Effect of Rice Husk Ash on the Engineering properties of Silty Clay

Anusree G*, Chippy R Prasad*, Ganesh G S*, Godley Thomas*, Gokul S V*, Lopa Syam*, Prasanth S#

Abstract— This paper studies the variations in the index and engineering properties of silty clay on usage of lime and rice husk ash as stabilizing agents. A number of laboratory experiments were conducted on silty clay soils and RHA modified soil mixes. Lime was used as the main stabilizing agent and RHA proportions were varied as 5, 10, 15, and 20% of the lime content used for stabilization. The test results show that RHA in combination with lime can be used as an economic and eco friendly stabilizing agent giving a significant improvement in the index and engineering properties of soil.

Index Terms— Lime , Rice husk ash, soil stabilization, unconfined compressive strength, compaction, silty clay, index properties

1 Introduction

THE rapid industrialization and urban development has lead to a scenario where we are in short of land for constructional activities. Hence we are forced to construct our buildings and structures on the available land, which may not have the required engineering properties. The construction of a structure on a weak soil deposit is the major constraint faced by geotechnical engineers as the soil deposit will have low shear strength and high compressibility which can cause excessive settlements for structures constructed over it. Pile foundations prove to be a very uneconomical solution for small structures for which an improvement of soil properties is just required. This emphasizes the need for soil stabilization in context to constructions over weak and soft deposits.

Commonly adopted methods for soil stabilisation are adding stabilizing agents to soil. Cement, Lime etc are the common stabilizing agents used. In this study, lime is used as the stabilizing agent. Lime stabilization can be very well applied to cohesive and weak soil deposits, but the cost of stabilisation increases as lime is not a waste product. Rice husk ash is a waste product that can cause environmental pollution and this can be used in conjunction with lime for stabilisation.The incorporation of Rice husk ash for soil stabilisation helps to reduce the overall cost of stabilisation, provides a better way for disposing the waste product etc. Ricehusk ash also has pozzolanic properties which can help in binding particles together and makes the overall stabilization process economical. In this study, a significant portion of the lime used for stabilisation of soil was replaced by Rice husk ash and the effect of rice husk ash on the geotechnical properties of soil was studied. Rice husk ash was replaced in varying percentages of 5, 10, 15 and 20% of the total lime content used for stabilization. It was found out that Rice husk ash can be used as an economic stabilizing agent in conjunction with lime for stabilizing weak soil deposits.

* *Under graduate students in civil engineering, UKF College of Engineering & Technology, Kollam, Kerala*
# *Assistant Professor in Civil Engineering, UKF College of Engineering & Technology, Kollam, Kerala. E-mail: prasaniththejus@gmail.com*

2 Soil Stabilization Using Lime and RHA

Lime is a very good stabilizing agent which chemically reacts with soil and improves its strength. Quick lime when added to soil reacts with water present in pores to form slaked lime, there by removing excess pore water pressures. Calcium inos present in lime replaces the sodium and potassium ions of clay minerals, thereby chemically modifying the soil and makes it more stable. Also due to the alkaline medium generated by the addition of lime to soil, silicates and aluminates from clay minerals undergo dissolution. This reacts with calcium ions and form pozzolanic compounds which bind the particles together and impart strength to soil.

Rice husk is an agricultural waste obtained from milling of rice. Every year approximately 120 million tones of paddy is produced in India. This gives around 24 million tones of rice husk that is about 20% of paddy produced. On burning 17-25 percentage of rice husk is converted into ash. That is more than 4.4 million tones of rice husk ash (RHA) is produced in every year in India. RHA consist of 80-90% of silica, and the silica content will be more if it is burned under high temperature. Large silica content in rice husk ash makes it a good pozzolanic material and can be used for soil stabilization. The use of RHA in soil stabilisation also gives a good method of disposal of Rice husk ash which can otherwise cause environmental pollution.

