International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 4, Issue 01, January-2018

STRENGTH BEHAVIOUR OF LIME TREATED SOIL WITH RICE HUSK ASH

E.Ramanjaneya Raju[1], D.Prudhvi Raju[2], V.Chanakya Varma[3].J.N.S.Suryanarayana Raju[4].

[1]*Assistant Professor, Department of Civil Engineering, SRKREC, A.P. India*
[2]*Assistant Professor, Department of Civil Engineering, SRKREC, A.P., India.*
[3]*Assistant Professor, Department of Civil Engineering, SRKREC, A.P., India.*
[4]*Assistant Professor, Department of Civil Engineering, SRKREC, A.P., India.*

Abstract— ***Improvement in characteristics of expansive soil by using different materials has been a challenging job for engineers. The present study, which aim to establish basic standards for the use of Lime and Rice husk ash in the stabilization of expansive soils. This study presents an experimental study in the stabilization of an expansive soil, improvement of its properties by the addition of Lime and Rice husk ash. The test result reveals that the optimum content of admixture for achieving maximum strength is approximately 4% lime mixed with 10% Rice husk ash by mass of the soil.Based on the results, it can be concluded that the expansive soil can be successfully stabilized by lime and Rice husk ash.***

Keywords— ***Expansive Clay, Lime, Rice husk ash, Compaction, Atterberg limits, UCS, CBR.***

I.INTRODUCTION

Soil stabilization is the process which is used to improve the engineering properties of the soil and thus making it more stable. Soil stabilization is required when the soil available for construction is not suitable for the intended purpose. It includes compaction, preconsolidation, drainage and many other such processes. Expansive soils are clays that have the tendency to swell and soften when their moisture content is increased, or shrink and dry-cracked when their moisture content is decreased. Soils containing the clay mineral montmorillonite generally exhibit these properties.

Problems associated with expansive soils, which located in many regions. In India, these soils are generally called as black cotton soils and cover about 20% of the total land area. They are found in the states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Tamilnadu. During the last few decades' damage due to swelling action has been observed clearly in these regions in the form of cracking and breakup of pavements, building foundations, embankments and irrigation systems. One method to control the volume changes of expansive soil is to stabilize it with admixtures that prevent it from volume changes or adequately modify the volume changes characteristics of expansive soil. Lime and Rise husk ash have been used to stabilize expansive soils to relatively shallow depths under footings and sub grade.

Use of lime significantly changes the characteristics of a soil to produce long-term permanent strength and stability, particularly with respect to the action of water and frost.

Rice Husk Ash (RHA) is by-product material produced from the process of manufacturing puffed rice, contains large amount of iron oxide and silicate. It has higher density, stay in the top layer and then transported to a water basin with a low temperature for solidification. The end product is a solid, hard material that goes to the crusher for further processing. In present investigation Rice Husk Ash (RHA) is selected to study the effects of the index and engineering characteristics of problematic soil. In order to utilize the rice husk ash for the improvement of problematic clay a detailed program has been formulated and index, compaction, shear strength and CBR tests have been conducted on problematic clay with increasing % of RHA.

Numerous investigators (Holtz and Gibbs, 1956; Mc Dowell, 1959; Uppal and Chadda, 1969; Ramaiah et al, 1972; Thomson and Robnett, 1976; Gokhale, 1977; Pise and Khanna, 1977; Mohan Raj and Jaisingh, 1985; Ramana Sastry et al, 1986; Lakshmana Rao et al, 1987; Osinubi, 1988; Ramana Sastry, 1989; Basma and Tuncer, 1991; Hopkins et al, 1994; Mukherjee, 1995; Bansal et al, 1996; Little, 1996; Petry, 1997; Miller and Zaman, 2000) have studied the influence of lime, cement, lime-cement, lime-fly ash, lime –rice husk ash and cement – fly ash mixes on soil properties, mostly focusing on the strength aspects to study their suitability for road bases and sub-bases.

II. LITERATURE REVIEW

The effects of the ash on the soil-lime mixtures were investigated with respect to unconfined compressive strength (UCS) and coefficient of permeability by Alhassan (2008), and the results show that the UCS of the specimens increased with increasing RHA content at specified lime contents to their maximum values at 6% RHA.

Muntohar (2004) shows that the addition of 6% lime in combination with RHA principally has a significant effect on reducing swell and swelling pressure and increase the durability of soils.

Stabilizing agents, such as cement and lime, were used by Haji Ali et al. (1992) in order to evaluate the effectiveness of them on engineering properties, such as Atterberg limits and compaction test, and results show that lime is a more effective stabilizing agent.

