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Effect of Rice Husk Ash on the Compaction and Strength Properties of Shed Soil Treated With Carbide Lime and Sodium Hydroxide

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Abstract: *The locally available shedi soil in Mangalore coast has been used in this investigation. The shedi soil which is also known as lithomargic soil is found to be problematic which is reported by many investigators due to its low strength and it is susceptible to erosion when it comes in contact with water. In this investigation, an attempt has been made to overcome this problem to use Rice husk ash (RHA) which is an agro industrial waste and carbide lime (CL) which is an industrial waste to improve strength and stiffness of shedi soil. The optimum percentage of RHA is found to be 20% and carbide lime 6% for improvement in strength of shedi soil. To understand the effect of salt to the stabilized soil 1% NaOH has been added and strength tests have been carried out for curing periods varying from 0 to 90 days. It has been observed that the strength achieved is better compared to rice husk ash and carbide lime stabilized soil, this may be due to the formation of alkali silicate hydrate and alkali aluminate hydrate gel along with calcium silicate hydrate and calcium aluminium silicate hydrated gel.*

Keywords - *Carbide lime, Rice husk ash, Shedi soil, unconfined compression test (UCC)*

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I. Introduction

Lithomargic soils are formed by mechanical weathering of rocks and they are locally called as shedi soil. These type of soils are commonly available in southwestern coast of India. These soils are mainly composed of silt sized particles and they exist in Meta-stable state [1]. Every Civil engineering project requires transition of load from superstructure to the surrounding soil. If the surrounding soil at the construction site such as road subgrade foundation, embankment foundation is of poor quality, care should be taken to improve its gradation. Altering the gradation of poor soil can either be done by mixing with the transported soil or by use of chemical admixture. Now a days, increase in the rapid urbanization and industrialization has lead to the production of large quantity of waste, such as fly ash, rice hush ash, carbide lime, cement kiln dust etc. The use of land for disposal of these wastes has led to scarcity of land and also causing hazardous to the environment. Stabilization of poor soil with such disposal waste has not only reduce the environmental problem but also as an alternative source for the replacement of cement and lime which are not economical [2]. India produces about more than 4 million tons of rice husk ash per year [3]. RHA is rich in silica content but cannot alone be used in the stabilization of soil due to lack in cementitious properties [4]. The high percentage of silica content in RHA can be utilized extensively for lime stabilization technique [5]. Carbide lime is a by-product of acetylene gas production, soil stabilization with the lime and carbide lime shows a similar strength [6].

II. Materials

2.1 Lithomargic soil/Shedi soil

Soil was collected from Surathkal, Mangalore District, Karnataka, India. Soil is air dried and Pulverized in the ball mill after separating the pebbles and sieved through 425 micron IS sieve. The physical properties of shedi soil are as shown in Table 1

2.2 Rice husk ash (RHA) and Carbide lime (CL)

High silica content of Agro-Industrial waste Riche husk ash has been collected from Sri Balaji rice mill, Davanagere district. Similarly Industrial waste rich in calcium content Carbide lime is collected from Gottegari Hobli, Bangalore district. Physical and chemical properties RHA and CL are shown in Table 2 and 3 respectively.
Grain size distribution of all the materials used in the study are as shown in Figure 1.

2.3 Sodium hydroxide

Chemically Pure sodium hydroxide is used to know the effect of salts on the Stabilized shedi soil. For this purpose 1% of Sodium hydroxide is mixed with Shedi soil and optimum dosage of RHA and CL.

Tablee 1 Physical properties of Shed soil

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

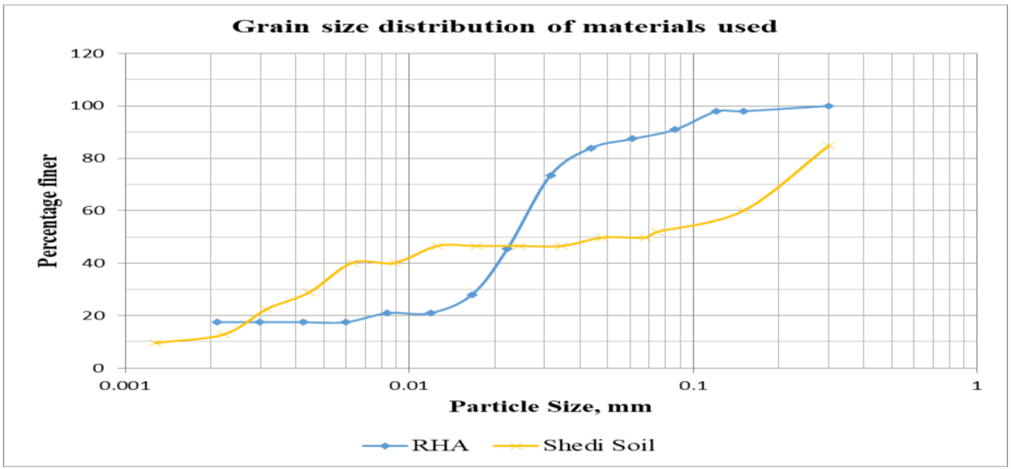

Fig. 1 Grain size distribution curves of Shedi soil, and Rice husk ash (RHA)

