Experimental Study of Clayey Soil with Lime and Rice Husk Ash

B Kanddulna[#1], N Kisku[*2], K Murari[#3]J P Singh[*4]

[#1]*Lecturer, G P Dumka, (M Tech Student)*
[*2]*Assistant Professor, Department of BIT Sindri, Dhanbad*
[*3]*Associate Professor, Department of BIT Sindri, Dhanbad*
[*4]*Associate Professor, Department of BIT Sindri, Dhanbad*
Jharkhand, INDIA

Abstract

Clay soil is highly typical soil because it undergoes differential settlement, poor shear strength and high compressibility .For this the most effective and economical methods to improve clayey soil is addition of stabilizing agents such as lime or rice husk ash (RHA). It is essential to improve load bearing capacity of clayey soil, for taking more load. In this study, highly plastic clay was stabilized by using lime and rice husk ash (RHA).The present investigation has been carried out with agricultural waste materials like Rice Husk Ash (RHA) and cheaply available lime is mixed with clayey soil improvement of weak sub grade in terms of compaction and strength characteristics. In this investigation lime and rice husk ash (RHA) is added 5%, 10% 15% and 20% by weight of soil. The main objective of this investigation is to access cheaply availability of lime and rice husk ash for improving engineering property of clayey soil for making capable of taking more load form structure to foundation. In this experimental investigation, the stabilizer reduces the MDD 1.382 to 1.325 g/cm^3 with lime and rice husk ash reduces MDD 1.382 to 1.330 g/cm^3. The investigations show optimum strength at 15 % of lime and 15% of rice husk ash (RHA). OMC of clayey soil increases from 22% to 25.8% with lime and 25.5.with RHA

Keywords— *Clayey Soil, Lime, Rice Husk Ash (RHA)*

1. Introduction

Clay soil often possess poor strength characteristic and pose serious construction problem causing large differential settlement to the structure constructed over them. Since Clayey soil exhibit high swelling and shrinkage when exposed to change in moisture content and hence found to be most troublesome from engineering considerations. This behaviour is due to presence of a mineral montmorillonit, Kaolinite and Illite but mostly due to montmorillonit. Sometimes, it is not possible to avoid clayey soil in such sites because of non-availability of alternative locations having good load bearing capacity. The stabilization of clayey soil in such location is required by using various admixtures so that the strength of subgrade characteristic of soil can be improved. Stabilization can be achieved by using either by pozzolanic material or chemicals. The fly ash, rice husk ash (RHA) construction demodulation waste (C&D), bagasse ash, saw dust ash and ground granulated blast furnace slag(GGBS) are some pozzolanic materials which can be used in stabilization of clayey soil. Lime, cement, calcium chloride, sodium chloride, sodium silicate, calcium carbide and lime sludge are some chemicals used in stabilization of soil. However, the previous works with RHA and Lime has shown that it is promising potential of improving engineering properties of soil for subgrade purpose. Thus this work focused on investigating the effect of RHA and Lime on some geotechnical properties of clayey soil which are relevant for evaluating the performance of subgrade soil.

2. MATERIALS USED AND METHODOLOGY

2.1. Soils

The soil used in this study was obtained from Baliapur, Near BIT Sindri, Dhanbad,. The soil sample was collected carefully.The clays were collectedatadepthofabout0.5.to 2.5 m. The disturbed soil was excavated, placed in plastic bags, and transported to the laboratory for testing. Laboratory tests were carried out to classify each type of soil. The engineering properties of clayey soils are presented in Table-1.

