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Effect of Rice husk ash on the Liquid limit and Shrinkage limit of Lithomargic soil treated with carbide lime and sodium salts

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ABSTRACT:*This paper demonstrate the effect of Rice husk ash (RHA) and carbide lime(CL) on Liquid limit and shrinkage limit of locally available lithomargic soil. The use of silica rich waste RHA and calcium rich waste CL minimizes the disposal problem and also reduces the cost of stabilization. For this detailed experimental analysis of Liquid limit (LL) and Shrinkage limit (SL) were carried out on lithomargic soil/Shedi soil (SS) with an increment of 5% RHA and 2% CL respectively. Results show that addition of RHA and Carbide lime increases the liquid limit (LL) and Shrinkage limit (SL) due to the formation of pozzolanic compounds which resembles flocculated structure. Similarly effect of salts such as NaCl, and NaOH of 1% is added to the stabilized Lithomargic soil. Results show that there is a marginal variation in the liquid limit and Shrinkage limit is observed upon addition of small dosage of salts.*

KEYWORDS :*carbide lime, liquid limit, rice hush ash, shedi soil, shrinkage limit.*

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I. INTRODUCTION

The soil condition and their formation is different from one another depending upon the environment, climatic conditions and their seasonal fluctuation, based on this, the soils can be classified into transported soil and residual soil. Due to their formation and chemical disintegration has lead to the formation of problematic soil among one is the lithomaric soil which is also called as shedi soil (SS). This soil is present in between weathered laterite and hard granite gneiss and is found at a depth of 1–3 m below the top lateritic outcrop throughout the western coast of south India. Lithomargic clays are mainly composed of hydrated alumina and kaolinite powder, consisting mainly of silt and sand particles. These soil flow like water when water gushes through this layer during monsoon and many times washes–off the fine soil, creates cavities and at times causes heavy settlement and sliding of the top layers after the application of load. These soils are unsuitable for construction hence need to be improved by changing its gradation either by mechanical or chemical means. Rapid urbanization and industrialization has lead to many waste products such as fly ash, Rice husk ash (RHA) can be effectively utilized in the stabilization of problematic soil. Environmental impact due to conventional additives can be reduced by the utilization of industrial by-products, which are sustainable, and easily available[1] Despite Atterberg's limit is one of the methods for identification and classification of soil, it can also be correlated to various properties such as surface area, cation exchange capacity, mineralogical and geological history, swelling behavior, California bearing ratio, shear strength, compaction characteristics [2] [3]. Liquid limit of the fine grained soil is controlled by Clay content, Type of clay mineral and its shape and size [4]. Addition of lime to the fine grained soil improves the plasticity, workability and strength [5, 6] [7]. Further addition of NaOH and NaCl accelerate the benefits of lime [8]. Liquid limit of low plastic clays cannot be determined by Casagarande apparatus because of Difficulty in grooving, tendency of sliding [4]. Hence in this study an attempt is made to study the consistency limit of RHA stabilised silty soil in the presence of carbide lime and other additives.

II. MATERIALS AND METHODOLOGY

2.1 Lithomargic clay / Shedi soil

Shedi soilwas collected from NITK campus Surathkal, Mangalore district, India, The soil waspulverized and sieved through 425 micron IS sieve after separating pebbles, Geotechnical properties of the soil were shown in Table 1

2.2 Rice husk ash (RHA)

Agro industrial waste i.e. RHA is collected from Sri Balaji rice mill near APMC market, Davangere District, having a particle size less than 425 micron. Their Physical and chemical properties are shown in Table 2.

