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Behavior of Clayey Soil Stabilized with Rice Husk Ash & Lime (Review)

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ABSTRACT:
Soil stabilization is gaining popularity among the construction engineers and geotechnical engineering researchers due to the low land to population ratio in India. As the huge quantity of RHA produced by local industry has to be disposed off safely in order to have a minimum impact on the environment. Use of RHA for geotechnical purposes may prove to be a suitable technique for the pollution free disposal of RHA. 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 pozzolanic material in soil stabilization. However, rice husk ash cannot be used solely since the materials lack in calcium element. As a result, rice husk ash shall be mixed with other cementitious materials such as lime and cement to have a solid chemical reaction in stabilization process. Lime is calcium oxide or calcium hydroxide. In this research work the percentage of lime used was 3%, 6%, 9% and that of RHA were 5%, 10% and15%.

KEYWORDS: Clayey soil; Lime; Rice Husk Ash (RHA); Unconfined Compressive Strength (UCS).

1. INTRODUCTION: Soil improvement could either be by modification or stabilization or both. Soil modification is the addition of a modifier (cement, lime etc.) to a soil to change its index properties, while soil stabilization is the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification. Over the times, cement and lime are the two main materials used for stabilizing soils. Soil is the basic construction material. It supports the load coming over due to the construction of super structure and in case of roads the sub grade supports the sub base/ base course in the pavement. Soil generally consisting of water, air and solid particles and it is formed due to the integration of rocks. The soil at a particular site may not be suitable for the construction due to its low bearing capacity and higher compressibility or even sometimes unnecessary swelling in case of expensive soils. In such situations improvement of soil at a location is necessary due to increasing cost of the land and vast demand of high rise buildings. Keeping in view the above stated problems, geotechnical researchers are trying to evolve some cost effective ground improvement techniques by using industrial wastes and agricultural wastes like rice husk ash, fly ash and blast furnace slag etc. however, on relative scale, the use of rice husk ash has found only limited research.

Clayey soils are known as problematic soils from engineering point of view. The behavior of clayey soils when subjected to load depends upon its mineral composition and its effective size which is

less than 2µ. Surface activity is very high due to the presence of crystalline minerals in clayey soil. They have poor shear strength and may also lose shear strength further due to wetting or other physical disturbances. Some type of clayey soil expands when exposed to moisture. The clay mineral montmorillonite is largely responsible for swelling characteristics of the soil. Black cotton soil is expensive soil and when moisture content of soil decreases, it shrinks and cracks are developed. These cracks may further travel deep into the ground. These types of soils are not fit for construction work. Change in volume in expensive soils depends upon the variation of moisture content. Now a days geotechnical engineers cannot afford to change the site due to the presence of problematic soils and hence the improvement of existing soils deposit is the only option.

In case of clayey soils which exhibit swell and shrink behavior and are compressible if saturated, following techniques are normally used for a viable solution.

- Replacement of the clayey soil:- If the soil is less expensive and it has a shallow depth and replaced it with granular soils.
- The clayey soil can be stabilized with cement and lime.
- The moisture variation of soil can be controlled with the help of moisture barriers and impervious membranes can be installed to stop flow of water.

Rice husk is a by-product of agro industry and is obtained through milling of rice. It is reported that one ton rice husk is produced from every four ton of rice. World produced approximately 500 million tons rice in every year and Asian farmers produced approximately 90% rice of total production. China and India produced more than half of total crop. The rice husk produced during the milling is normally used as a fuel in the industry. After burning rice husk in boilers as a fuel, the residual as poses a serious problem during its disposal. After burning the rice husk produced about 15%-20% of its weight as ash. Rice husk ash is very light weight and it easily carried by water and wind hence contributing to environmental pollution. The large quantity of rice husk ash produced requires huge areas for disposal. Due to presence of high percentage of siliceous material, rice husk ash shows pozzolonic properties.

Lime as an additive, brings numerous valuable changes in the engineering properties of soil. When lime is added in soil as an additive, it decreases soil plasticity and swell shrink potential apart from improving strength properties. Generally lime is calcium hydroxide or calcium oxide. These materials are extremely used in construction work from an ancient time. Stabilization of soil by lime is attained through cation exchange, lime carbonation, flocculation and pozzolanic reaction. The quick lime is more effective than hydrated lime as a stabilizer. Lime stabilization is not efficient for sandy soils. Some materials like RHA, fly ash reacts with lime and can further improve the engineering properties of clayey soil.

2. MATERIAL USED:

A. Soil: Soil sample is collected from a proposed for the construction of road alignment in guduvanchery area, Chennai. The soil was hand sorted to remove any pebbles and vegetative matter. The soil was oven dried for 24 hours at 105ºC before using it for experimental work.