2.2. Lime

For this practical purpose the lime used is commercially available lime, available in the market. Lime found in the form of quicklime (calcium oxide – CaO), hydrated lime (calcium hydroxide – Ca[OH]2. it can be used to treat soils. Quicklime is manufactured by chemically transforming calcium carbonate (limestone – CaCO) into calcium oxide. Hydrated lime is created when quicklime chemically reacts with water. It is hydrated lime that reacts with clay particles and permanently transforms them into a strong cementitious matrix. Most lime used for soil treatment is “high calcium” lime. On some occasions, however, "dolomitic" lime is used. Dolomitic lime contains 35 to 46 percent magnesium oxide or hydroxide. Dolomitic lime can perform well in soil stabilization, although the magnesium fraction reacts more slowly than the calcium fraction. The chemical properties of lime are presented in Table-2.

2.3 Rice Husk Ash

Rice milling generates a byproduct known as rice husk. During milling of paddy about78% of weight is, received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. The rice husk ash was collected from Maithon Dhanbad, Jharkhand, India. The rice husk ash used in this study was prepared by burning at the temperature within the range of600 ^{0}C to 800 ^{0}C at approximately 48 hours. Its appearance in colour was grey. The specific gravity of Rice Husk Ash (R.H.A).is founded 2.04.ThechemicalpropertiesofRHAarepresentedinTable-3

Soil Sample

Used Lime

Used RHA

TABLE - 1

ENGINEERING PROPERTIES OF SOIL

Parameter	Values
Specific Gravity	2.30
Optimum Moisture Content (%)	22.00
Maximum Dry Density(g/cm^3)	1.382
Liquid Limit (%)	58.00
Plastic Limit (%)	23.00
Plasticity Index (%)	35.00
California Bearing Ratio(CBR)	2.46
Unconfined Compressive Strength(Kg/cm^2)	1.20
Permeability(cm/s)	2.8 X10^{-6}

TABLE - 2

CHEMICAL PROPERTIES OF LIME

Constituent	Chemical Formula	Composition
Calcium oxide	CaO	75.77
Magnesium oxide	MgO	3.70
Ferric Oxide	Fe_2O_3	0.16
Aluminium Oxide	Al_2O_3	0.12
Silicon dioxide	SiO_2	0.31
Sulphur trioxide	SO_3	0.02
Chlorine	Cl	0.04
Potassium oxide	K_20	0.03
Manganese Oxide	MnO	< 10

TABLE – 3

CHEMICAL COMPOSITION OF RHA

Constituent	Chemical Formula	Composition (%)
Silicon dioxide	SiO_2	88.32
Aluminium Oxide	Al_2O_3	0.46
Ferric Oxide	Fe_2O_3	0.67
Calcium oxide	CaO	0.44
Magnesium oxide	MgO	0.12
Disodium trioxide	Na_2O_3	2.91
Potassium oxide	K_2O	5.81

TABLE -4

RESULTS OBTAINED FROM GRAIN SIZE DISTRIBUTION

Clay & Silt	Fine Sand	Medium Sand	Coarse Sand	Gravel
Less than 0.075 mm	Above 0.075 and below 0.0475 mm	Above 0.0475	Above 2.0 and below 4.75 mm	Above 4.75 and below 80 mm
89.5(%)	1.9(%)	5.5 (%)	0.20(%)	0.30(%)

GRAPH OF GRAIN SIZE DISTRIBUTION

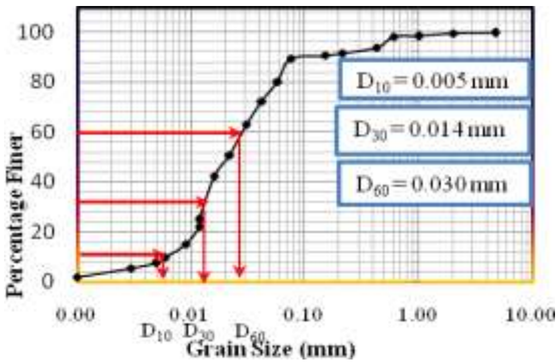

Fig.1. Grain size distribution curve

C_c, Cu and liquid limit of soil gives that soil is inorganic clays with high plasticity.

WORKING PROCEDURE

For experimental work three series of clayey soil were taken and observed their behaviour for MDD, OMC, LL, PL, CBR values, Permeability and Unconfined Compression Test.