Akshaya Kumar Sabat studied the effect of polypropylene fibre on engineering properties of rice husk ash –lime stabilized expansive soil. He concluded that the addition of Rice Husk and Lime decreases the MDD and increases the OMC of the expansive soil. MDD goes on decreasing and OMC goes increasing with increase in percentage of polypropylene fibre in the rice husk ash –lime stabilized expansive soil. Addition of rice husk ash and lime increases the UCS and soaked CBR of the expansive soil with the addition of polypropylene fibre.

Sahoo et.al (2010) also has studied the strength characteristics of fly ash mixed with lime stabilized soil and found out that the maximum strength of the soil is attained when the soil is mixed with 15% of fly ash and 4% of lime, further increase in the admixtures results in the decrease in the strength of the soil.

Singhai and Singh (2014) carried out the experimental investigation on soil which was treated with different proportion of FA (5%,10%,15%,20%,25%) and RHA (,10%,15%,20%,25%,30%) and Optimum moisture content, Maximum dry density and California bearing capacity is evaluated. Tests were conducted on BC soil and Fly Ash, Rice husk ash mixtures prepared at optimum water content. The MDD, OMC values were decreased and CBR increased.

III. EXPERIMENTAL INVESTIGATION

A. Materials

1. Soil: Soil used in this experimental investigation was a locally available black cotton soil from Bhimavaram,India.The Index properties of the soil were determined as per IS codes and are presented in Table-1. The soil was classified as CH.

TABLE I: INDEX PROPERTIES OF SOIL

S.No.	Property	Value
1.	**Grain size distribution** Sand (%) Silt (%) Clay (%)	 0 10 88
2.	**Atterberg limits** Liquid limit (%) Plastic limit (%) Plasticity index (%)	 75 32 43
3.	**Compaction properties** Optimum Moisture Content, O.M.C. (%) Maximum Dry Density, M.D.D (gm/cc)	 29.5 1.41
4.	**Specific Gravity (G)**	2.64
5.	**IS Classification**	CH
6.	**Soaked C.B.R (%)**	1.19
7.	**Differential free swell (%)**	100

2. Lime: Hydrated lime was used in this investigation. It has 75–80% of calcium hydroxide and 7% silica.

3. Rice husk ash (RHA): The rice husk ash was collected from Bhimavaram,India. Rice Husk Ash is by-product material produced from the process of manufacturing puffed rice, contains large amount of iron oxide and silicate. Well-burnt RHA passing through 425μ sieve was used in this investigation for convenient mixing with clay and compaction.The constituents of Rice Hush Ash are listed in Table 2. The RHA used showed high silica content of 93%, which is an indication of a good pozzolanic material.

Table 2. Composition of Rice Husk Ash (RHA)

S.No.	Constituent	Composition (%)
1.	Sio_2	93.2
2.	Al_2O_3	0.59
3.	Fe_2O_3	0.22
4.	CaO	0.51
5.	MgO	0.41
6.	K_2O	2.93
7.	Loss on Ignition	1.91

B. Tests Conducted

Compaction tests, UCS and CBR tests were conducted in three different series. In the first series, compaction tests, UCS and CBR tests were conducted on the untreated Expansive clay. In the second series, compaction tests, UCS and CBR tests were conducted on both clay-lime mixes to study the effect of lime on the values of optimum moisture content (OMC), Maximum dry density (MDD), UCS and CBR of the expansive clay used. In the third series, compaction tests, UCS and CBR tests were conducted on RHA-clay-lime mixes to study the effect of RHA on the values of OMC&MDD, UCS and CBR of clay-lime mixes.

C. Proportion

Proportions were selected based on study of pervious literature about the improvement in soil properties and utilization of waste material. Proportion used is sated in Table 3 along with the values of various Abbreviations: Expansive clay=E.C, L=Lime, RHA=Rice husk ash.

Table 3 Material Proportion and coding

S.No.	Description	Coding
1.	E.C	S-1
2.	E.C+2%L	S-2
3.	E.C+3%L	S-3
4.	E.C+4%L	S-4
5.	E.C+5%L	S-5
6.	E.C+4%L+5%RHA	S-6
7.	E.C+4%L+10%RHA	S-7
8.	E.C+4%L+15%RHA	S-8

The tests were conducted on samples prepared at various combinations of the above variables.

D. ***Sample Preparation and Test Procedure***

1. UCS test: Unconfined compression test (UCS test) is performed in accordance with IS: 2720 part 10 (1973). The required amount of the air-dried soil passing a 4.75 mm sieve was measured and thoroughly mixed with the placement water content and predetermined amount of the additives. The sample sizes were of 38 mm diameter and 76 mm length. The tests are performed at their OMC and MDD.

