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A Laboratory Study on the Affect of Rice Husk Ash & Lime on the Properties of Marine Clay

Dr. D. Koteswara Rao, G.V.V. Rameswara Rao, P.R.T. Pranav

Abstract* - The soil found in the ocean bed is classified as marine soil. It can even be located onshore as well. The properties of marine soil depend significantly on its initial conditions. The properties of saturated marine soil differ significantly from moist soil and dry soil. Marine clay is microcrystalline in nature and clay minerals like chlorite, kaolinite and illinite and non-clay minerals like quartz and feldspar are present in the soil. The soils have higher proportion of organic matters that acts as a cementing agent. Clay is an impermeable soil, meaning it holds water, as opposed to permeable soil that allows water to rapidly drain, like a gravel or sand. It is also an expansive soil, such as the marine clay which predominates in almost all countries of the world, which when shrinking or expanding, can damage foundations and structures. The shrink and swell movements are due to changes in soil moisture. Providing uniform soil moisture next to and under your foundation is the only best thing to reduce or minimize the damaging effects of expansive soil. Accumulation of various waste materials is now becoming a major concern to the environmentalists. Rice Husk ash is one such by-product from Timber industries and Wood cutting factories. Rice Husk ash by itself has little cementitious value but in the presence of moisture it reacts chemically and forms cementitious compounds and attributes to the improvement of strength and compressibility characteristics of soils. So in order to achieve both the need of improving the properties of marine clays and also to make use of the industrial wastes, the present experimental study has been taken up. In this paper the effect of Rice Husk ash and Lime on strength properties of marine clay has been studied.

Index Terms: **Rice Husk Ash (RHA), OMC, MDD, CBR.**

I. INTRODUCTION

The development of any country depends on the transportation facilities and the construction projects. For the projects to be successful, the soil used for the foundation beds must be strong which requires better soil properties. Expansive soils have the tendency to swell when they come in contact with moisture and to shrink if moisture is removed from them. These volume changes in swelling soils are the cause of many problems in structures that come into their contact or constructed out of them. The expansive soils in India have liquid limit values ranging from 50 to 100 %, plasticity index ranging from 20 to 65 % and shrinkage limit from 9 to 14 %.

A substantial literature has concluded the severity and extent of damage inflicted by soil deposits of selling nature, to various structures, throughout the world (Ganapathy, 1977; Jones and Jones, 1995; Abduljauwad, 1995; Osama and Ahmed, 2002; Zhan, 2007, D. Koteswara Rao 2011). The loss caused due to damaged structures proved the need for more reliable investigation, of such soils and necessary methods to eliminate or reduce the effect of soil volume change.

Many innovative foundation techniques have been devised as a solution to the problem of marine soils. The selection of any one of the techniques is to be done after detailed comparison of all techniques for the well suited technique for the particular system. The various additives used for stabilizing expansive soils are lime, calcium chloride, Rice Husk Ash, fly ash, gypsum and others. All over the world, problems of marine clay have appeared as cracking and break-up of pavements, railway and highway embankments, roadways, building foundations, irrigation systems, water lines, canal and reservoir linings. The estimated damage was very expensive to the pavements running over the marine clay sub grades.

Various remedial measures like soil replacement, pre-wetting, moisture control, chemical stabilization have been practiced with varying degrees of success. Unfortunately the limitations of these techniques questioned their adaptability in all conditions. So work is being done all over, to evolve more effective and practical treatment methods, to alleviate the problems caused to any structures laid on marine clay strata. Investigation on chemical stabilization (Petry and Armstrong, 1989; Prasada Raju, 2001) revealed that electrolytes like potassium chloride, calcium chloride and ferric chloride may be effectively used in place of conventionally used lime, because of their ready dissolvability in water and supply of adequate cations for ready cation exchange.

II. OBJECTIVE OF STUDY

The objectives of the present experimental study are

i. To determine the properties of the Marine clay and Rice Husk Ash.

ii. To evaluate the performance of Marine clay when stabilized with Rice Husk Ash as an admixture and its suitability for the pavement sub grade.

iii. To evaluate the performance of stabilized Marine clay with an optimum of Rice Husk Ash, Lime and their suitability for the pavements.

III.STABILISATION OF MARINE CLAYS

Soil stabilization is a procedure where natural or manufactured additives or binders are used to improve the properties of soils. Chemical additives, such as lime, cement, Rice Husk Ash, and other chemical compounds have been used in marine clays stabilization for many years with various degrees of success. The clay minerals have the property of absorbing certain anions and cations and retaining them in an exchangeable state. The exchangeable ions are held around the outside of the silica-alumina clay mineral structural unit.