1. Series-1Claysoil
2. Series-2ClaySoil+Lime(Different Percentages)
   - 2.1 Claysoil+5 % Lime
   - 2.2 Claysoil+10 % Lime
   - 2.3 Claysoil+15 % Lime
   - 2.4 Claysoil+20 % Lime
3. Series-3ClaySoil+Lime(Different Percentages)
   - 3.1 Claysoil+5 % RHA
   - 3.2 Claysoil+10 % RHA
   - 3.3 Claysoil+15 % RHA
   - 3.4 Claysoil+20 % RHA

3. RESULTS AND DISCUSSIONS

3.1 Compaction Test Results with lime& RHA

Tests are carried out to know the behaviour of clayey soil with various percentages of lime. To study the behaviour of soil, experiments are conducted with 5%, 10%, 15% and 20% lime by dry weight of soil

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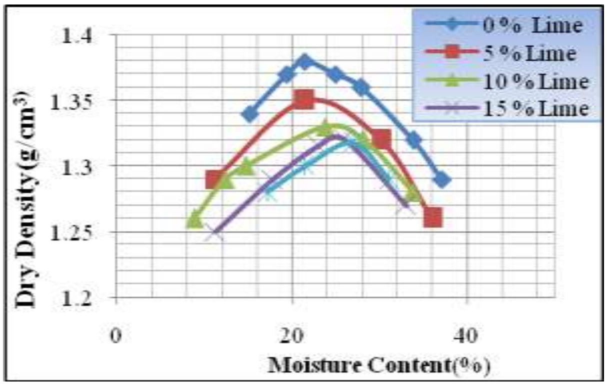