2.3 Carbide lime (CL)

One of the major industrial waste i.e. CL is collected from the disposal zone of the oxy-acetylene gas welding plant near GottigereHobli of Bangalore urban District in Karnataka State. Their Physical and chemical properties were presented in Table 2

Grain size distribution of all materials used in the study are shown in Fig 1

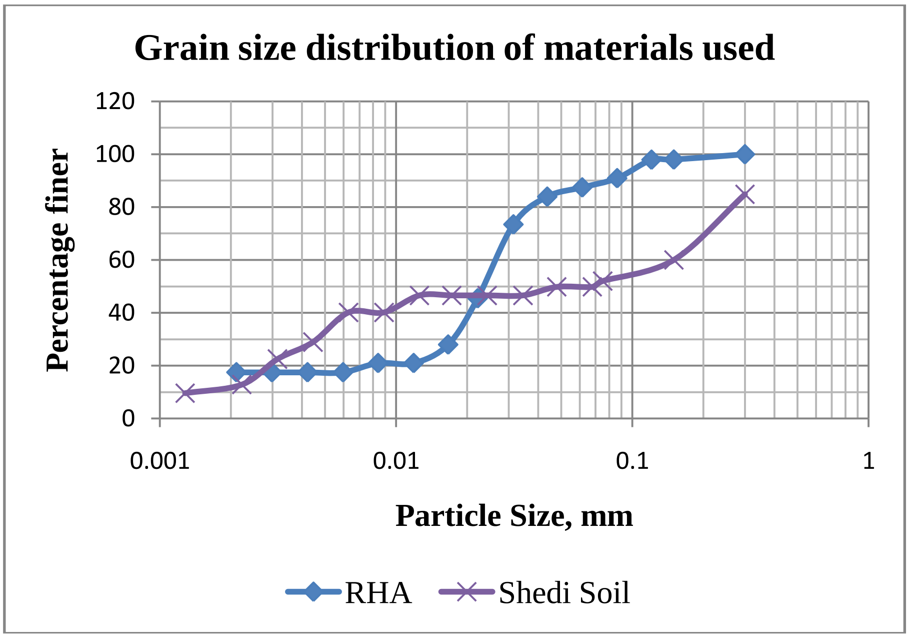

Fig .1 Grain size distribution of Shedi soil, and RHA

Table 1: Geotechnical properties of Shedisoil

Sl No	Properties		Value
1	Colour		Pink
2	Grain Size Distribution	Fine Sand, %	48
		Silt size, %	40
		Clay size, %	12
3	Specific gravity of soil solids		2.65
4	Consistency limits	Liquid limit, %	45
		Plastic limit, %	NP
		Shrinkage limit, %	33
6	Compaction parameters	OMC, %	23
		MDD, kN/m^3	15.6
7	Unconfined Compressive Strength, kPa		175

Table 2:Physical properties of Rice Hush Ash and Carbide Lime

Sl. NO.	Physical Properties		RHA	Carbide lime
1	Colour		Grey	Grayish white
2	Specific gravity of solids		1.95	2.1
3	Grain Size Distribution	Silt size %	72	94
		Clay size %	18	6

Table 3:Chemical composition of Carbide Lime and RHA

Chemical composition	Carbide lime Quantity %	RHA Quantity %
Silica (SiO_2)	5.71	85
Alumina (Al_2O3)	2.61	2.5
Ferric oxide (Fe_2O_3)	0.72	0.5
Calcium oxide (CaO)	83.1	1
Magnesium oxide (MgO)	0.8	0.5
Sodium oxide (Na_2O)	0.05	0.3
Potassium oxide (K_2O)	0.08	0.2
Others	0.29	-
Loss on Ignition	5.71	11

2.4 Salts
Chemically pure salts such as Sodium hydroxide and sodium chloride of 1% are used to know the effect of these on the Liquid and shrinkage limit of shedi soil.

2.5 Methodology
Liquid limit values were determined as perthe procedure mentioned in the reference[9] and Shrinkage limit values were determined as per the procedurementioned in the reference [10]

