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Efficacy of Rice Husk Ash and Lime on Strength Behaviour of Dredged Soils

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***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. Dredged Marine sample is uncommon type of clay and normally exists in soft consistency. In this study, Vizhinjam and Vallarpadam dredged soils are considered. The dredged soils are treated with different proportion of ricehusk ash and lime in order to obtain strength values Laboratory experiments to check the geotechnical properties of soil like hydrometer tests, proctor test, Atterbergs limit and UCC test were conducted. Organic content is also determined. The results shows that RHA and lime when used together can improve the strength property of the dredged soil. Upon the addition of rice husk ash and lime, the UCC value increases. The test result reveals that the optimum content of additive for achieving maximum strength is approximately between 4 to 6% lime mixed with 10% ricehusk ash of the dry weight of the soil.**

***Keywords*: Lime, Ricehusk ash, Dredged Soil, Land Reclamation, Stabilization**

1. Introduction

Most of the essential structures are built along coastal areas that are composed of highly compressible and weak soils up to significant depths. 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. Dredged soils are microcrystalline in nature and clay minerals like chlorite, kaolinite and illite 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. Soft alluvial and marine clay deposits have very low bearing capacity and excessive settlement characteristics, with obvious design and maintenance implications on tall structures and large commercial buildings, as well as port and transport infrastructure. Before commencing construction, stabilization of these soft soils is essential for both long term and short term stability of the structure. The engineering properties of such dredged fills are too poor to support the construction of structures. Even after years of self-weight consolidation, the fills still have a high water content, low bearing capacity, and high compressibility. Dredging is essential for the proper functioning of harbour, ports, land reclamation, and widening sections of river and maintenance of water bodies. Therefore, it is essential to stabilize the soft clayey soil before any construction work is conducted. Commonly adopted methods for soil stabilization are adding stabilizing agents to soil. It was found out that Rice husk ash can be used as an economic stabilizing agent in conjunction with lime for stabilizing. This paper attempts to understand and evaluate the effect of additives, namely ricehusk ash and lime on engineering properties of Vizhinjam and Vallarpadam dredged soils. Additives were added in different concentrations in this study and their effects on compaction characteristics and strength characteristics were evaluated.

2. Materials

A. Vizhinjam dredged soil

Collected from Vizhinjam Sea Port, Thiruvananthapuram district in Kerala, the dredged soil (Fig. 1) is obtained at a depth of 20m. The natural properties of the dredged soil are given below in Table 1.

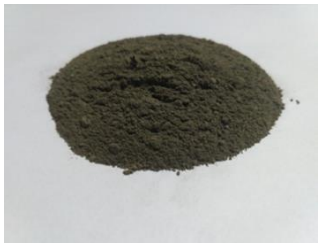

Fig. 1. Vizhinjam dredged soil

B. Vallarpadam dredged soil

Collected from Vallarpadam, Eranakulam district in Kerala. The natural properties of the dredged soil are given below in Table 1.

Fig. 2. Vallarpadam Dredged Soil

Table 1
Properties of Vizhinjam Dredged Soil

Properties	Vizhinjam Values	Vallarpadam Values
Specific Gravity	2.14	2.61
Natural Moisture Content (%)	61.5	58.4
Max Dry Density (g/cc)	1.53	1.56
Optimum Moisture Content (%)	27	35.6
Liquid Limit (%)	61	77
Plastic Limit (%)	32	33.68
Plastic Index (%)	29	43.32
Shrinkage Limit (%)	11	12.4
Unconfined Compressive Strength (kg/cm^2)	0.322	0.612
Organic Content (%)	16.66	19.21
Differential Free Swell Index	40	35
Grain Size Distribution (%)		
Sand (%)	11	12
Silt (%)	53	33.5
Clay (%)	36	54.5
Soil Classification	MH	CH

C. Ricehusk ash

Rice milling generates a by-product know as husk (Fig. 3). This surrounds the paddy grain. The properties of ricehusk ash are given in Table 2.