Fig. 2. Compaction graph with Lime

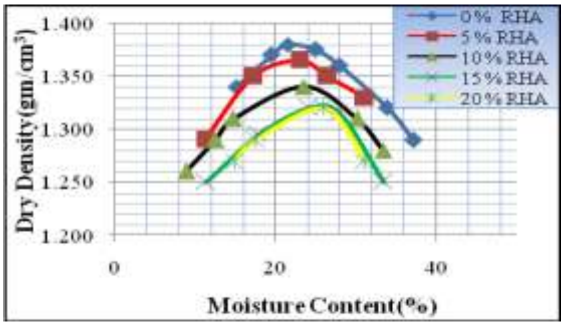

Fig.3. Compaction graph with RHA

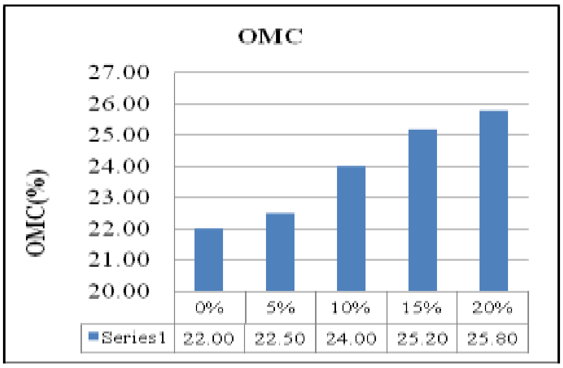

Fig. 4 -Variation of OMC with various percentages of lime

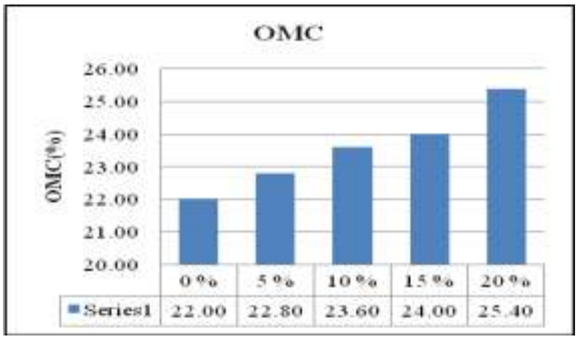

Fig. 5 -Variation of OMC with various percentages of RHA

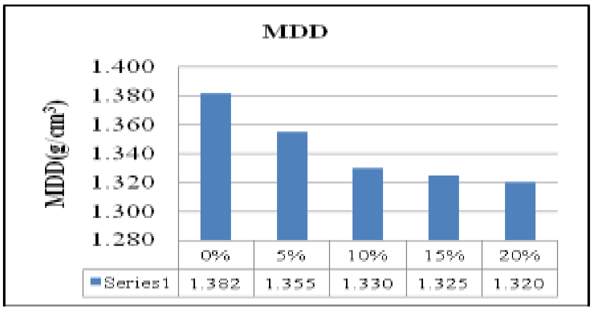

Fig. 6 -Variation of MDD with various percentages of lime

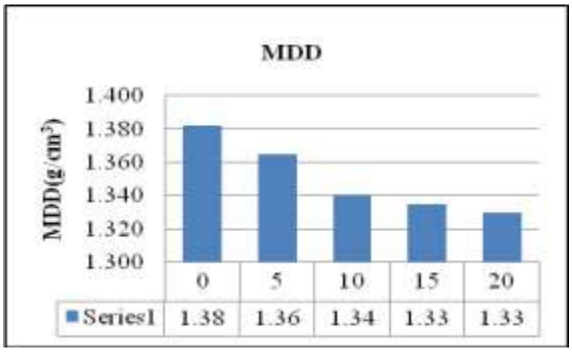

Fig. 7-Variation of MDD with various percentages of RHA

Fig.-4 and Fig. 5 shows that the optimum moisture (OMC) of clayey soil increases with the addition of lime and RHA up to 20 % and Fig.-6 and Fig. 7 shows that the maximum dry density (MDD) of clayey soil decreases with the addition of lime and RHA up to 20 %.

