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CONSOLIDATION BEHAVIOUR OF RICE HUSK ASH AND LIME STABILISED DREDGED SOIL

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***ABSTRACT**:- India has long coastal region having clay extended to a depth of 10m to 30m. The increased demand of land for various uses so available limited space necessitates the construction over the soft marshy lands. Dredged Marine sample is uncommon type of clay and normally exists in soft consistency. The engineering properties of dredged soils are too poor to support the construction of structures. In this study, Vizhinjam dredged soil is considered. The dredged soils are treated with optimum percentage of rice husk ash and lime in order to obtain strength values. Laboratory experiments to check the geotechnical properties of soil like hydrometer tests, proctor test, Atterberg limit and UCC test were conducted. Organic content is also determined. The optimum amount of rice husk ash and lime to be added is determined by unconfined compression tests. The results shows that RHA and lime when used together can improve the strength property. The coefficient of consolidation and time for 90% consolidation of stabilized soil and non-stabilized soils were determined by using conventional surcharge preloading method. And the results shows that RHA and lime when used together can decrease the coefficient of consolidation and time for 90% consolidation.*

***Keywords**:- Lime, Ricehuskash, Consolidation, Dredged Soil, Land Reclamation.*

1. INTRODUCTION

The rapid industrialization and urban development has lead to a scenario where we are in short of land for constructional activities. Hence we are forced to construct our buildings and structures on the available land, which may not have the required engineering properties. Most of the essential structures are built along coastal areas that are composed of highly compressible and weak soils up to significant depths. 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. Consolidation behaviour of soil forms an essential engineering property in design of structures.

This paper attempts to understand and evaluate the effect of additives, namely ricehusk ash and lime on engineering properties of Vizhinjam dredged soil. Additives were added in different concentrations in this study and their effects on compaction characteristics and consolidation behaviour were evaluated.

2. MATERIALS

2.1. VIZHINJAM DREDGED SOIL

Collected from Vizhinjam Sea Port, Thiruvananthapuram district in Kerala, the dredged soil (Fig. 2.1) is obtained at a depth of 20m. The natural properties of the dredged soil are given below in Table. 2.1.

Fig.2.1.Vizhinjam Dredged Soil

Table. 2.1. Properties of Vizhinjam Dredged Soil

PROPERTIES	VALUE
Specific Gravity	2.14
Natural Moisture Content (%)	61.5
Max Dry Density (g/cc)	1.53
Optimum Moisture Content (%)	27
Liquid Limit (%)	61
Plastic Limit (%)	32
Plastic Index (%)	29
Shrinkage Limit (%)	11
Unconfined Compressive Strength (kg/cm^2)	0.322
Organic Content (%)	16.66
Differential Free Swell Index	40
Grain Size Distribution (%)	
Sand (%)	11
Silt (%)	53
Clay (%)	36
Soil Classification	MH

2.2. RICEHUSK ASH

Rice milling generates a by-product know as husk (Fig. 2.2). 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. The properties of ricehusk ash are given in Table. 2.2.

Fig.2.2. Ricehusk ash

Table 2.2. 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

2.3. LIME

Lime, chemically known as Calcium Oxide commonly known as quick or burnt lime (Fig. 2.3), is a widely used chemical compound. It is a white, caustic, alkaline crystal solid at room temperature. The properties of lime is given in the Table. 2.3.

Fig.2.3. Lime

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Table. 2.3. Properties of Lime

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

3. EXPERIMENTAL PROGRAMME

The various engineering properties of the soil 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 and conventional odeometer test. All the tests were carried out as per standards.

3.1. 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. And the consolidation test were carried out on non-stabilized soil and stabilized soil.

4. RESULTS AND DISCUSSIONS

4.1. 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 4.1. The variation of OMC and dry density is shown in the Fig. 4.1 and 4.2.

Table.4.1. Compaction characteristics of soil – ricehusk ash mix.