3 Materials Used

The materials used for the study were soil, Lime, Rice husk ash and water. The properties of different materials were tested which are discussed in the following sections

3.1 Soil

The soil sample used for study was collected from Chathanoor area in Kollam district. The clayey soil was white in colour and soil was taken from a depth of around 2 to 4m from ground surface. The properties of the soil are given in Table 3.1

TABLE 3.1
PROPERTIES OF SOIL

Properties	Results
Specific Gravity	2.62
Consistency limits	
Liquid limit LL	63
Plastic limit PL	37
Plasticity index PI	26
Particle size distribution	
Sand(%)	18
Clay (%)	60
Silt (%)	22
Compaction characteristics	
Max dry density (g/cc)	1.6
OMC (%)	24

3.2 Lime and Rice husk Ash

Powdered Quick lime available from local market was used for this study. Rice husk Ash was prepared by burning the rice husk obtained. Uncontrolled burning was done on rice husk to make it ash

4 METHODOLOGY

The soil collected from the field was air dried, pulverized and sieved through various sizes to perform the various laboratory tests. Optimum lime content was determined on the basis of literature surveys. It was found from most of the literatures that optimum lime content for stabilisation was between 2 to 7%. A pH test was conducted using the collected soil sample and varying percentages of lime to determine the optimum lime content. The optimum lime content was found to be around 4%, which matched with the literature surveys. Then Rice husk ash was added in varying percentages (5, 10, 15, 20% of the total lime content in soil) to partially replace lime. Tests were carried out on unstabilised soil, lime stabilized soil and RHA modified lime stabilized mixes to determine the optimum replacement level of lime with rice husk ash. The various tests conducted were standard proctor compaction and unconfined compressive strength test, all in accordance with IS 2720 recommendations.

5 RESULTS AND DISCUSSIONS

The most important property for a weak soil deposit is its shear strength which gives a measure of the load it can take before it fails. The shear strength value is of utmost importance when any construction work is being carried out over the soil. Compaction characteristics were also determined to study the effect that RHA produces on soil.

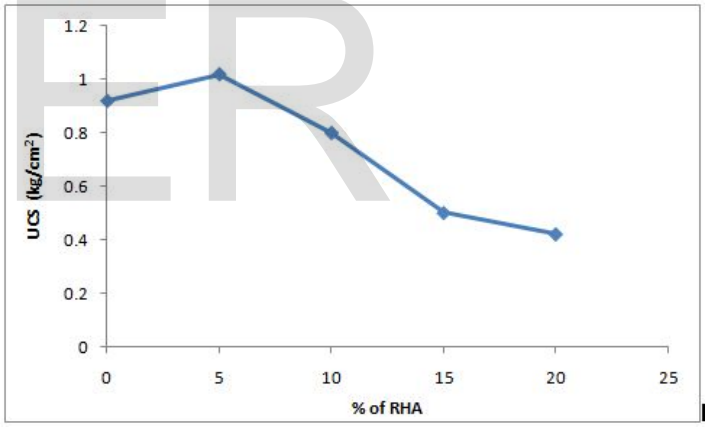
5.1 Unconfined Compressive Strength

In order to arrive at variations in shear strength, unconfined compressive strength test was carried out on untreated and lime and rice husk ash modified soils. The test was carried out after the specimen was moist cured for 28 days. Curing is important for the hydration reactions to ocuur to give full strength to soil. The results of the test are shown in table 5.1 and figure 5.1. It was found out that the unconfined compressive strength increases on addition of lime. A small replacement of lime by RHA was found to give better strength. As the RHA % increases, there is a reduction in strength, which can be very well understood by the fact that RHA is not that effective a stabilizing agent when compared to lime. When smaller quantities of lime are replaced by rice husk ash, sufficient quantity of lime is still present in soil to improve the strength and this in combination with the pozzolanic activity of rice husk ash was found to give better strength. The optimum dosage of Rice husk ash was found to be around 10%, above which replacement of lime by rice husk ash significantly reduces the strength.