3.2 Atterberg Limits with lime& RHA

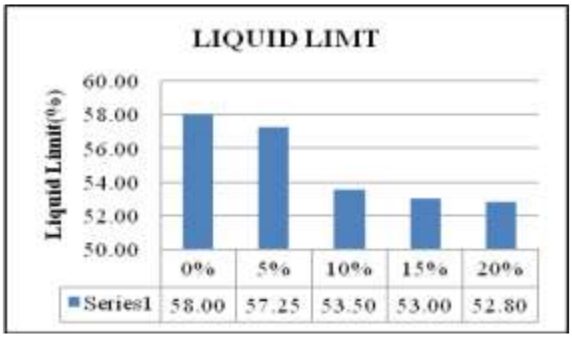

Fig. 8 - Variation of Liquid Limit with various percentages of lime

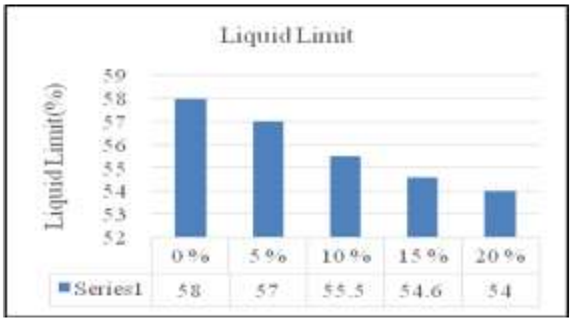

Fig. 9- Variation of Liquid Limit with various percentages of RHA

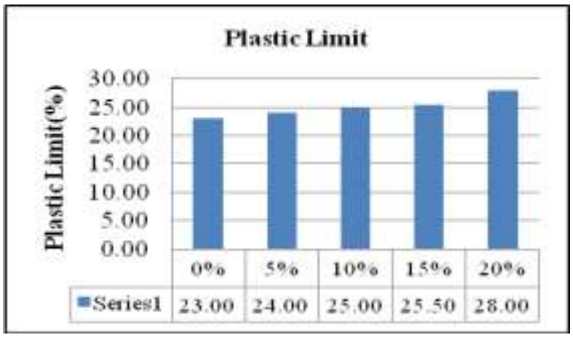

Fig.10- Variation of Plastic Limit with various percentages of lime

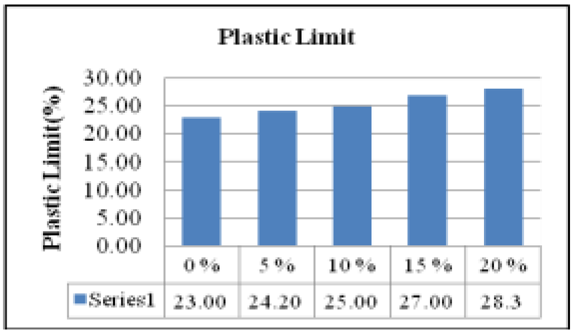

Fig.11 - Variation of Plastic Limit with various percentages of RHA

Fig.-8 and Fig. 9 shows that the Liquid Limit (LL) of clayey soil decreases with the addition of lime and RHA up to 20 % and Fig.-10 and Fig. 11 shows that the Plastic Limit (PL) of clayey soil increases with the addition of lime and RHA up to 20 %.

3.3 C.B.R. Test

This study was conducted on soil samples with various percentages of lime and RHA. This experiment determines C.B.R. percentage of soil-lime and soil RHA mixtures and natural soils with 5%, 10%, 15%and 20% lime and RHA.

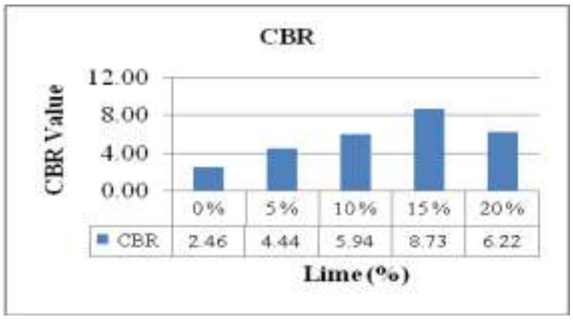

Fig.12 - Variation of CBR value with various percentages of lime

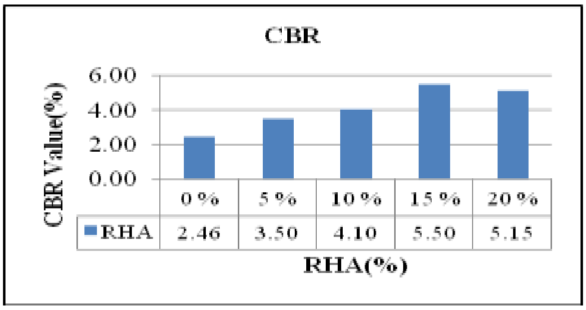

Fig.13 - Variation of CBR value with various percentages of RHA

The experimental results shows in Fig. 12 and Fig .13with lime and RHA respectively Fig. 12 and Fig .13 shows that CBR value increases with addition of Lime and RHA upto 15 % Lime and 15 % RHA.