2. CBR Test**:** The required amount of the air-dried soil passing a 4.75 mm sieve was measured and thoroughly mixed with the placement water content and predetermined amount of the additives. The blend was statically compacted by pressing in the spacer disk of 50 mm thickness with the help of the testing machine. The penetration test was done on the specimen in soaked condition. The load penetration curve was plotted and the CBR value obtained.

IV. TEST RESULTS AND DISCUSSION

The results as obtained from the above laboratory tests are presented as follows.

A. Compaction test

Fig. 1 shows the variation of OMC and fig.2 shows the variation of MDD of the Expansive clay mixes with % variation of lime content.

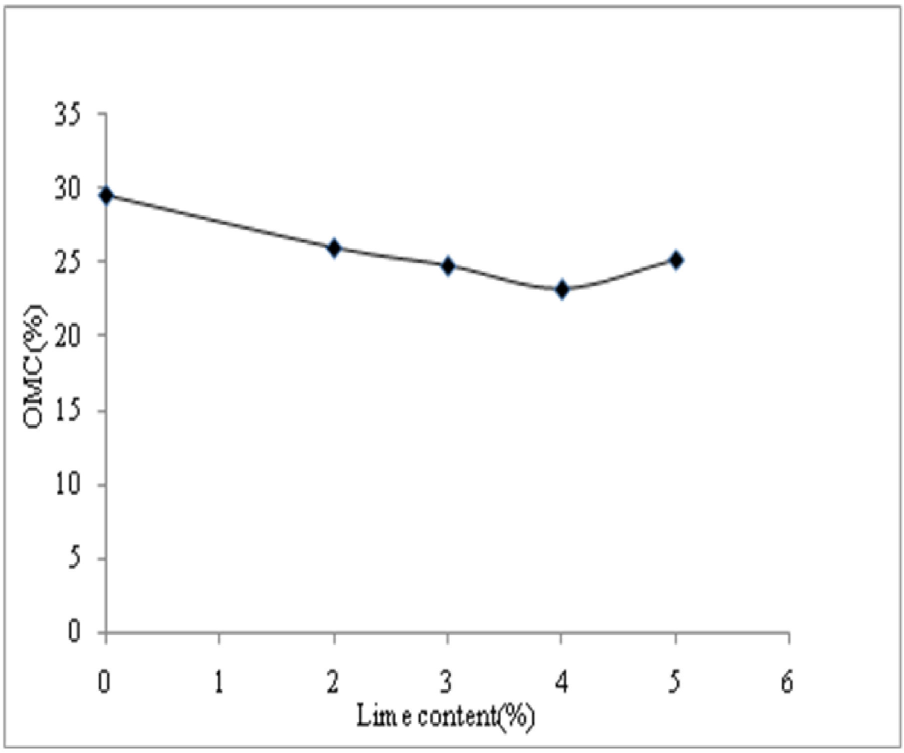

Fig. 1 Variation of OMC with lime content

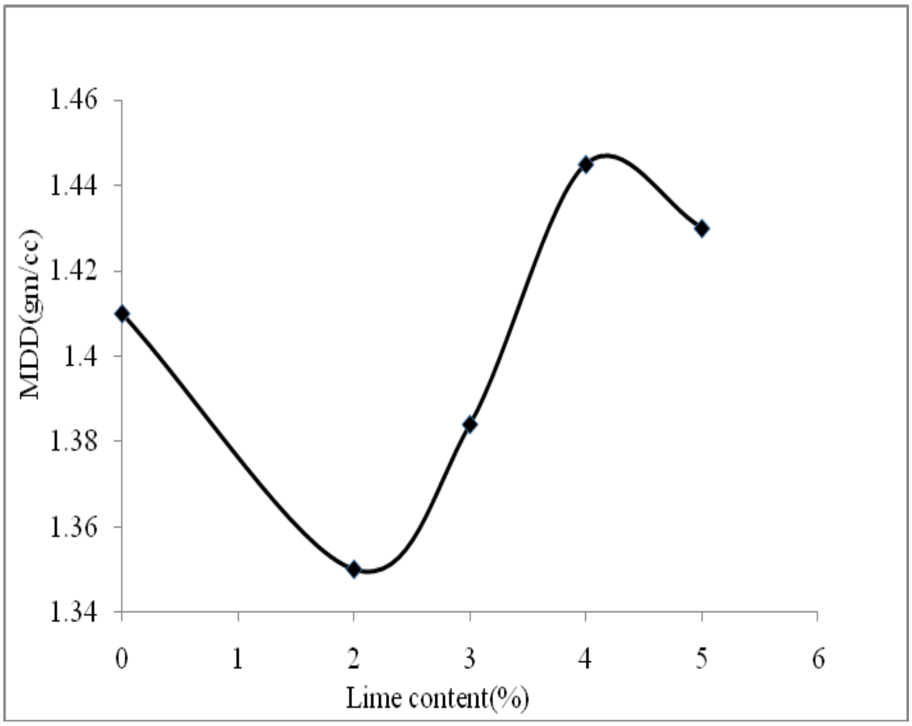

Fig. 2 Variation of MDD with lime content

It was observed that out of the different combinations tried in this investigation, 4% lime is found to be optimum. The OMC goes on decreasing with the addition of lime content up to 4% beyond the addition of 4% lime, there is increasing in OMC and MDD goes on increasing up to 4% of lime content beyond the addition of 4%, there is reduction in M.D.D values of treated Expansive clay.