Concentration (%)	0	5	10	15	20
OMC (%)	27	25	24	22	21
Dry density (kN/m³)	14.92	17.4	18.21	19.21	19.83

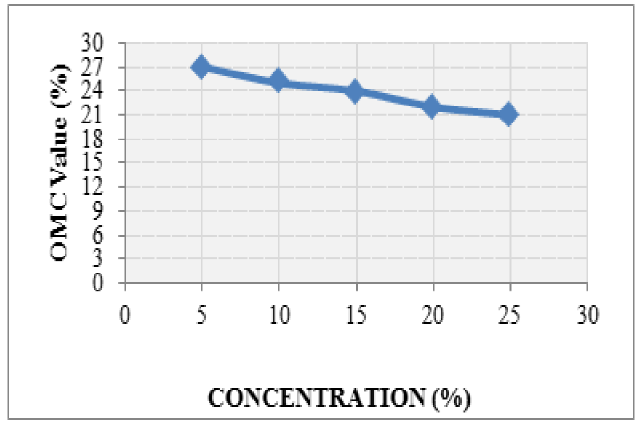

Fig.4.1. Variation of OMC with Ricehusk ash

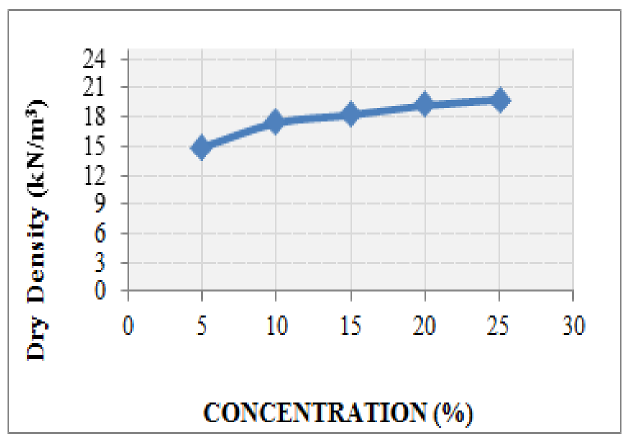

Fig.4.2. Variation of Max Dry Density with Ricehusk ash.

4.2. 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 the untreated soil. Variation of UCS value with rice husk ash is given in Table. 4.2. And graph representing the variation is shown in the Fig 4.3. UCS values increases with addition of rice husk ash upto 10% then decreases. From the results it is clear that excess RHA introduced to soil and hence forming weak bonds between soil and cementitious compound formed.

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Table.4.2. Variation of UCS with rice husk ash.

Concentration (%)	0	5	**10**	15	20
UCC (kN/m²)	31.57	69.81	**100.31**	80.56	70.01

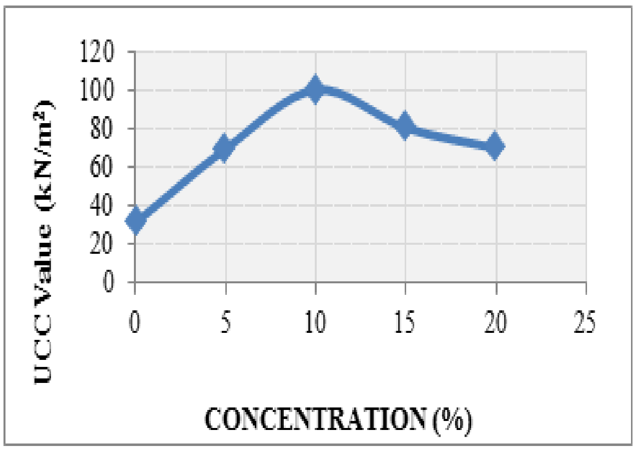

Fig 4.3. Variation of UCS with rice husk ash.

4.3. EFFECT OF 10% RICEHUSK ASH + LIME ON COMPACTION

The soil 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. 4.3. The variation of OMC and dry density is shown in the Fig. 4.4 and 4.5 respectively.

Table.4.3. Compaction characteristics of lime – rice husk ash – soil mix.

Concentration (%)	2	4	6	8
OMC (%)	35.4	37.3	38.4	38.8
Dry density (kN/m³)	18.2	19.4	18.6	18

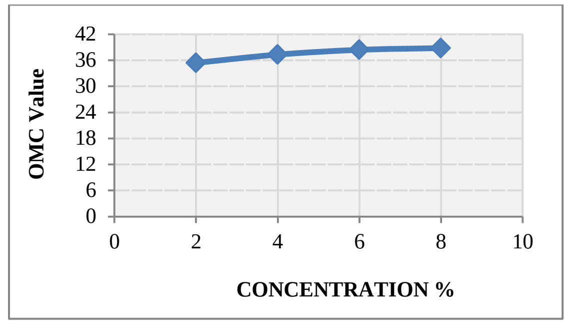

Fig.4.4. Variation of OMC with Lime in RHA- soil mix.