Table 2 Physical properties of RHA and Carbide lime

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

Table-3 Chemical properties of RHA and Carbide lime

Chemical composition	*Carbide lime*	*RHA*
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

III. Methodology

Compaction tests have been carried out by mini compaction as per the procedure [7] and unconfined compression strength test (UCC) was carried as per the procedure [8].

IV. Results and Discussion

4.1 Variation of Maximum Dry unit weight and optimum moisture content of RHA stabilized shedi soil

The variation of maximum dry unit weight (MDU) and optimum moisture content (OMC) with rice husk ash content is as shown in Figure 2 and 3 respectively. It can be inferred that maximum dry unit weight decreases as rice husk ash content is increased. The continuous decreasing trend of maximum dry unit weight of stabilized soil mass is because of lower value of specific gravity of rice husk ash in comparison to that of soil. It can also be observed that optimum moisture content increases as rice husk ash content is increased. The increasing trend in optimum moisture content is due to the higher water holding capacity of rice husk ash [9].

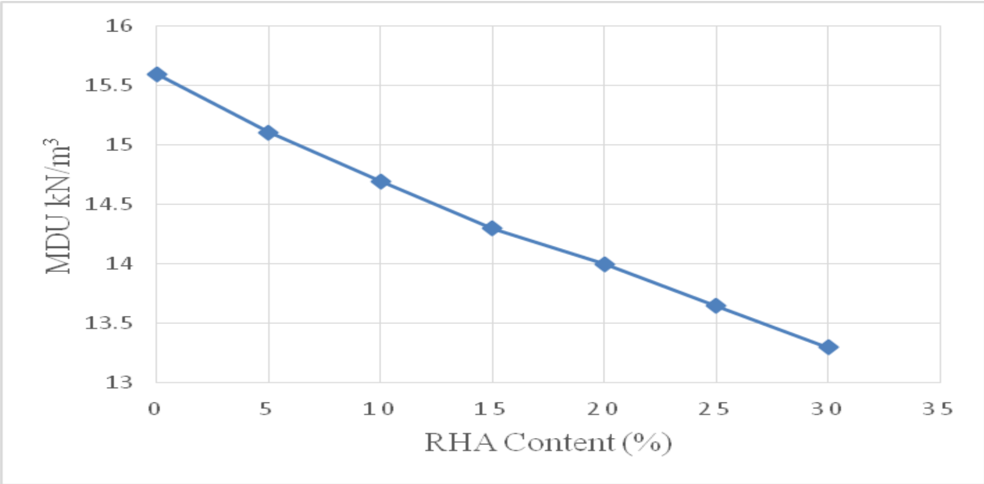

Fig. 2 Variation of maximum dry density of shedi soil and RHA mixture

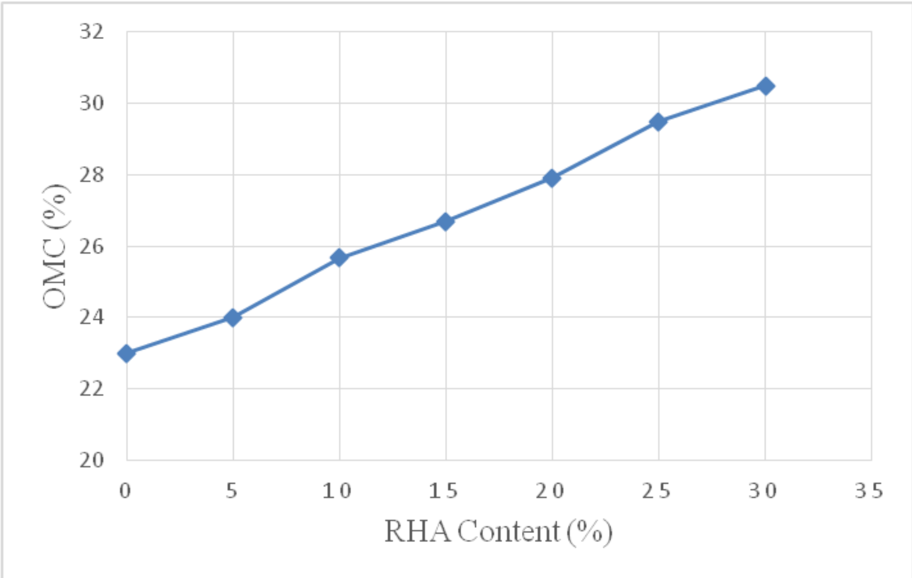

Fig. 3 Variation of optimum moisture content of shedi soil and RHA mixture

4.2 Variation of Maximum Dry unit weight and optimum moisture content of RHA stabilized shedi soil in the presence of Carbide lime