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Compositional variation through ionic or isomorphism substitution within the clay mineral crystal lattice can leave the structural unit with a net negative charge. Substitution also reduces the crystal size and alters its shape. Exposed hydroxyl groups and broken surface bonds can also lead to a net negative charge on the structural unit. The presence of this net negative charge means that soluble cations can be attracted or adsorbed on to the surface of the clay mineral structural units without altering the basic structure of the clay mineral. The ability of clay to hold cations is termed as its cation exchange capacity. The most common soluble cations are Na^+, K^+, Ca^{2+}, Mg^{2+}, H^+, and NH_4^+. Cation exchange capacity (C.E.C.) has major significance in determining clay mineral properties, particularly the facility with which they adsorb water. Cation exchange capacity (C.E.C.) measures two of the fundamental properties of clays:

1. The surface area and the charge on this surface area.
2. The surface of clay can be of two sorts; external and internal.

The external exchange capacity measures nothing more than the average crystalline size. The surface capacity of adsorption is largely dependent upon broken bonds and surface growth defects.

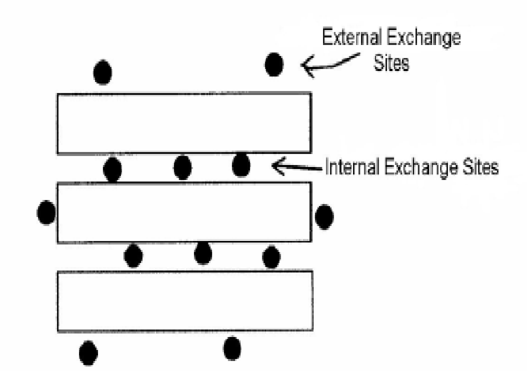

Fig 1: Different Types of Exchange Sites on Clay Particles, Surface and Absorbed Ion Interlayer Sites.

The internal exchange capacity is much more interesting in that it reflects the overall charge imbalance on the layer structure and the absorption capacity of the clays. The exchange capacity is an estimate of both the number of ions adsorbed between the layers of a clay structure and of those adsorbed on the outer surfaces. C.E.C., measured in terms of milli equivalent of the atomic weight of solvent/100 gram of the dry solid, which varies widely for various types of clay minerals.

The exchange capacity is almost always measured as a function of the number of cations (positively charged) which can be measured on the clay surface once it is washed free of exchange salt solution. The operation is performed by immersing a quantity of clay in an aqueous solution containing a salt, usually chloride or ammonium hydroxide. The soluble ions adsorbed with the water onto the interlayer structure can affect the adsorbed water arrangement in several ways. Principally, they act as a bond of varying strength holding the structural layer together and controlling the thickness of adsorbed water. Their effectiveness will depend on the size and charge. Thus Na^+, K^+ will tend to be weak and a clay-water system containing these ions will be capable of adsorbing large amounts of water. Ca^{2+}, Mg^{2+}, on the other hand, will have stronger links and a clay-water system containing them will possess substantially lower water content. Inclusion of Fe^{3+} or Al^{3+} would reduce the water content and plasticity and this is in fact the basis of the electro-chemical or electro-osmotic method of clay stabilization In this study, Granulated Blast Furnace Slag (GBFS), Granulated Blast Furnace Slag-$FeCl_3$ Blends (GBFS-$FeCl_3$) will be utilized as cementitious materials while trying to stabilize the marine clay sample.

IV. RICE HUSK ASH

Rice milling generates a by-product know as husk. This surrounds the paddy grain. During milling of paddy about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75% organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, is known as Rice Husk Ash (RHA). This RHA in turn contains around 85% - 90% amorphous silica. So for every 1000 kg of paddy milled, about 220 kg (22%) of husk is produced, and when this husk is burnt in the boilers, about 55 kg (25%) of RHA is generated. India is a major rice producing country, and the husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion and/ or by gasification. An about 20 million tone of RHA is produced annually. This RHA is a great environmental threat causing damage to the land and the surrounding area in which it is dumped. Lots of ways are being thought of for disposing them by making commercial use of this RHA.

Fig 2: Rice Husk Ash

Table 1: Physical Properties of Rice Husk Ash

S. No	PROPERTY		VALUE
1	Grain size distribution(percent finer than)	4.75 mm	100
		2.0 mm	96
		0.6 mm	80
		0.425 mm	50
		0.21 mm	29
		0.075 mm	8

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2	SPECIFIC GRAVITY	2.01

Table 2: Chemical Properties of Rice Husk Ash

CONSTITUENTS	Composition
SiO_2	86 %
Al_2O_3	2.6%
Fe_2O_3	1.8%
CaO	3.6%
MgO	0.27%
Loss in ignition	4.2%

V. USES OF RICE HUSK ASH

A. As a stabilizer

The Rice Husk Ash would appear to be an inert material with the silica in the crystalline form suggested by the structure of the particles, it is very unlikely that it would react with lime to form calcium silicates. It is also unlikely that it would be as reactive as Rice Husk Ash, which is more finely divided. So Rice Husk Ash would give great results when it used as a stabilizing material.

B. In lightweight fill

The ash would appear to be a very suitable light weight fill and should not present great difficulties in compaction, provided its initial moisture content is kept within reasonable limits (say less than 50%). The very high angle of internal friction of the material will mean that its stability will be high. However, its lack of cohesion may lead to problems in construction due to erosion and shearing under heavy rollers. To overcome these it will probably be desirable to place a 3 to 6 inch thick blanket layer of cohesive material every 2 to 3 ft.