Fig. 3. Ricehusk ash

Table 2
Properties of Ricehusk ash

Properties	Value
Specific Gravity	2.16
Max Dry Density (g/cc)	1.15
Optimum Moisture Content (%)	38.46
Coefficient of uniformity (C_U)	11.18

D. Lime

Lime, chemically known as Calcium Oxide commonly known as quick or burnt lime (Fig. 4), is a widely used chemical compound. It is a white, caustic, alkaline crystal solid at room temperature. The properties of lime are given in the Table 3.

Table 3
Properties of Lime

Components	Amount (%)
Calcium Hydroxide	90
Silica	1.5
Ferric oxide	0.5
Magnesium Oxide	1
Alumina	0.2
Carbon dioxide	3

Fig. 4. Lime

3. Experimental programme

The various engineering properties of two soils were determined by different laboratory experiments such as specific gravity test, grain size analysis test, Atterberg limit test, modified Proctor compaction test, unconfined compressive strength test. All the tests were carried out as per standards.

A. Mix preparation

The study was carried out by performing compaction by adding ricehusk ash (5%, 10%, 15% and 20%) and lime (2%, 4%, 6 % and 8%) in different proportions to the dry weight of soil.

4. Results and discussions

A. Effect of ricehusk ash on compaction

The result shows that the OMC decreases and the dry density increases upon addition of ricehusk ash. The result of compaction test is shown in Table 4. The variation of OMC and dry density is shown in the Fig. 5 and 6.

Table 4
Compaction characteristics of soil – ricehusk ash mix.

Concentration of ricehusk ash	Vizhinjam		Vallarpadam	
	OMC	MDD	OMC	MDD
	%	kN/m^3	%	kN/m^3
0%	27	14.92	35.6	15.29
5%	25	17.40	33.6	16.4
10%	24	18.21	32.6	17.21
15%	22	19.21	30.6	18.21
20%	21	19.83	29.6	19.83

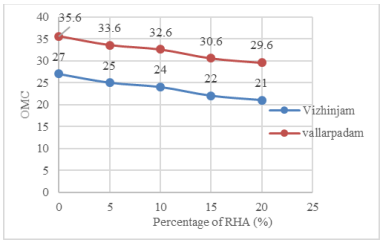

Fig. 5. Variation of OMC with Ricehusk ash

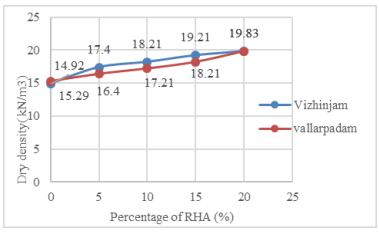

Fig. 6. Variation of Max Dry Density with Ricehusk ash.

B. Variation of UCS value with ricehusk ash

The optimum amount of ricehusk ash is found to be 10% as the increase in strength is to be 1.54 times compared to untreated vizhinjam soil and for vallarpadam soil the increase in strength is to be 2.12 times. Variation of UCS value with rice husk ash is given in Table 5. And graph representing the variation is shown in the Fig 7. UCS values increases with addition of rice husk ash upto 10% then decreases on both the soils. From the results it is clear that excess RHA introduced to soil and hence forming weak bonds between soil and cementitious compound formed.

Table 5
Variation of UCS with rice husk ash

RHA %	Vizhinjam Dredged Soil	Vallarpadam Dredged Soil
0	31.51	29.63
5	69.81	99.44
10	**100.31**	**129.94**
15	80.56	110.19
20	70.01	99.64

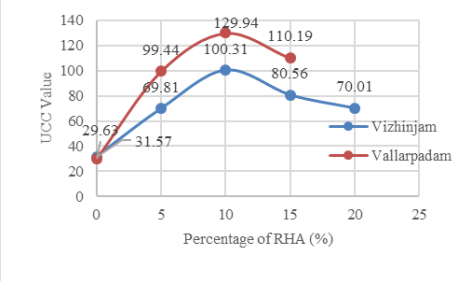

Fig. 7. Variation of UCS with rice husk ash

C. Effect of 10% ricehusk ash + lime on compaction

Soils with optimum amount of ricehusk ash (10%) is then treated with varying percentage of lime (2, 4, 6 and 8% respectively). The result of compaction test is shown in Table 6. The variation of OMC and dry density is shown in the Fig. 8 and 9 respectively.