B.Unconfined Compressive strength (UCS) Test

The unconfined compressive strength test was conducted on untreated and treated sample at their obtained OMC from compaction tests and cured for 3,7,14 and 28 days. Fig.3 shows the variation of UCS (Kg/cm^2) for different curing periods to all the lime contents. As the percentage of lime is increased the strength is also increased. The maximum unconfined compressive strength of stabilized soil was observed to be 3.95 Kg/cm^2.

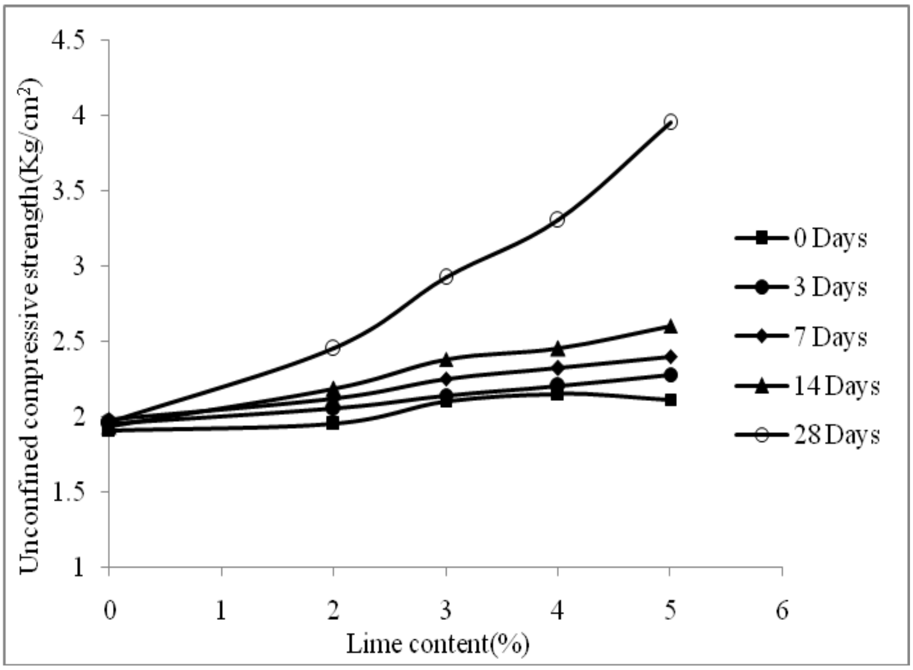

Fig. 3 Variation of UCS with lime content

Addition of lime to expansive clay results in chemical reactions, due to the pozzolanic reaction flocculation of clay particles taking place, resulting in agglomeration into large sized particles, which resist the applied compressive load more effectively than those of untreated clay.

C.California Bearing Ratio (CBR) Test

The soaked CBR values of various mixes of Expansive clay and Lime using OMC obtained from compaction tests are determined. The soaked CBR after immersing in water for four days , that is when full saturation is likely to occur, is also determined. Fig. 4 shows Variation of CBR with % variation in Lime content is presented.