C. Other uses

The low density of the compacted Rice Husk Ash over a wide range of moisture contents, coupled with small pore size and high permeability should make the material very suitable as a final filter for water supply. Un-burnt Rice Hull might be used as a first stage filter. Because of their cheapness, both materials could be replaced frequently if necessary. The low compacted Rice Husk Ash would suggest its use in light weight concrete.

D. Lime

Lime, chemically known as, Calcium oxide (CaO), commonly known as quicklime or burnt lime, is a widely used chemical compound. It is a white, caustic, alkaline crystal solid at room temperature.

Fig 3: Lime

Properties of lime

- Lime is a white amorphous solid.
- It has a high melting point of 2600°C.
- It is highly stable and even fusion cannot decompose it.

E.Chemical Properties

- On hydration, quick lime forms slaked lime or lime water. When water is added to lime it becomes hot and cracks to form a white powder. This is called slaking of lime.

$$CaO + H_2O \longrightarrow \underset{\text{slaked lime}}{Ca(OH)_2}$$

- Calcium oxide is a basic oxide. It can react with acids to give calcium salts.

$$CaO + \underset{\text{sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{calcium sulphate}}{CaSO_4} + H_2O$$

- With acidic oxides like silicon dioxide and phosphorus pent oxide, it forms silicates and phosphates. This property makes lime useful as a flux in metallurgy to remove impurities.

$$CaO + SiO_2 \longrightarrow \underset{\text{calcium silicate}}{CaSiO_3}$$

$$3CaO + P_2O_5 \longrightarrow \underset{\text{calcium phosphate}}{Ca_3(PO_4)_2}$$

Lime is routinely used as a soil modification agent to improve the performance of sub grade soils with the primary goal of reducing volume change. Effective mixing of lime and soil is critical to ensuring that the expected improvements occur throughout the soil mass. Lime also decreases the apparent amount of fines in a soil by causing flocculation and agglomeration of the clay particles (Little 1995). This results in an increase in the percentage of sand and silt size particles as measured by standard grain size distribution methods (Basma and Tuncer 1991.Lime also tends to reduce the swell potential of fine grained soils (Kennedy et al 1987). Moisture content plays an important role in the swell potential of a lime treated soil; soils with moisture content below optimum show a much greater swell potential than soils with moisture content above optimum (Sweeney et al 1988).

It is found that soils with a significant amount of montmorillonite developed almost no increase in unconfined compressive strength. They concluded that most of the lime was used to break down the montmorillonite and the montmorillonite also had too great of a surface area for the cementitious compounds to significantly affect the strength.

F. Double layer theory

A Double Layer (DL, also called an Electrical Double Layer, EDL) is a structure that appears on the surface of an object when it is placed into a liquid. The object might be a solid particle, a gas bubble, a liquid droplet, or a porous body. The DL refers to two parallel layers of charge surrounding the object. The first layer, the surface charge (either positive or negative), comprises ions adsorbed directly onto the object due to a host of

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chemical interactions. The second layer is composed of ions attracted to the surface charge via the Coulomb force, electrically screening the first layer. This second layer is loosely associated with the object, because it is made of free ions which move in the fluid under the influence of electric attraction and thermal motion rather than being firmly anchored. It is thus called the diffuse layer.

The quick lime is more effective as stabilizer than the hydrated lime, but the latter is safer and convenient to handle generally the hydrated lime is used. It is also known as slaked lime. The higher the magnesium content of the lime, the less is the affinity for the water and the less is the heat generated during mixing. Lime stabilization is not effective for sandy soils however these soils can be stabilized in combination with clay, fly ash and other pozzolanic materials. Annual worldwide production of quicklime is around 283 million metric tons. China is by far the world's largest producer, with a total of around 170 million metric tons per year. The United States is the next largest with around 20 million metric tons per year.

VI. LABORATORY STUDIES

Table 3: Differential Free Swell

S. No.	Degree of expansion	DFS
1	Low	< 20%
2	Moderate	20 - 35%
3	High	35 – 50%
4	Very High	>50%

PROPERTIES OF MARINE CLAY

Visual characteristics of soil

The following properties were observed from visual classification in dry condition.

Colour -- Black colour
Odour -- Odour of decaying vegetation
Texture -- Fine grained

VII. MATERIAL USED

A. Marine Clay

The soil used in this study is marine clay, obtained from Kakinada Sea Ports Limited, collected at a depth of 1.5m from ground level. The Index &Engineering properties of marine soil are determined as per IS code of practice and determined & presented in table 4.

B. Rice Husk Ash

Locally available Rice Husk Ash was used in the present work. The physical properties are determined and presented in Table 5.

C. Lime

Commercial grade lime mainly consisting of 58.67% CaO and 7.4% Silica was used in the study.