III. RESULTS AND DISCUSSION
3.1 Liquid Limit of RHA stabilized shedi soil in the presence of Carbide lime
Liquid limit of shedi soil has been carried out by varying percentage of rice husk ash i.e from 5% to 30% in an increment of 5% and tests were carried out for both immediate as well as 7 days of curing period and the results are presented in the Fig.2. The liquid limit of RHA treated shedi soil increases upon addition of RHAis due to the replacement of the soil grains with the rice husk ash particle and also higher water holding capacity of RHA [11]. Liquid limit of shedi soil alone is 45% and upon addition of RHA content liquid limit increases from 45% to 69% on immediate testing however after 7 days of curing there is no significant change in the liquid limit was observed this is due to, they are inert and hence, even their finer fractions do not contribute to liquid limit values [12]. Further to know the effect of carbide lime on stabilizedshedi soil, carbide lime at an increment of 2% is added to the shedi soil and optimum RHA mixture and the variation of liquid limit were presented in Fig.3. Results show that liquid limit of shedi soil stabilized with 20% RHA is 61% on immediate testing and it increases with the addition of carbide lime,upon curing period of 7 days it increases marginally and is found to be 70% for 10% of CL, this marginal increase is due the flocculation of the soil particle due to the presence of calcium ions in the composite and brings the structural changes in the treated carbide lime composite [13].

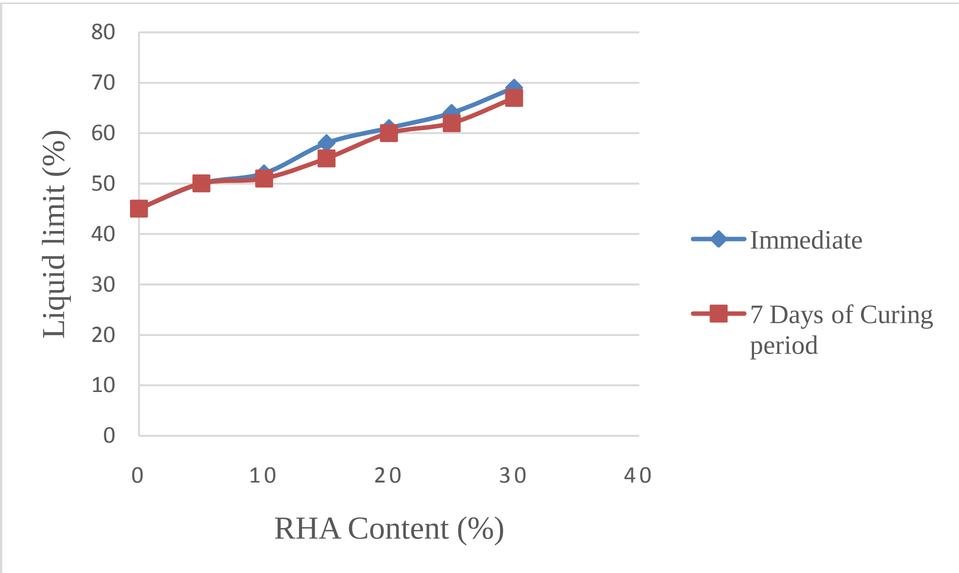

Fig. 2 Liquid limit of Shedi soil and RHA mixture for immediate and 7 days of curing period