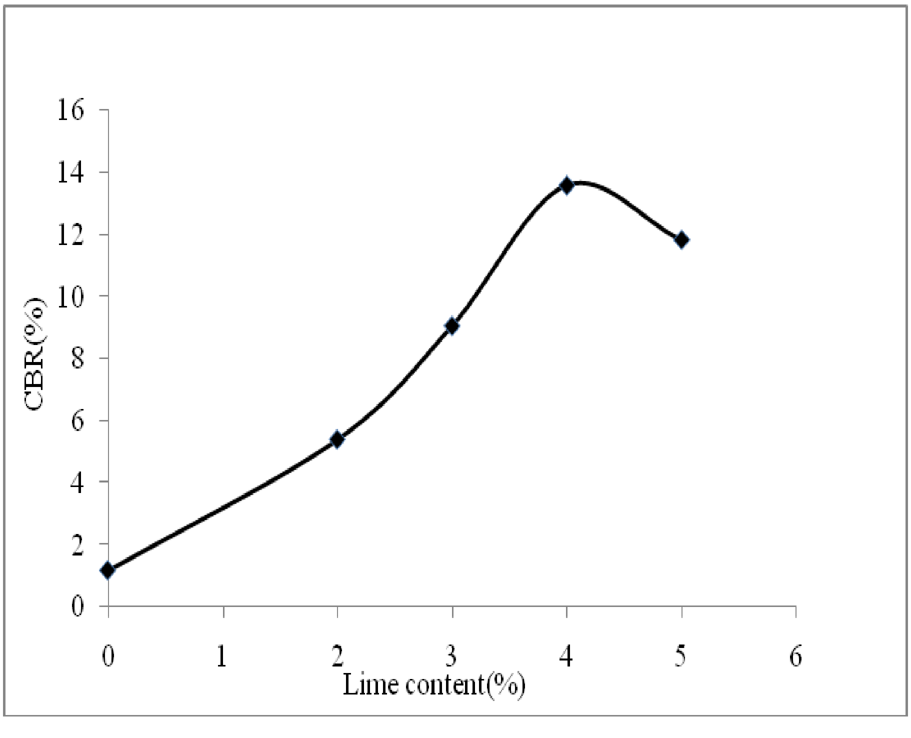

Fig. 4 Variation of CBR with lime content

D. Compaction test

Fig. 5 shows the variation of OMC and fig.6 shows the variation of MDD of the Expansive clay-Lime mixes with % variation of RHA.