VIII. PROPERTIES OF MARINE CLAY

The soil was initially air dried prior to the testing. The tests were conducted in the laboratory on the marine clay to study the behaviour of marine clay, when it was untreated, treated (with chemicals, GBFS and reinforcement techniques) for the modal flexible pavements and also for the foundation soil beds.

The following tests were conducted as per IS Codes of practice.

i. The grain size distribution
ii. Index properties –Liquid Limit, Plastic Limit, Shrinkage Limit
iii. Swell Tests- Differential Free swell, Swell Pressure
iv. Strength tests- California bearing ratio

D. Visual characteristics of soil

The following properties were observed from visual classification in dry condition.

Colour -- Black colour
Odour -- Odour of decaying vegetation
Texture -- Fine grained
Dry strength -- medium
Dylatancy -- Less Sluggish
Plasticity --Highly plastic
Classification -- Highly Compressible Clay (CH)

Table 4: Physical properties of Marine Clay

S.No	Property		Symbol	Value
1	Gravel			0%
2	Sand			14%
3	Fines	Silt		30%
		Clay		56%
4	Liquid Limit		W_L	74%
5	Plastic Limit		W_P	27%
6	Plastic Index		I_P	47%
7	Shrinkage limit		W_s	12%
8	Soil Classification			CH
9	Specific Gravity		G	2.38
10	Differential Free Swell		DFS	70%
11	Optimum Moisture Content		O.M.C.	36%
12	Maximum Dry Density		M.D.D.	1.27 gm/cc
13	Cohesion		C	12 .20 t/m^2
14	Angle of Internal Friction		ϕ	2.5^0
15	CBR Value (soaked)			1.754 %

IX. PROPERTIES OF RHA

Table 5: Grain Size of Rice Husk Ash

S. No	PROPERTY		VALUE
1	Grain size distribution (percent finer than)	4.75 mm	100
		2.0 mm	96
		0.6 mm	80
		0.425 mm	50
		0.21 mm	29

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		0.075 mm	8
2	SPECIFIC GRAVITY		2.01

Table 6: Constituents & Composition of Rice Husk Ash

CONSTITUENTS	Composition
SiO_2	86 %
Al_2O_3	2.6%
Fe_2O_3	1.8%
CaO	3.6%
MgO	0.27%
Loss in ignition	4.2%

Proctor Compaction Soil and Rice Husk Ash

Compaction tests were conducted to get the OMC and MDD of the mix of different proportions of soil and Rice Husk Ash using standard proctor compaction machine.

Table 7: Optimum moisture content and Maximum Dry Density values of marine clays and Rice Husk Ash

Mix proportion	Water Content (%)	Dry Density (g/cc)
100% Soil	36.00	1.270
85%Soil+15%RHA	27.20	1.430
80%Soil+20%RHA	27.60	1.480
75%Soil+25%RHA	29.93	1.486
70%Soil+30%RHA	27.3	1.430

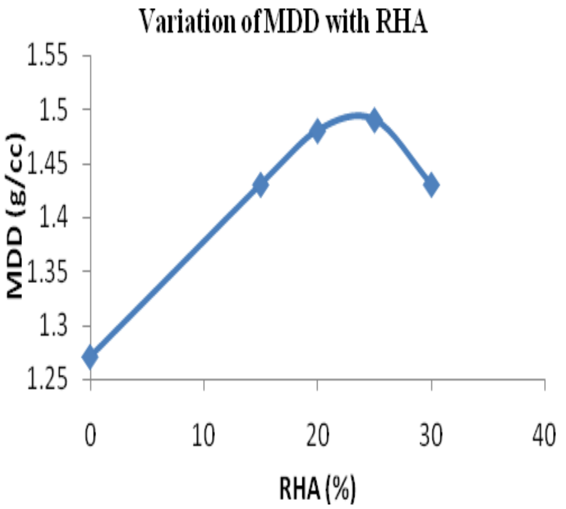

Fig 4: Variation of MDD with Rice Husk Ash content

CBR TEST RESULTS FOR MARINE CLAY WITH RICE HUSK ASH:

The soaked and un soaked CBR values of various mixes of marine clay and Rice Husk Ash using OMC obtained from compaction are determined .the soaked CBR after immersing in water for four days , that is when full saturation is likely to occur, is also determined. Variation of CBR with % variation in Rice Husk Ash is presented.