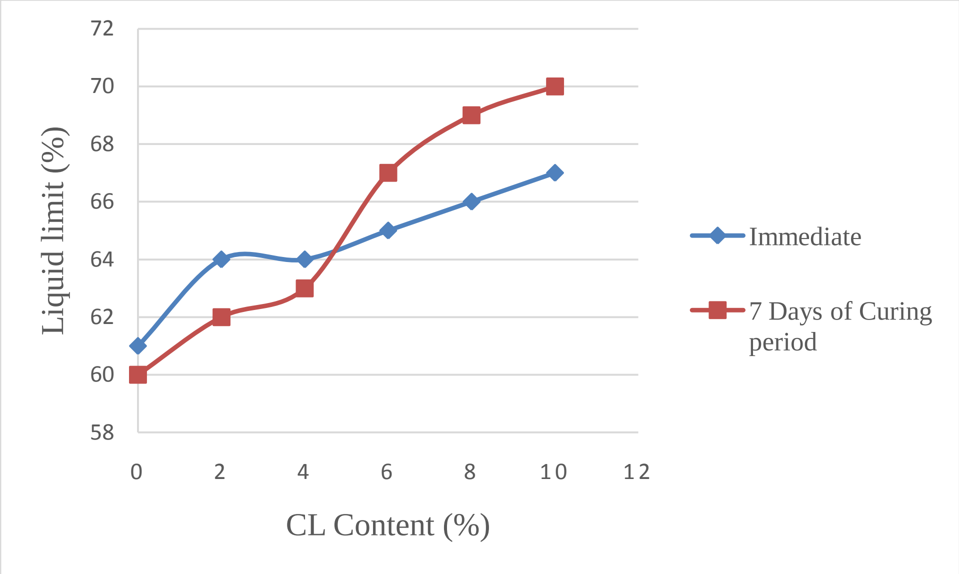

Fig.3 Liquid limit of [SS +20%RHA] and CL mixture for immediate and 7 days of curing period

3.2 Shrinkage limit of RHA stabilisedshedi soil in the presence of Carbide lime

Variation in shrinkage limit of shedi soil-RHA mixture is shown Fig.4.Shrinkage limit of the RHA stabilized shedi soil increases with an increment of RHA content. Shrinkage limit of shedi soil alone is found to be 33% and increases with the increase of the RHA content both on immediate and 7 days of curing period, this due to the replacement of the soil with the RHA particle which is inert and forms a rigid skeleton which resist towards the shrinkage. Shrinkage limit of the carbide lime treated shedi soil and optimum dosage of 20% RHA increases on immediate and 7 days of testing, this is due to immediately on adding carbide lime, the soil structure turns into flocculated one and the flocculated structure shows a high shrinkage limit [13] due do chemical reaction between the soil-RHA and CL and results in an increase in the shrinkage limit and resist towards the shrinkage.

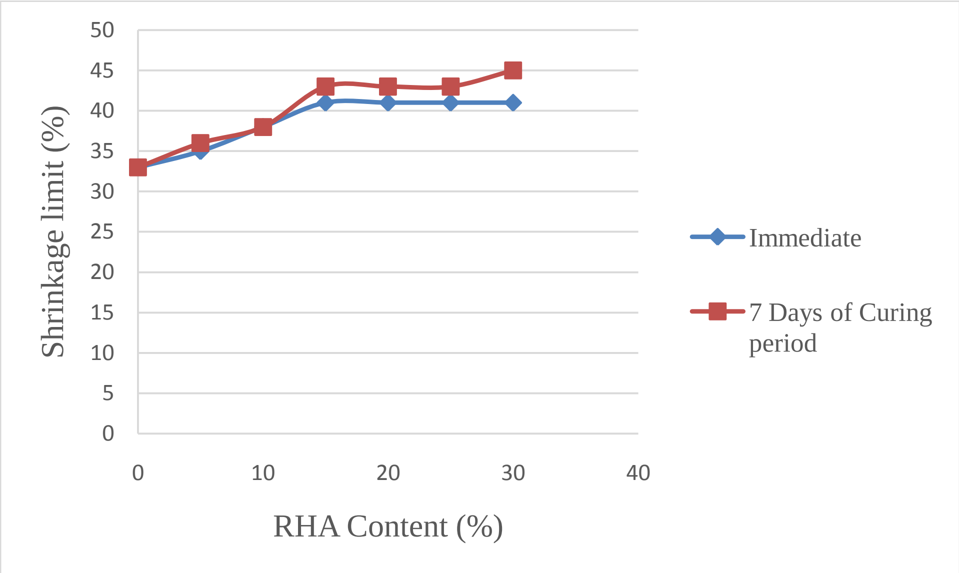

Fig.4 Shrinkage limit of Shedi soil and RHA mixture for immediate and 7 days of curing period