3.4 Permeability Test

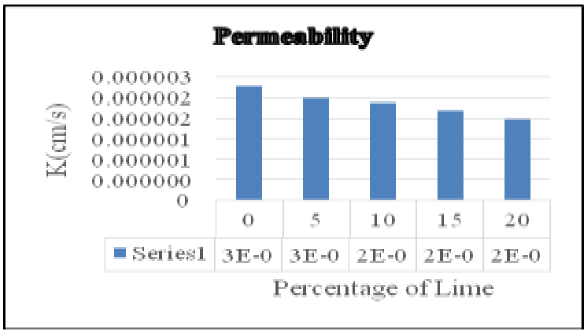

Fig. 14- Variation of permeability with various percentages of lime

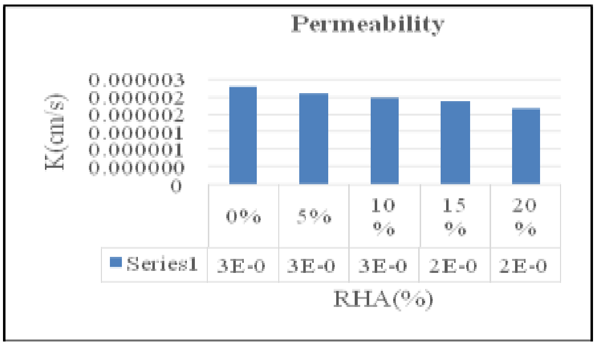

Fig -15 Variation of Permeability value with various percentages of RHA

The experimental results show in Fig. 14 and Fig .15with lime and RHA respectively Fig.14 and Fig .15 shows that Permeability decreases with addition of Lime and RHA.

3.5 Specific Gravity

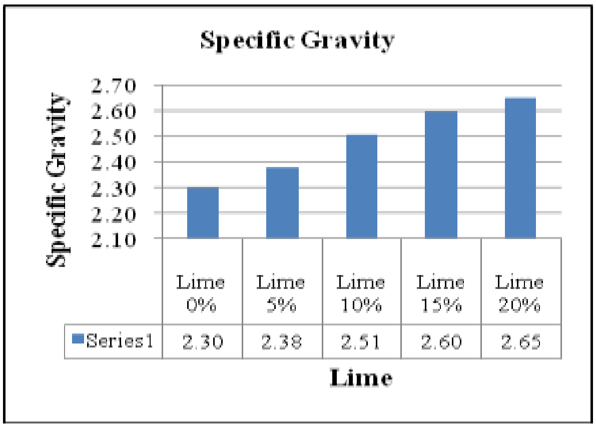

Fig -16 Variation of Specific Gravity with various percentages of lime

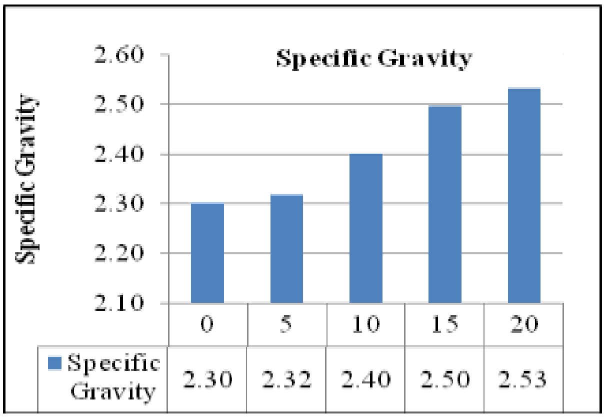

Fig -17 Variation of Specific Gravity with various percentages of RHA

The experimental result shows in Fig. 16 and Fig .17with lime and RHA respectively Fig.16 and Fig .17 shows that specific gravity increases with addition of Lime and RHA.