(1) CBR Curve for 100% soil

The soaked CBR Curve for soil without any admixture and chemical was shown in Fig 5

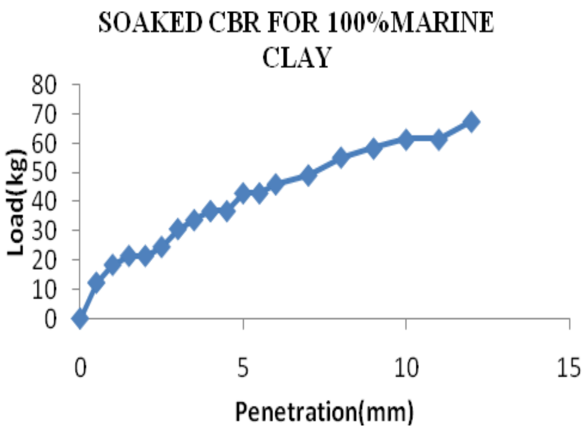

Fig 5 : CBR curve for onlysoil

Soaked CBR value: 1.754%

CBR Curve for 85% soil + 15% Rice Husk Ash

The soaked CBR Curve for soil with 15% RHA was shown in Fig 6

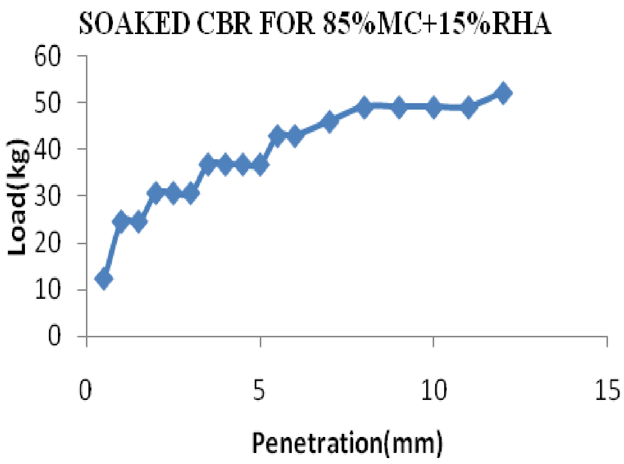

Fig 6 : CBR curve for 85% MC + 15% RHA

Soaked CBR value: 2.240%

CBR Curve for 80% soil + 20% Rice Husk Ash

The soaked CBR Curve for soil with 20% RHA was shown in Fig 7

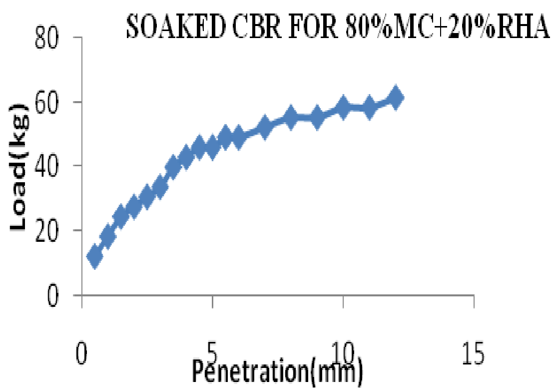

Fig 7 : CBR curve for 80% MC + 20% RHA

Soaked CBR value: 2.460%

CBR Curve for 75% soil + 25% Rice Husk Ash

The soaked CBR Curve for soil with 25% RHA was shown in Fig 8

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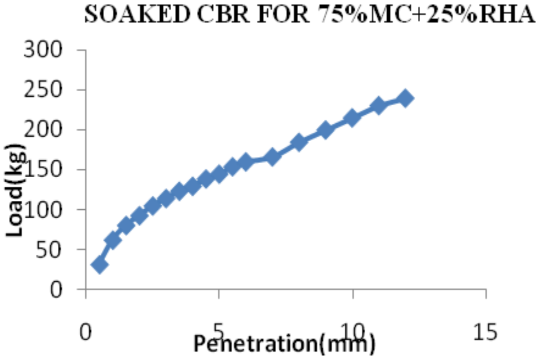


Fig 8 : CBR curve for 75% MC + 25% RHA

Soaked CBR value: 8.290%

CBR Curve for 70% soil + 30% Rice Husk Ash

The soaked CBR Curve for soil with 30% RHA was shown in Fig 9

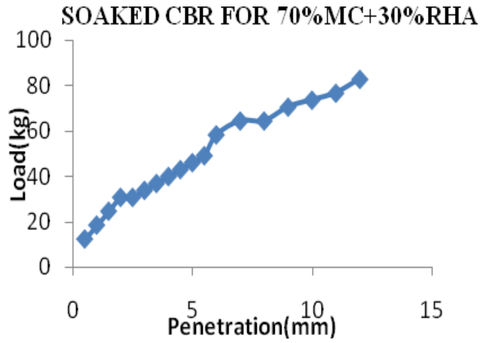


Fig 9 : CBR curve for 70% MC + 30% RHA

Soaked CBR value: 2.460%

Table 8: Variation of soaked CBR values with Rice Husk Ash

Mix proportion	Water Content (%)	Soaked CBR
100% soil	36.00	1.754
85%soil+15%RHA	37.26	2.240
80%soil+20%RHA	36.88	2.460
75%soil+25%RHA	25.71	8.290
70%soil+30%RHA	39.55	2.460