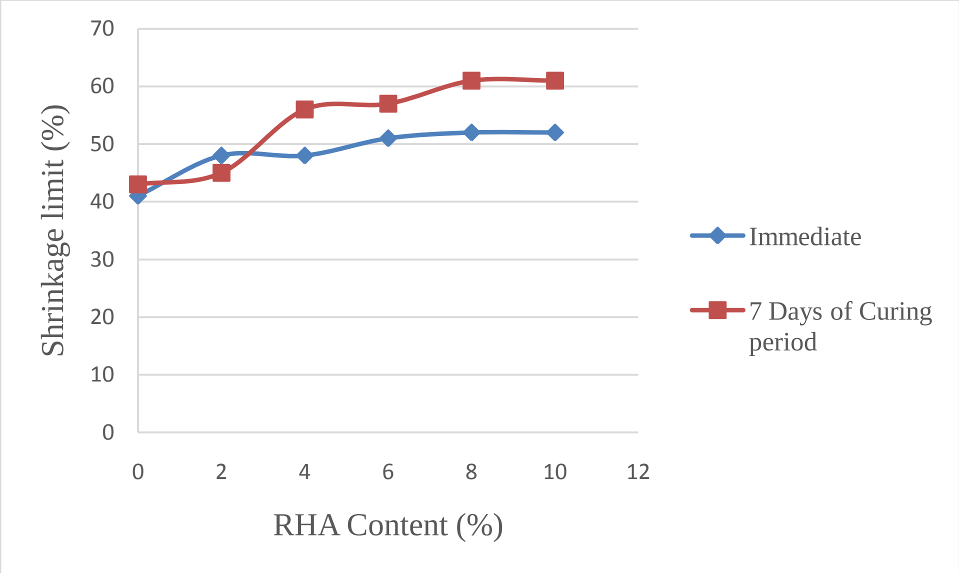

Fig.5 Shrinkage limit of [shedi soil+20%RHA] and CL mixture for immediate and 7 days of curing period

3.3 Effect of Salts on the Liquid limit and Shrinkage limit of RHA stabilizedshedi soil in the presence of carbide lime

Optimization of RHA and carbide lime were found from strength testes carried out by varying the percentage of RHA and Carbide lime to shedi soil in an increment of 5% and 2% respectively. From the results, it was observed that 20% RHA and 6% CL are the optimum dosage for the stabilization of shedi soil [14].

Changes in the liquid limit and shrinkage limit with the addition of salts were presented in Table 4 both for immediate and 7 days of curing period. Addition of 1% sodium salts such as 1% NaCl and 1% NaOH to the shedi soilstabilized with optimum percentage of RHA and carbide lime i.e. 20% and 6% respectively, Liquid limit decreases immediately due to delay in the formation of pozzolanic compounds and increases on 7 days of curing period is due to formation of C-S-H gel, and S-C-S-H by sodium salts, which is more voluminous[15]. The increase in shrinkage limit is due to the aggregation of the particles after curing period of 7 days and also effect of the flocculation with curing, hence the shrinkage limit increased. With 1% NaCl on curing for 7 days, the shrinkage limit increases significantly from 49% to 63%. This is due to increased bond strength and due to enhanced soil-lime reactions. Also, curing with 1% NaOH the shrinkage limit increases continuously for 7 days of curing from 44% to 61% [16].

Table 4 Consistency limits of Carbide lime treated [shedi soil +20%RHA] mixture and other additives

Mix description	**Liquid Limit (%)**		**Shrinkage limit (%)**	
	Immediate	7-Day	Immediate	7-Day
Shedi soil alone	45	45	33	33
Shedi soil+20%RHA	61	60	41	43
Shedi soil+20%RHA+6%CL	65	67	51	57
Shedi soil+20%RHA+6%CL+1%NaCl	57	70	49	63
Shedi soil+20%RHA+6%CL+1%NaOH	56	71	44	61

IV. CONCLUSIONS

1. The liquid limit of Shedi soil increases with increase in rice husk ash content due to higher water holding capacity of RHA.
2. Shrinkage limit of shedi soil increase with increase in rice husk ash content. This is due to formation of a rigid skeleton with interconnected contact surfaces of rice husk ash particles in the composite, which has got superior resistance towards shrinkage than that of original soil skeleton.
3. There is a marginal variation in the Consistency limits of carbide lime treated shedi soil-rice husk ash mixture, with introduction of small dosages of additives like sodium chloride and sodium hydroxide. This is due to dominating quality of carbide lime present in the treated composite in comparison with that of additive.

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