TABLE 5.1
UNCONFINED STRENGTH OF SOIL SPECIMENS

% Lime	% RHA	UCS (kg/cm²)
Untreated soil	0	0.36
4	0	0.92
3.8	5	1.02
3.6	10	0.8
3.4	15	0.5
3.2	20	0.42

Fig 5.1: Variation of unconfined compressive strength with



RHA

5.2 Compaction Characteristics

Compaction test was carried out in accordance to IS 2720 provisions on untreated as well as lime modified RHA mixes. The results obtained are shown in table 5.2. It was found that the dry density decreases with increase in rice husk ash content and the OMC increases with increase in percentage of rice husk ash. The decrease in dry density on addition of rice husk ash is due to the low specific gravity of rice husk ash when compared to soil. The increase in Optimum moisture content mat can be attributed to fact that more moisture is requird for chemical reactions to occur.

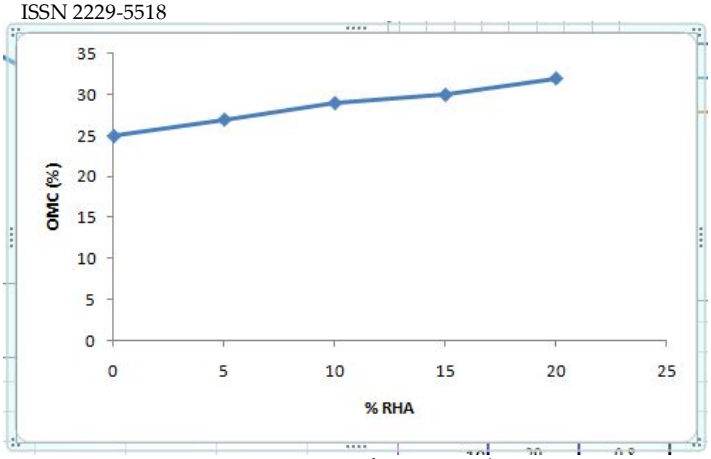


Fig 5.2: Variation of OMC with % RHA

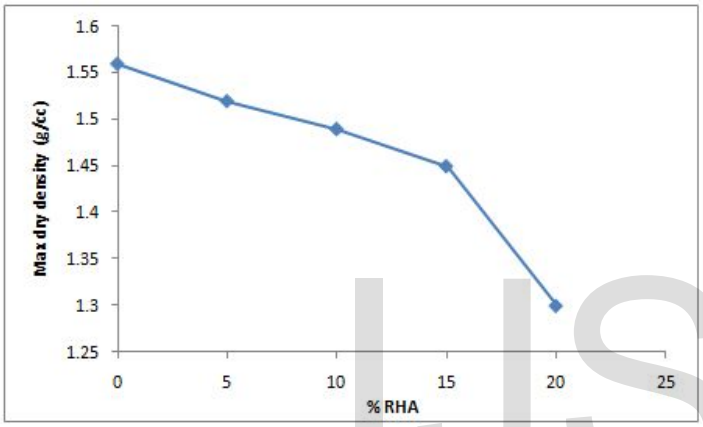


Fig 5.3: Variation of MDD with RHA

TABLE 5.2
COMPACTION CHARACTERISITCS OF SOIL SPECIMENS

Soil Mix	MDD (g/cm^3)	OMC (%)
Untreated soil	1.57	24
Soil + Lime	1.56	25
Soil + Lime + 5% RHA	1.52	27
Soil + Lime + 10% RHA	1.49	29
Soil + Lime + 15% RHA	1.45	30
Soil + Lime + 20% RHA	1.30	32

6 CONCLUSIONS

The main objective to use RHA is to reduce the burden of waste material which can be very effectively done by use it as a soil stabilizer by partially replace the soil with lime. RHA can be used very effectively in the backfilling with soil as well as making the subgrades of the roads as it is being lighter in weight and if lime can be added, it will have a water proofing property as well. The maximum dry density and optimum moisture content of RHA – soil mix decreased and increased respectively as the RHA content increased in soil. The curing period of the mix may be a governing parameter as the hydration of lime is depended on it. So it is expected that as the curing period increased, the strength will be increase which may be another investigation parameter. Lime and rice husk ash mixtures enhanced the compressive and tensile strength of the soil up to 4 times. The shear strength of the soil increase by addition of the lime or rice husk ash mixture. The results of the study revealed that 5% replacement of Lime by rice husk ash not only makes the stabilisation economical but also improves the strength of soil

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