Table No.1: Physical properties of soil

Sr. no.	Properties of soil	Results
1	Liquid limit	36.5%
2	Plastic limit	24.89%
3	Plasticity index	11.61%
4	Classification of soil	CI
5	Specific gravity	2.23
6	MDD kg/cm^3	1.797
7	OMC %	15.15%
8	UCS (Kg/cm^2)	0.624

B. Rice Husk Ash: Rice husk ash, basically a waste material, is produce by rice - mill industry while processing rice from paddy. Rice husk ash is a pozzolanic material that could be potentially used in soil stabilization, though it is moderately produced and readily available. RHA has a good pozzolanic property.

Table No.2: Chemical properties of RHA

Sr. no.	**Component**	**%**
1	Silica (SiO2)	83.60
2	Alumina (Al2O3)	3.5
3	Iron Oxide (Fe2O3)	1.10
4	Sodium(NA2O)	0.17
5	Lime (CaO)	1.80
6	Magnesia Oxide (MgO)	1.28
7	Potassium (K2O)	0.29

C. Lime: Locally available lime was used in this study.

3. RESULTS AND DISCUSSIONS:

1. UCS test results: UCS test was conducted in laboratory on soil sample with addition of different percentages of lime and RHA and the results obtained are shown in table no 3 and the figures 1 & 2 shows the graphs for UCS. Figure 1 shows the UCS value for different percentages of lime and figure 2 shows the UCS value for different percentages of RHA.

Table no. 3.UCS test results on soil samples.

UCS Value (Kg/ cm^2)			
Additives	4 days	7 days	14 days
3% Lime	2.33	5.32	6.46
6% Lime	4.55	6.26	8.62
9% Lime	1.66	3.69	4.50
5% RHA	2.24	3.29	4.06
10% RHA	3.34	4.55	6.14
15% RHA	1.78	2.75	3.14

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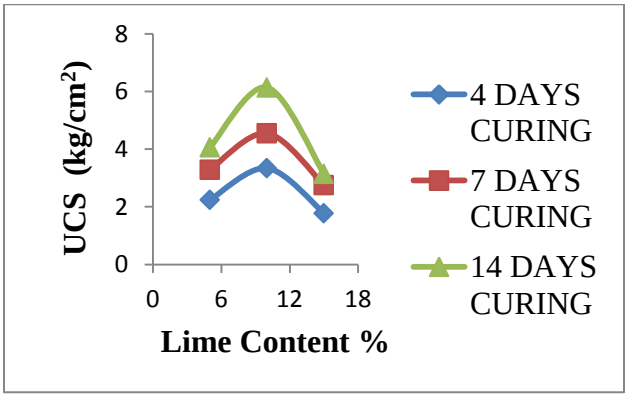

Figure1. Combined graph showing UCS of soil for different proportions of lime at 4, 7 and 14 days curing period.

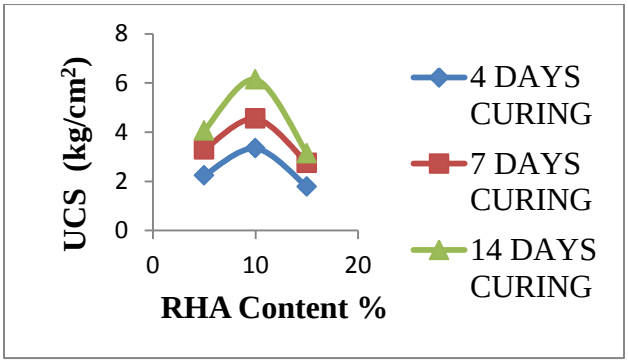

Figure2. Combined graph showing UCS of soil for different proportions of RHA at 4, 7 and 14 days curing period.

Discussions: From the results obtained from unconfined compressive strength test, it was observed that for virgin soil unconfined compressive strength was 0.624 kg/cm^2. The effect of addition of lime and RHA on UCS is shown in table no. 3. The results shows that UCS increases with addition of lime content upto 6% in soil at 4, 7 and 14 days curing period. The results shows that UCS increases with addition of RHA content upto 10% in soil at 4, 7 and 14 days curing period. Further addition of RHA does not contribute much towards strength and it may be due to low specific gravity of RHA.

4. CONCLUSIONS:

1. Based on the UCS value comparison, 6% addition of lime showed the good improvement of 92.74% in UCS value for 14 days curing compared to virgin soil and for 10% of RHA with 89.93% for a same period of curing. Unconfined compressive strength increases with increase in curing period. When RHA used as substitute or partial replacement along with lime in stabilizing clayey soils, it more economical for construction and solving the disposal problems by utilizing the RHA.

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