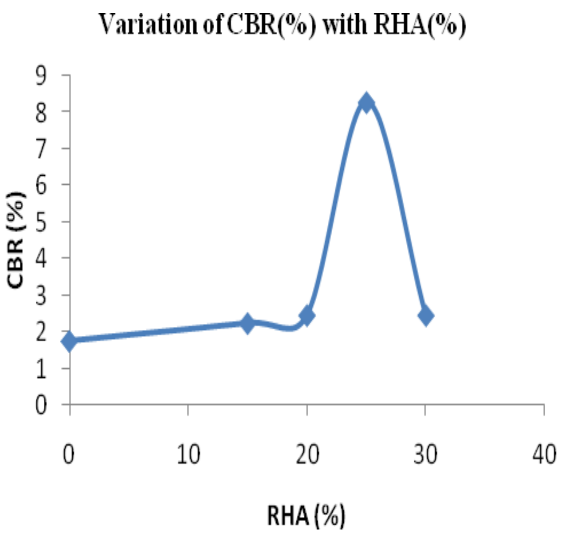


Fig 10: Variation of CBR(%) with RHA(%)

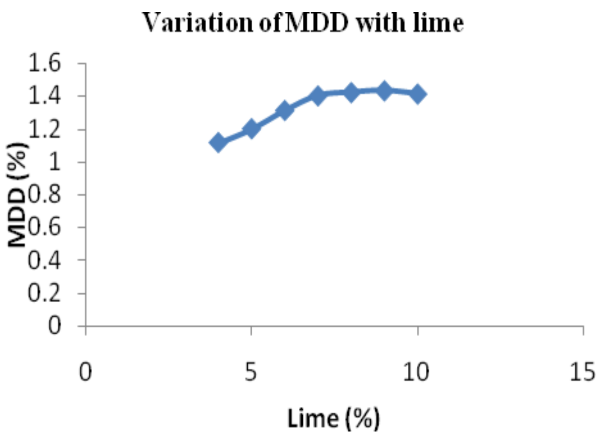
Table9: Properties of the Stabilized Marine Clay with an optimum of 25 % Rice Husk Ash

S. No	Property	Symbol	Marine Clay	MC + 25% RHA
1	Liquid Limit (%)	W_L	74 %	62 %
2	Plastic Limit (%)	W_P	27 %	29 %
3	Plasticity Index (%)	I_P	47 %	33 %
4	Shrinkage Limit (%)	W_s	12 %	16 %
5	Soil Classification	--	CH	CH
6	Specific Gravity	G	2.38	2.53
7	Differential Free Swell (%)	DFS	70 %	19 %
8	Optimum Moisture Content (%)	O.M.C	36 %	29.93%
9	Maximum Dry Density (gm/cc)	M.D.D	1.27	1.486gm/cc
10	Cohesion (t/m^2)	C	12.20 t/m^2	7.8 t/m^2
11	Angle of Internal Friction(_)	Ø	2.5^0	8.2^0
12	CBR value (%)	Soaked	0.754 %	8.290 %

X. PROCTOR COMPACTION RESULTS FOR RICE HUSK ASH TREATED MARINE CLAY WITH VARIOUS PERCENTAGES OF LIME

Table 10: Variation of MDD values with Lime

Mix proportion	Water Content (%)	MDD (%)
100%Soil+25%RHA+4%Lime	38.30	1.113
100%Soil+25%RHA+5%Lime	39.48	1.198
100%Soil+25%RHA+6%Lime	37.48	1.311
100%Soil+25%RHA+7%Lime	22.68	1.401
100%Soil+25%RHA+8%Lime	21.03	1.421
100%Soil+25%RHA+9%Lime	20.65	1.432
100%Soil+25%RHA+10%Lime	19.96	1.412



CBR RESULTS FOR RICE HUSK ASH TREATED MARINE CLAY WITH VARIOUS PERCENTAGES OF LIME

(1)CBR Curve for 75% soil + 25% Rice Husk Ash + 4%Lime

The soaked CBR Curve for Mix with 4% Lime was shown in Fig 11.

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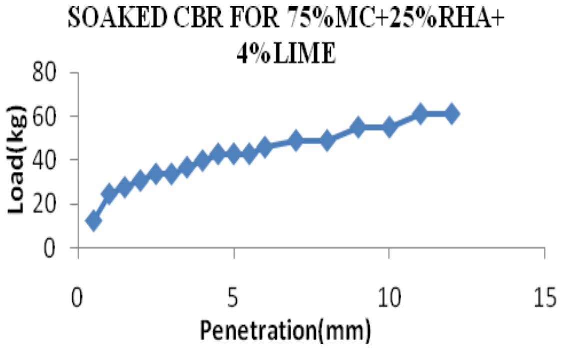

