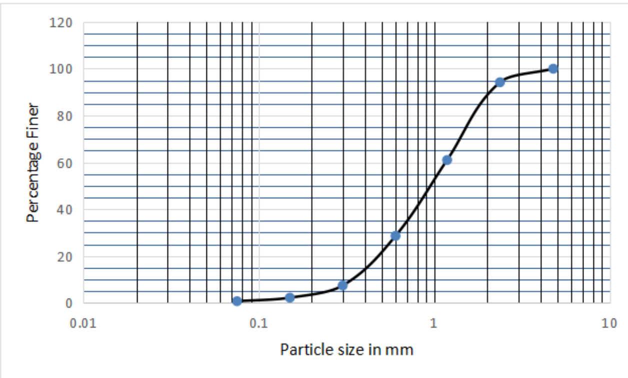
3.1 Specific gravity

Soil+%RHA	Specific gravity
0	2.24
5	2.16
10	2.15
15	2.13
20	2.12



3.2.Grain Size Analysis:

IS Sieve size in (mm)	Mass Soil Retained (gm)	Cumulative mass soil retained (gm)	Cumulative soil retained in (%)	Cumulative % finer (N) (100%-of soil retained)
4.75	67	67	12.8	88.4
2.36	78	138	27.2	74.2
1.18	119	258	49	39.1
0.6	57	341	56.7	32
0.3	12	420	71	14
0.15	48	430	88.4	5
0.075	16	482	98.3	3.4
Pan	15	498	99.9	0.5



Coecfficient of Curvature = 1

Coefficient of Uniformity= 7.71

Hence,therefore soil is well graded and coarse grained

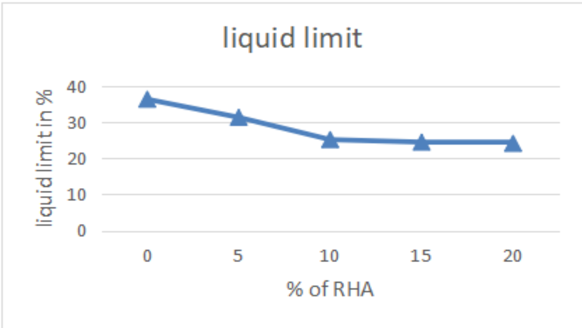
3.3.Atterbag Limits:

Atterberg Limits such as Liquid Limit, Plastic Limit and Plasticity Index were determined for laterite soil with varying proportions of Rice husk ash. For determination of Atterberg's Limits, 120 grams of Laterite soil sample was weighed passing 425 Micron sieve. Accordingly mixing proportion (RHA) was weighed using a weighing balance and was mixed with Laterite soil. The same procedure was followed for other proportions as well The weight of Laterite Stabilization of soil by using rice husk ash Recent Innovation & Challenges in Civil Engineering. Natural Soil weighed for determination of Liquid Limit. Same amount of Laterite soil was taken for determination of the Plastic Limit.

V. RESULT

Liquid Limit:

Description	Liquid Limit (%)
Soil alone	36.50
Soil+5% RHA	31.46
Soil+10%RHA	25.27
Soil+20%RHA	24.57
Soil+30%RHA	24.22



Plastic Limit:

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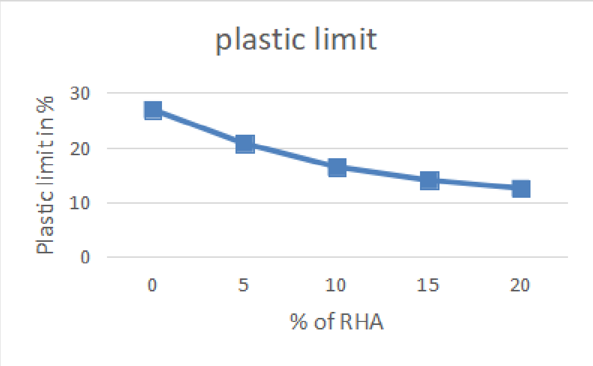
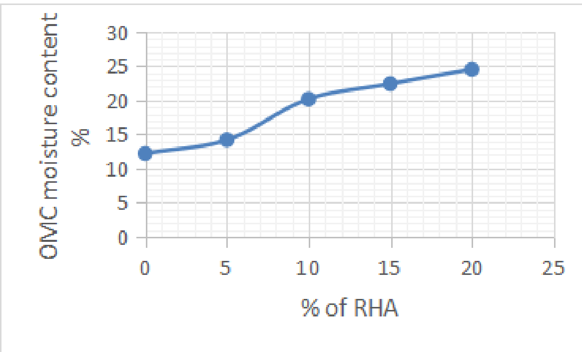
Soil+%RHA	Plastic limit
0	26.93
5	20.73
10	16.43
15	14.03
20	12.53



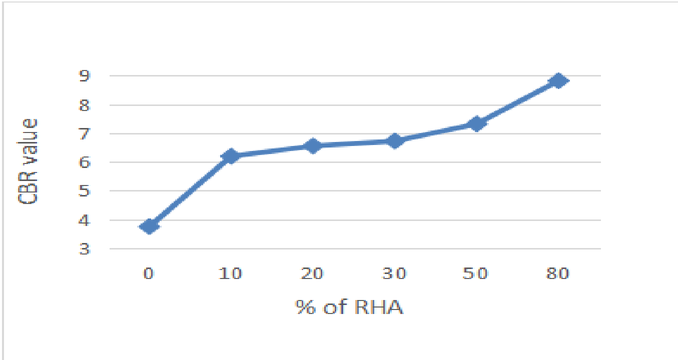
3.4. Standard Proctor Test:

Description	OC %	MDD in(g/cc)
Soil alone	12.21	2.23
Soil+5% RHA	14.21	2.22
Soil+10% RHA	20.18	2.19
Soil+15% RHA	22.43	2.1
Soil+20% RHA	24.53	2.02



3.5. Cbr Test:

Soil + % of RHS	CBR value
Soil + 0%	0.673
Soil + 5%	1.78
Soil + 10%	2.010
Soil + 15%	2.42
Soil+ 20%	1.78



VI. CONCLUSION

In conclusion, this study aimed to explore the effectiveness of rice husk ash (RHA) as a stabilizing agent for laterite soil. A multitude of significant findings were derived from a comprehensive series of laboratory experiments.

❖Firstly, the addition of RHA in varying proportions demonstrated a significant improvement in the soil's engineering properties.

❖The tests revealed increased compressive strength, reduced plasticity index, and enhanced durability of the stabilized soil samples.

❖ The Specific Gravity of the soil decreases as the proportion of rice husk ash (RHA) increases.

❖ Coefficient of Curvature = 1, Coefficient of Uniformity= 7.71, Hence, therefore soil is well graded and coarse grained

❖ Liquid limit in soil First increases up to 5% and then decreases with increase in proportion of RHA.

❖ The plastic limit in soil exhibits an initial increase up to a 5% proportion of rice husk ash (RHA), followed by a subsequent decrease with further increments of RHA content.

❖ As the proportion of rice husk ash (RHA) increases, the maximum dry density (MDD) of the soil decreases. ❖ CBR Value Increases up to 15% RHA and then decreases hence at mixing 15% RHA strength is maximum. These results indicate that RHA can be successfully employed as a viable and eco-friendly alternative for soil stabilization.

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