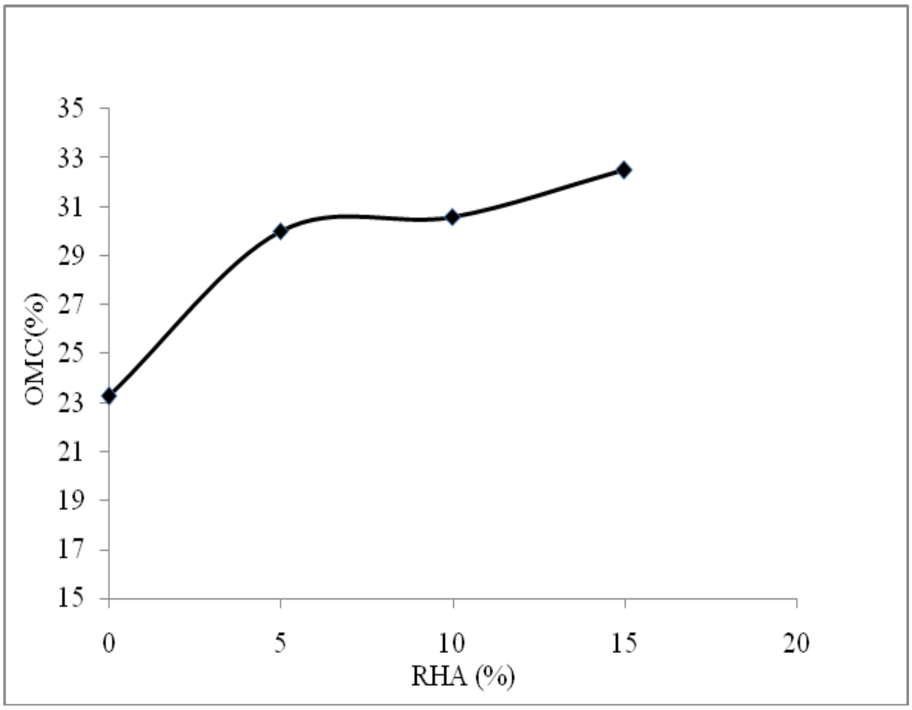

Fig. 5 Variation of OMC with RHA content

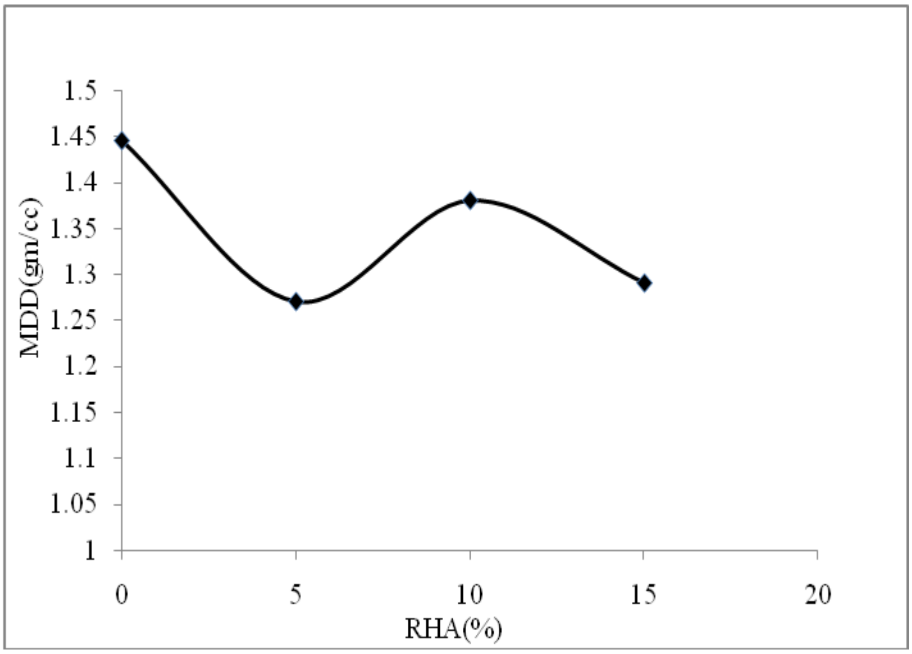

Fig. 6 Variation of MDD with RHA content

It was observed that out of the different combinations tried in this investigation, 10% RHA is found to be optimum. The OMC goes on increasing with the addition of RHA and MDD first decreased and attain a maximum value of 1.38gm/cm^3 at 10% addition of RHA.So we select 10% RHA as optimum for Expansive clay-Lime mixes.

E.Unconfined Compressive strength (UCS) Test

The unconfined compressive strength test was conducted on Expansive clay-Lime and Expansive clay-Lime+RHA treated sample at their obtained OMC from compaction tests and cured for 3,7,14 and 28 days. Fig.7 shows the variation of UCS (Kg/cm^2) for different curing periods to all the RHA contents. As the percentage of RHA is increased the strength is also increased. The maximum unconfined compressive strength of stabilized soil was observed to be 4.90 Kg/cm^2.

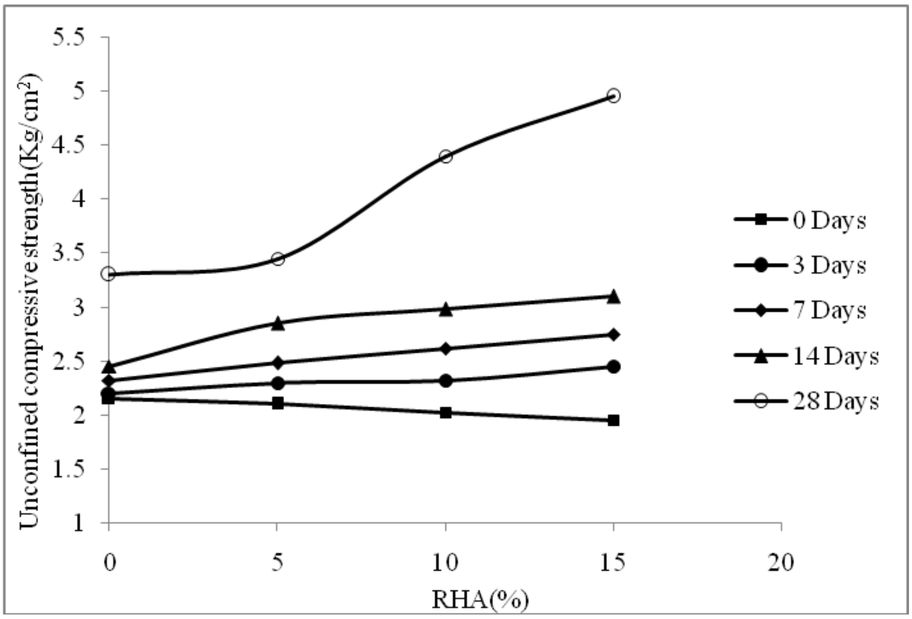

Fig. 7 Variation of UCS with RHA content

The presence of high silica content 93.2% in RHA increases pozzolanic reaction and increases the resistance to the applied compressive load of the lime treated clay-RHA blend. This improvement is reflected in Fig. 7.

F.California Bearing Ratio (CBR) Test

The California Bearing Ratio (CBR) test was conducted on Expansive clay-Lime and Expansive clay-Lime+RHA treated sample at their obtained OMC from compaction tests under 4 days of soaking. Fig.8 shows the variation of CBR (%) for different percentage of RHA contents. As the percentage of RHA is increased the CBR value is also increased. The maximum CBR value was observed to be 20.64%.