Fig 11 : CBR curve for 75% MC + 25% RHA + 4%Lime

Soaked CBR: 3.136 %

CBR Curve for 75% soil + 25% Rice Husk Ash + 5%Lime

The soaked CBR Curve for Mix with 5% Lime was shown in Fig 12

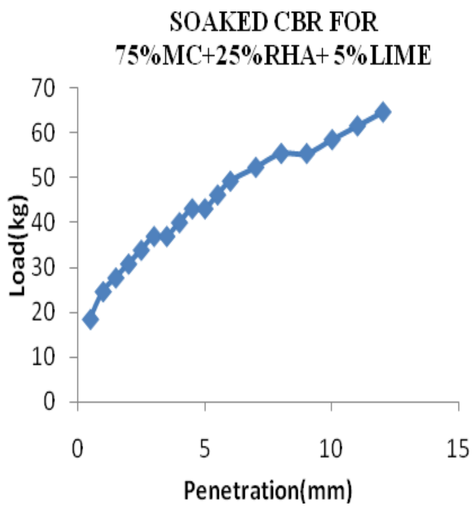

Fig 12 : CBR curve for 75% MC + 25% RHA + 5%Lime

Soaked CBR: 3.136 %

CBR Curve for 75% soil + 25% Rice Husk Ash + 6%Lime

The soaked CBR Curve for Mix with 6% Lime was shown in Fig 13

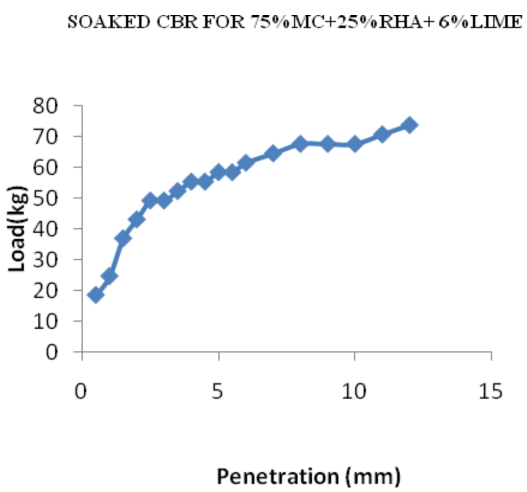

Fig 13 : CBR curve for 75% MC + 25% RHA + 6%Lime

Soaked CBR: 4.256 %

CBR Curve for 75% soil + 25% Rice Husk Ash + 7%Lime

The soaked CBR Curve for Mix with 7% Lime was shown in Fig 14

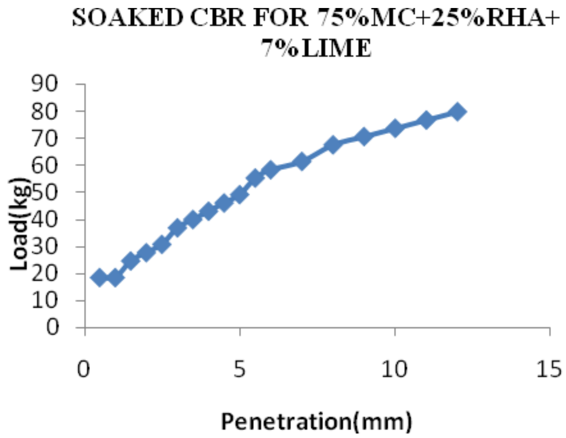

Fig 14 : CBR curve for 75% MC + 25% RHA + 7%Lime

Soaked CBR: 3.384%

CBR Curve for 75% soil + 25% Rice Husk Ash + 8%Lime

The soaked CBR Curve for Mix with 8% Lime was shown in Fig 15

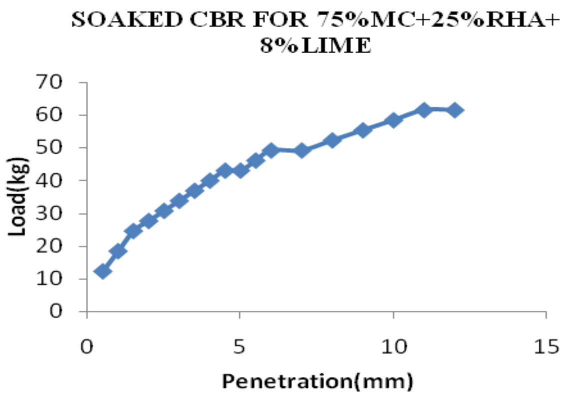

Fig 15 : CBR curve for 75% MC + 25% RHA + 8%Lime

Soaked CBR: 3.136%

CBR Curve for 75% soil + 25% Rice Husk Ash + 9%Lime

The soaked CBR Curve for Mix with 9% Lime was shown in Fig 16

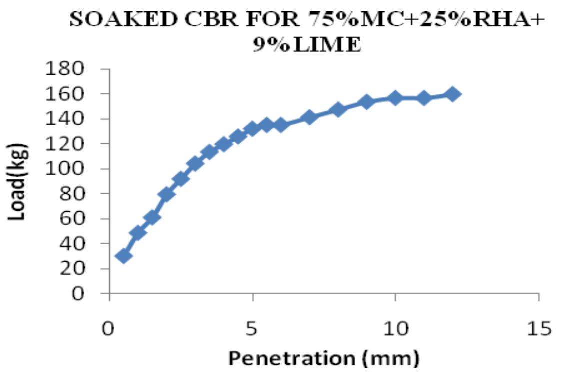

Fig 16 : CBR curve for 75% MC + 25% RHA + 9%Lime

Soaked CBR: 9.632%

CBR Curve for 75% soil + 25% Rice Husk Ash + 10%Lime

The soaked CBR Curve for Mix with 10% Lime was shown in Fig 17

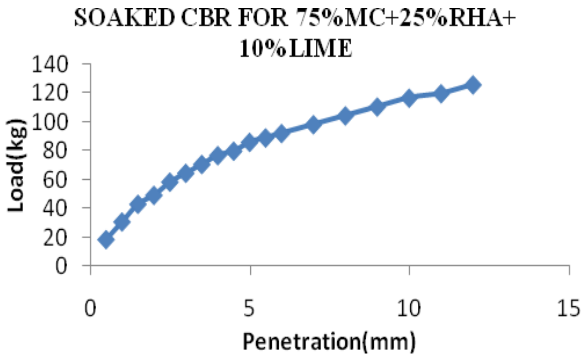

Fig 17 : CBR curve for 75% MC + 25% RHA + 10%Lime

Soaked CBR: 6.272%

Table 11: Variation of Soaked CBR values of MC+RHA+ Lime

(75%MC+25%RHA+)	Water Content (%)	Soaked CBR
4%Lime	38.3	3.136
5%Lime	39.48	3.136
6%Lime	37.48	4.256
7%Lime	22.68	3.584
8%Lime	21.03	3.136
9%Lime	20.65	9.632
10%Lime	19.96	6.272

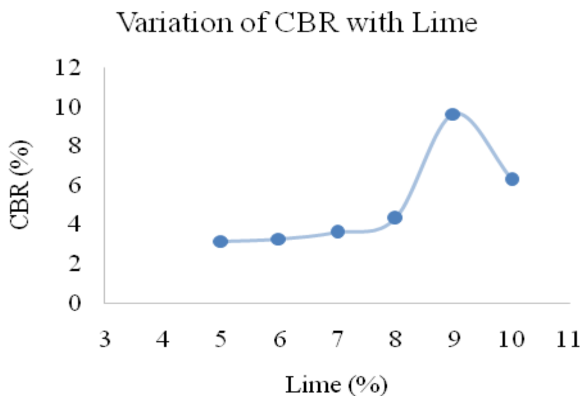

Fig 18.Variation of soaked CBR values of MC+RHA+ Lime

Table 12: Properties of the Stabilized Marine Clay with an Optimum Mix Of 25 % Rice Husk Ash And 9% Lime

S.No	Property	Symbol	Marine Clay	MC + 25% RHA	75%MC + 25%RHA+ 9%LIME
1	Liquid Limit (%)	W_L	74 %	62 %	51.90%
2	Plastic Limit (%)	W_P	27 %	29 %	31.40%
3	Plasticity Index (%)	I_P	47 %	33 %	20.50%