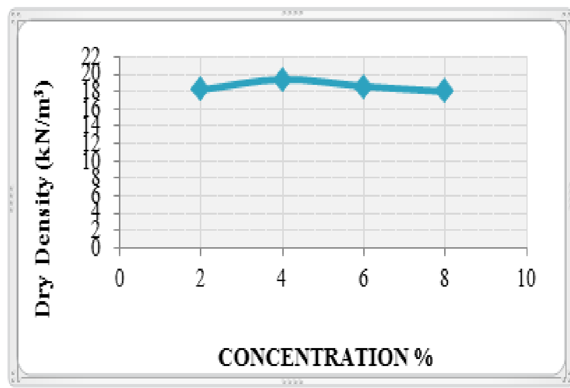

Fig.4.5. Variation of Max Dry Density with Lime in RHA- soil mix.

4.4. 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 soil – ricehusk ash mixture. Variation of UCS value with Lime in RHA-soil mix is given in Table.4.4. And graph representing the variation is shown in the Fig 4.6.

Table.4.4. Variation of UCS with Lime in RHA-soil mix.

Concentration (%)	2	**4**	6	8
UCC (kN/m²)	170.2	**210.6**	180.4	143.2

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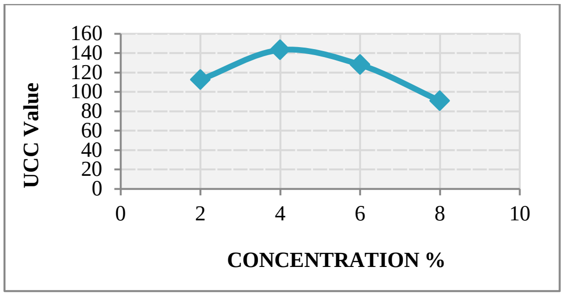

Fig.4.6. Variation of UCS with Lime in RHA- soil mix.

4.5. COEFFICIENT OF CONSOLIDATION

The variation of coefficient of consolidation for untreated soil and treated soil due to surcharge loading by conventional consolidation test is shown in Table. 4.5. Graphical representation of variation of C_V is shown in Fig. 4.7. The coefficient of consolidation decreases upon addition of optimum percentage of rice husk ash and lime.

Table.4.5. Variation of C_V values.

LOAD	0.2kg/cm²	0.4kg/cm²	0.6kg/cm²
Untreated Soil sample	27.016×10^{-3} cm²/sec	28.5×10^{-3} cm²/sec	53.0004×10^{-3} cm²/sec
Treated soil sample	11.680×10^{-3} cm²/sec	14.13×10^{-3} cm²/sec	40.505×10^{-3} cm²/sec

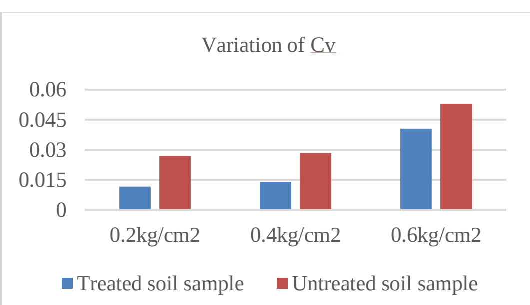

Fig.4.7. Variation of C_V values.

4.6. 90% CONSOLIDATION TIME

The variation of coefficient of consolidation for untreated soil and treated soil due to surcharge loading is shown in Table 4.6. Graphical representation of variation of t_{90} is shown in Fig 4.8. The time for 90% consolidation decreases upon addition of optimum percentage of rice husk ash and lime.

Table.4.6. Variation of t_{90} values.

LOAD	0.2kg/cm²	0.4kg/cm²	0.6kg/cm²
Untreated Soil sample	4.9 min	4.2 min	3.1 min
Treated soil sample	3.1 min	2.9 min	2.4 min

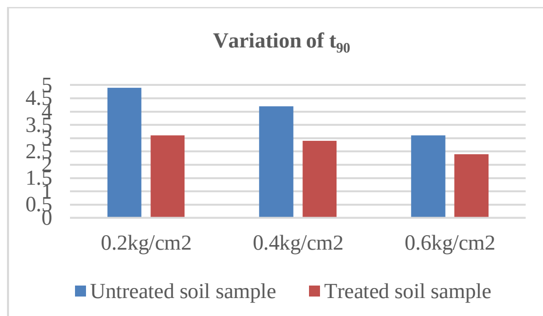

Fig.4.8. Variation of t_{90} values.

5. CONCLUSIONS

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

- The optimum moisture content increases and maximum dry density decreases upon addition of the lime.
- 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 soil and lime is found to be 4% with increase in strength of about 1.78 times when compared to the soil – ricehusk ash mix.
- The coefficient of consolidation and time for 90% consolidation decreases upon addition of optimum percentage of rice husk ash and lime.

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