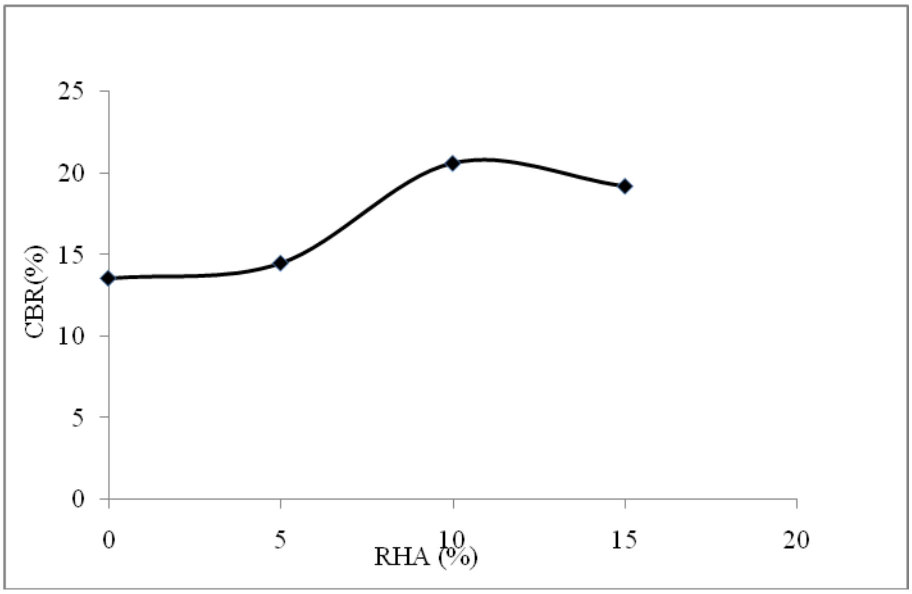

Fig. 8 Variation of CBR with RHA content

Under soaked conditions the CBR value of lime treated expansive clay is goes on increasing with the addition of RHA content. At 10%RHA content, the CBR value increases from **1.2%** at 100% expansive clay to **20.64%** at 90% of lime treated expansive clay+10% RHA. This is due to Rice-husk ash is rich in SiO_2 (93.2%), which increases the strength of the blend. Addition of RHA to clay-lime mixes generates Cementing property and a cementitious material due to pozzolanic reaction between $Ca(OH)_2$ and SiO_2. This is chiefly responsible for higher compressive strengths in RHA-clay-lime blends.

A minimum CBR value of 6% and 20% are recommended for the use in the sub grade and sub-base layer of strong and durable road pavements.

G.Atterberg's Limits

The Consistency limits of various mixes of expansive clay, expansive clay with lime and lime treated expansive clay with RHA are determined at their corresponding obtained OMC from Compaction tests. Fig. 9 shows the variation of W_L ,W_P and I_P of the expansive soil –lime mixes and expansive soil-Lime mixes with RHA content.

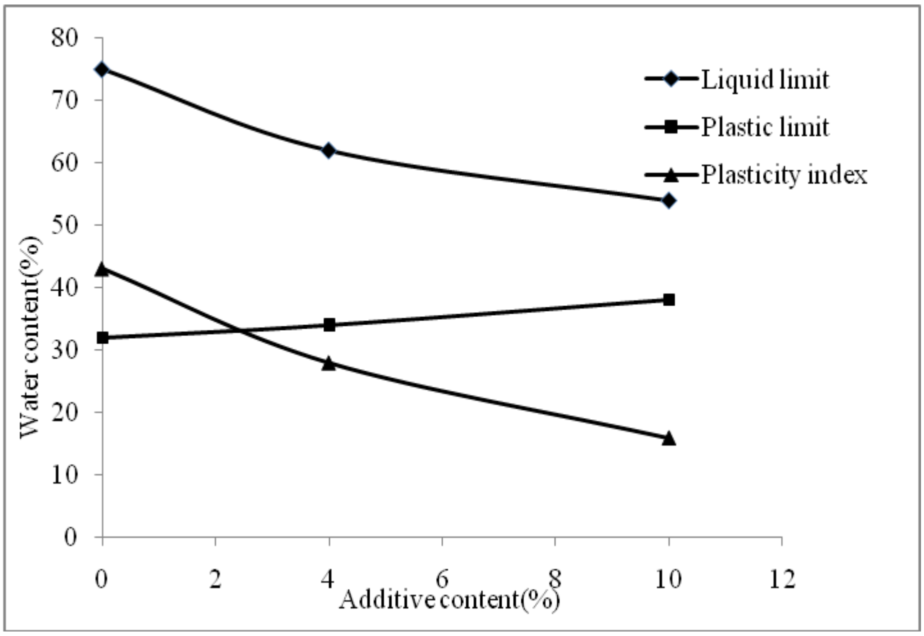

Fig.9 Variation of Liquid limit, Plastic limit and Plasticity index with additive content

From the Fig. 9 it was observed that Addition of 4% of Lime decreases the W_L to 62 % from 75%, I_P to 28% from 43%, and increases the W_P to 34 % from 32% .Increase in percentage of addition of RHA further decreases the W_L ,I_P and increases the W_P . The W_L decreases to 54 % , W_P increases to 38 % and I_P decreases to 16% when 10% RHA was added to expansive clay-lime mixes. It is observed that the addition of lime decreases the Liquid limit, Plasticity index and increases the Plastic limit of the expansive soil. Liquid limit, Plasticity index goes on decreasing and plastic limit goes on increasing with increase in percentage of RHA in expansive clay-lime mixes.