4	Shrinkage Limit (%)	W_s	12 %	16 %	19.14%
5	Soil Classification	--	CH	CH	CH
6	Specific Gravity	G	2.38	2.53	2.93
7	Differential Free Swell (%)	DFS	70 %	19 %	15.9%
8	Optimum Moisture Content (%)	O.M.C	36 %	29.93 %	20.65%
9	Maximum Dry Density (gm/cc)	M.D.D	1.27	1.486	1.432
10	Cohesion (t/m^2)	C	12.20	7.8	5.9
11	Angle of Internal Friction(_)	Ø	2.5^0	8.2^0	6.14^0
12	CBR value (%)	Soaked	1.754 %	6.7 %	9.632%

XI.CONCLUSION

- It is noticed that the liquid limit of the marine clay has been decreased by 16.21% on addition of 25% Rice Husk Ash and it has been further decreased by 29.86% when 9% lime is added.
- It is observed that the plastic limit of the marine clay has been improved by 7.40% on addition of 25% Rice Husk Ash and it has been further improved by 16.29% when 9% lime is added.
- It is observed that the plasticity index of the marine clay has been decreased by 29.78% on addition of 25% Rice Husk Ash and it has been further decreased by 56.38% when 9% lime is added.
- It is found that the O.M.C of the marine clay has been decreased by 18.52% on addition of 25% Rice Husk Ash and it has been further decreased by 42.63% when 9% lime is added.
- It is found that the M.D.D of the marine clay has been improved by 17.00% on addition of 25% Rice Husk Ash and it has been improved by 12.70% when 9% lime is added.
- It is observed that the C.B.R. value of the marine clay has been increased by 282.0% on addition of 25% Rice Husk Ash and it has been further improved by 449.14% when 9% lime is added.
- It is observed that the DFS value of the marine clay has been decreased by 72.80% on addition of 25% Rice Husk Ash and it has been further decreased by 77.28% when 9% lime is added.

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The soaked CBR of the soil on stabilizing is found to be 9.632 and is satisfying standard specifications. So finally it is concluded from the above results that the stabilized marine clay is suitable to use as sub grade material for the pavement construction and also for various foundations of buildings.

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