Maximum dry unit weight of carbide lime treated Shedi soil-rice husk ash mixture will decrease with increas in carbide lime content and is presented in Figure 4. This decrease is due to the Calcium ions from carbide lime changes the soil structure in treated soil mass. When calcium ion concentration increases in a treated soil mass, soil structure converts into flocculated one and void ratio increases. As a result of this, maximum dry unit weight decreases [10]. Optimum moisture content of carbide lime treated Shedi soil -rice husk ash mixture increases with increase in carbide lime content and is presented in Figure 5. This is due to which soil structure changes to flocculated one and water is arrested inside the flocs. As a result of this fact, optimum moisture content increases.

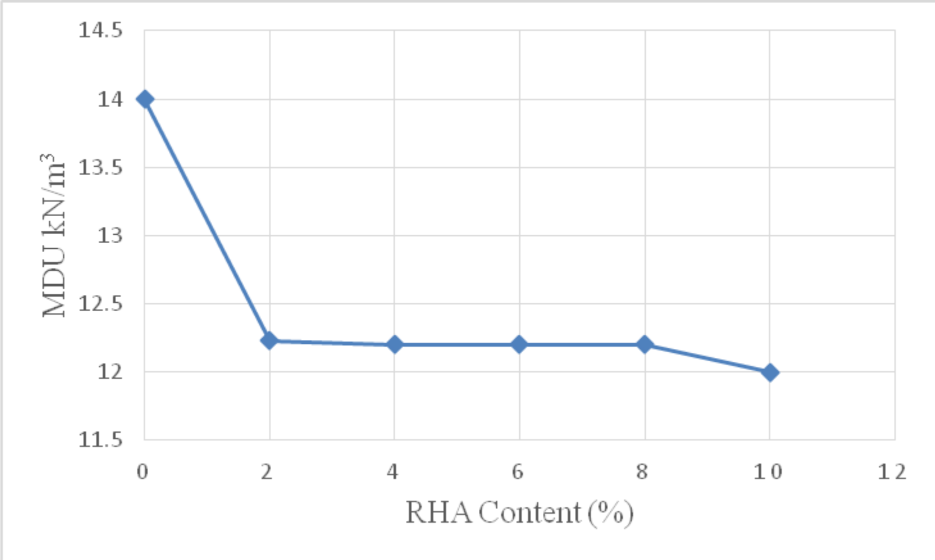

Fig. 4 Variation of maximum dry density of carbide lime treated [shedi soil+ 20% RHA] mixture

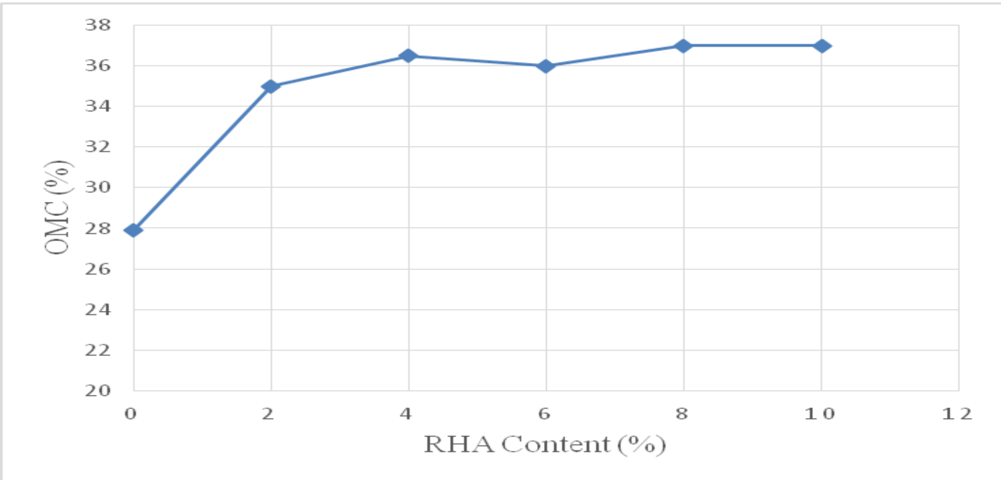

Fig. 5 Variation of optimum moisture content of carbide lime treated [shedi soil+ 20% RHA] mixture

4.3 Unconfined compression tests

Strength of lithomargic soil alone is found to be 175kPa, the optimum percentage of RHA and carbide lime, has been determined by adding RHA at an increment of 5% upto 30% to the shedi soil and it was found that strength of RHA treated soil is marginally improved due to agglomeration of shedi soil and RHA particle, Further strength is achieved by the addition of CL due to the formation of pozzolanic compound [11]. Thus optimum dosage of RHA and CL in the stabilization of shedi soil was found to be 20% and 6% respectively [11].