Table 6
Compaction characteristics of lime – rice husk ash – soil mix

Concentration of lime on 10% RHA	Vizhinjam		Vallarpadam	
	OMC	MDD	OMC	MDD
	%	kN/m^3	%	kN/m^3
0%	24	18.21	32.6	17.21
2%	35.4	18.75	34.5	17.92
4%	37.3	19.4	36.4	18.4
6%	38.4	18.6	37.5	19.2
8%	38.8	18	37.9	18.6

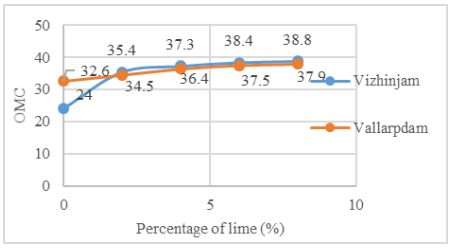

Fig. 8. Variation of OMC with Lime in RHA- soil mix

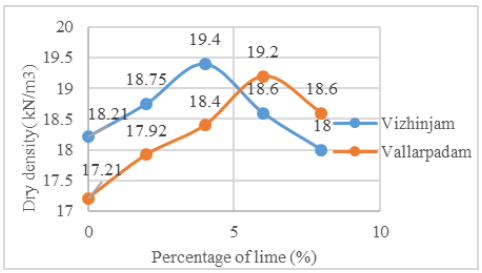

Fig. 9. Variation of Max Dry Density with Lime in RHA- soil mix

D. Variation of ucs value with 10% ricehusk ash + lime

The optimum amount of lime is found to be 4% as the increase in strength is to be 1.78 times compared to the vizhinjam soil – ricehusk ash mixture. And for vallarpadam soil the optimum amount of lime is found to be 6% as increase in strength is to be 1.98 times compared to the vallarpadaam soil – ricehusk ash mixture. Variation of UCS value with Lime in RHA-soil mix is given in Table 7. And graph representing the variation is shown in the Fig. 10.

Table 7
Variation of UCS with Lime in RHA-soil mix

Concentration of lime on 10% RHA	Vizhinjam Dredged soil	Vallarpadam Dredged soil
0	100.31	129.94
2	170.2	186.8
4	**210.6**	227.2
6	180.4	**257.4**
8	143.2	181.8

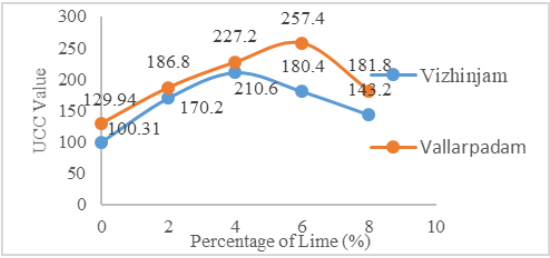

Fig. 10. Variation of UCS with Lime in RHA- soil mix

5. Conclusion

This study investigates the effect of two additives, namely ricehusk ash and lime on Vizhinjam and Vallapadam dredged soils with different concentrations. The following conclusions can be drawn:

- The optimum moisture content increases and maximum dry density decreases upon addition of the lime on both the soils.
- The optimum amount of ricehusk ash is found to be at 10% with an increase in strength of about 1.54 times compared to untreated vizhinjam soil and lime is found to be 4% with increase in strength of about 1.78 times when compared to the vizhinjam soil – ricehusk ash mix.
- The optimum amount of ricehusk ash is found to be at

10% with an increase in strength of about 2.12 times compared to untreated vallarpadam soil and lime is found to be 4% with increase in strength of about 1.98 times when compared to the vallarpadam soil – ricehusk ash mix.

- The UCC value increases upon addition of ricehusk ash and lime on both the soils.

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