From the above figures, it is clear that the problematic expansive clay was improved by stabilizing it with lime and RHA. And from the above discussions, it can be summarized that the materials lime and RHA had shown promising influence on the properties of expansive clay, thereby giving a two-fold advantage in improving problematic expansive clay and also solving a problem of waste disposal.

V. CONCLUSIONS

The effect of Rice husk ash (RHA) on expansive clay - lime mixes has been explored. Unconfined compressive strength (UCS) and California Bearing Ratio (CBR) of untreated expansive clay and expansive clay blended with lime and Rice husk ash (RHA) were studied.
The following are the main conclusions:

1. The addition of lime decreases the Liquid limit, Plasticity index and increases the Plastic limit of the expansive clay. Liquid limit, Plasticity index goes on decreasing and plastic limit goes on increasing with increase in percentage of RHA in lime treated expansive clay.

2. The UCS value is goes on increasing with the addition of lime content to the expansive clay, the UCS value increases from 1.96Kg/cm^2 at 0% lime to 3.95 Kg/cm^2 at 6% lime for 28 days curing.

3. The soaked CBR value is highest for 4%Lime content, the CBR value increases from 1.19% at 0% lime to 13.57% at 4% lime. Beyond the addition of 4%, there is reduction in CBR values of treated expansive clay.

4. The UCS value goes on increasing with the addition of RHA content to the lime treated expansive clay, the UCS value increases from 3.95Kg/cm^2 at 0% RHA to 4.90Kg/cm^2 at 15% RHA for 28 days curing.

5. The soaked CBR value is highest for 10%RHA, the CBR value increases from 13.57% at 0% RHA to 20.64% at 10% RHA. Beyond the addition of 10%, there is reduction in CBR values of lime treated expansive clay.

REFERENCES

[1] A K Sabat (2012), "Utilization of Bagasse Ash and Lime Sludge for Construction of Flexible Pavements in Expansive Soil Areas", Electronic Journal of Geo-technical Engineering, Vol.17, Bund.H, pp.1037-1046.

[2] A K Sabat and R P Nanda (2011), "Effect of Marble Dust on Strength and Durability of Rice Husk Ash Stabilized Expansive Soil", International journal of Civil and Structural Engineering, Vol. 1, No. 4, pp. 939-948.

[3] A N Ramakrishna and A V Pradeep Kumar (2006), "Stabilization of Black Cotton Soil Using Rice Husk Ash and Cement", in Proceedings of National conference Civil Engineering meeting the challenges of tomorrow, pp. 215-220.

[4] Chen, F.H., 1975. Foundation on Expansive Soil, Development in Geotechnical Engineering 12.Elsevier Scientific Publishing Company, New York, USA.

[5] D. Neeraja," Influence of lime and plastic Jute on strength and CBR Characteristics of Soft Clayey (Expansive) soil". *Global Journal of Researches in Engineering"* Volume 10, Issue 1 (Ver 1.0), April 2010.

[6] Mtallib, M. O. A., and Bankole, G. M., (2011), "The Improvement of the Index Properties and Compaction Characteristics of Lime Stabilized Tropical Lateritic Clays with Rice Husk Ash (RHA) Admixtures", Electronic Journal of Geotechnical Engineering, Vol. 16, Bund. I, pp.984-996.

[7] Muntohar, S., and Hantoro, G., (2000), "Influence of Rice Husk Ash and Lime on Engineering Properties of a Clayey Sub-grade", Electronic Journal of Geotechnical Engineering, Vol. 5.

[8] Mohammed Ali and Sreenivasulu.V. (2004) "An experimental study on the influence of Rice husk ash and Lime on properties of Bentonite", IGC, Warangal, PP 468-471.

[9] S Chandra, S Kumar and R K Anand (2005), "Soil Stabilization with Rice Husk Ash and Lime Sludge". Indian highways, Vol. 33, No.5, pp. 87-98.

[10] Sivapulliah P.V., Subba Rao K.S., and Gurumurthy, J.V., "Stabilization of rice husk ash as cushion below foundations on expansive soils", Ground Improvement, 2004, Vol. 8, No. 4, pp 137-149.