4.3.1Effect of sodium hydroxide on the strength properties of RHA stabilized shedi soil in the presence of carbide lime

The variation in strength of stabilized soil and soil alone for curing periods of 0, 7, 30, 60, 90 days are presented in Figure 6, soil alone shows a strength of 175kPa, apart from that addition of RHA to the shedi soil shows marginal improvement in the strength due to agglomeration of the soil and inert material. RHA possess angular, sub angular particle which increases the angle of internal friction [12]. Curing does not show any improvement in the strength of RHA-shedi soil composite due the absence of cementitious properties. Further strength is improved by the addition of carbide lime, as the carbide lime is added to shedi soil-RHA composite which increases the pH of the composite, where calcium ion from the carbide lime reacts with aluminium and silica of the shedi soil-RHA composite lead to the formation of Calcium silicate hydrate (CSH) and Calcium aluminium silicate hydrate (CASH) gel, which fill the voids of the composite lead to increase in the strength [13]. It is noticed that addition of small amount of sodium hydroxide to the stabilised shedi soil accelerates the

pozzolanic reaction and lead to the formation of alkali silicate hydrated gel and alkali aluminate hydrated gel along with the cementitious compounds such as CSH and CASH [14].
As seen from the Figure 6, addition of 1% sodium hydroxide to shedi soil-optimum RHA-optimum CL composite increases the strength compared to other combinations without 1% NaOH. This is due to the formation of pozzolanic compound along with alkali silicate and alkali aluminate hydrated gel which is a time dependent with the addition of 1% of NaoH.

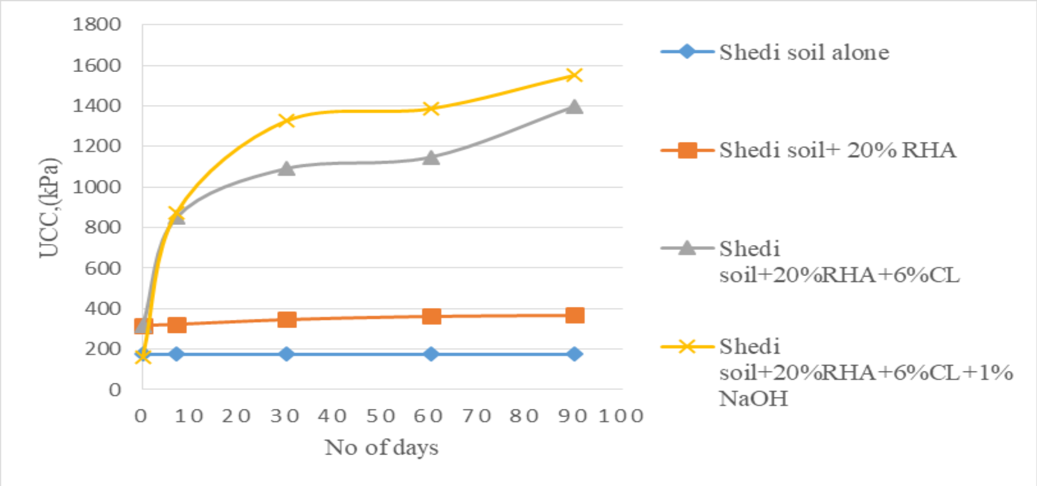

Fig. 6 Effect of curing on strength properties of Shedi soil stabilized with optimum RHA, optimum CL and 1% NaOH

V. Conclusions

Following conclusions have been drawn from the experimental study and analysis of the results:
1) Addition of RHA and CL to shedi soil decreases the dry density and increases the optimum moisture content due to the lower specific gravity of RHA and CL. The increase in optimum moisture content is due to higher water holding capacity of RHA
2)Strength of RHA treated composite is marginal due to lack in lime content , further strength is enhanced by the addition of carbide lime due to the formation of cementitious products such as CSH and CASH gel.
3)Addition of 1% of sodium hydroxide further improves the strength of the composite due to the formation of alkali silicate and alkali aluminate hydrated gel at high pH environment

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