3.6 Unconfined Compressive strength0

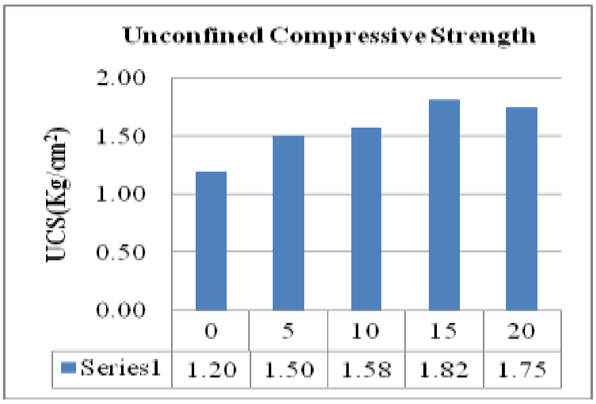

Fig. -18 Variation of UCS with various percentages of lime

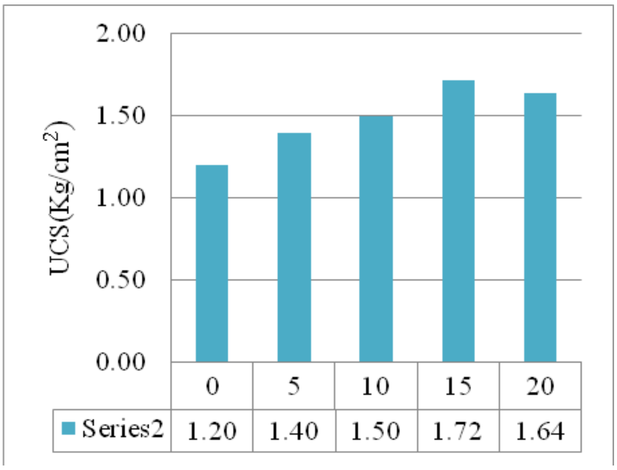

Fig. -19 Variation of UCS with various percentages of percentages of RHAT

The experimental results shows in Fig. 18 and Fig .19 with lime and RHA respectively Fig.16 and Fig .17shows that UCS increases with addition of Lime and RHA upto 15 %.

TABLE –5

Experimental Test Results with Lime

Materials	**Compaction**		**Atterburg Limit**			**CBR (Unsoaked)**	**UCS Kg/cm^2**	**Permeability (K) cm/s**	**Specific Gravity (G)**
	OMC (%)	**MDD (g/cc)**	**LL (%)**	**PL (%)**	**PI**				
C+L 0%	22.00	1.382	58.00	23.00	35.0	2.46	1.20	2.8 x10^{-6}	2.30
C+L5%	22.50	1.350	57.25	24.00	33.25	4.44	1.50	2.5 x10^{-6}	2.38
C+L10%	24.00	1.330	53.50	25.00	28.5	5.94	1.58	2.4 x10^{-6}	2.51
C+L15%	25.20	1.325	53.00	25.50	27.5	8.73	1.82	2.2 x10^{-6}	2.60
C+L20%	25.80	1.320	52.80	28.00	24.8	6.22	1.75	2.0 x10^{-6}	2.65

TABLE –5

Experimental Test Results with RHA

Material	**Compaction**		**Atterberg Limit**			**CBR**	**UCS Kg/cm^2**	**Permeability (K) cm/s**	**Specific Gravity**
	OMC (%)	**MDD (g/cc)**	**LL (%)**	**PL (%)**	**PI (%)**				
C+RHA 0%	22.0	1.382	58.00	23.0	35.0	2.46	1.20	2.8 x10^{-6}	2.30
C+RHA 5%	22.8	1.365	57.00	24.2	32.8	3.50	1.40	2.6 x10^{-6}	2.32
C+RHA10%	23.6	1.340	56.50	25.0	31.5	4.10	1.50	2.5 x10^{-6}	2.40
C+LRHA15%	24.0	1.335	55.50	27.0	28.5	5.50	1.72	2.4 x10^{-6}	2.50
C+RHA20%	25.4	1.330	54.00	28.3	25.7	5.15	1.64	2.2 x10^{-6}	2.53

CONCLUUSIONS

The following conclusions are drawn on the basis of test results obtained from experimental results.

1. OMC of soil increases with increase in the percentages of lime and rice husk ash.
2. MDD of clayey soil decreases with increase in the percentages of lime and rice husk ash content in clayey soil.
3. Liquid limit of clayey soil decreases with increase in percentage of lime and rice husk ash.
4. Lime and RHA reduces the plasticity of clayey soil.
5. Specific gravity increases with increase in percentage of lime and rice husk ash in clayey soil.
6. Lime is better stabilizing material than rice husk ash.
7. Permeability of clayey soil decreases with increases in the percentages of lime and rice husk ash.
8. CBR and UCS of clayey soil increases with increase in lime and RHA content upto 15 %. After that the value of CBR and UCS clayey soil decreases.

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