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Effect of Rise Husk Ash and Cement Mixtures on Unconfined Compressive Strength of Cohesive Soil

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Abstract

Current paper shows laboratory testing results on the Unified Compressive Strength (UCS) of cohesive soils stabilized with Cement and Rice Husk Ash (RHA). The mixture was compacted at the OMC, and at the dry and wet side of OMC. Clays exhibit generally undesirable engineering properties. So it is needed to improve the properties of soils using economic methods like treating with industrial and agricultural wastes i.e. fly ash, rice husk ash etc which are having cementious value. RHA was collected from United Rice Mill, Bahu Samana, NH-1. Locally available soil was mixed with 0%, 5%, 10% & 15% of RHA along with 0%, 6%, 8% & 10% cement. It is concluded by the results that because of increase in moisture content and decrease in dry density of soil, it can be made light in weight. The optimized maximum value of UCS of soil observed with 10% RHA addition after that further addition of RHA does not contribute more towards strength.

Keywords: Maximum Dry Density, Optimum Moisture Content, RHA, Stabilization, Unconfined Compressive Strength

1. Introduction

Clay generally shows undesirable properties. It tends to have lower shear strengths and it generally lose its strength further upon adding moisture or by any physical disturbances[1]. Clays can be compressible and plastic and it may shrink at higher temperature or after drying and expand in contact of moisture. Expansive soil or black cotton soil show this undesirable feature. Creep can be occurred in cohesive soils with time and under constant loading. Cohesive soils tend to have less resilient modulus values[2]. Because of these characteristics, clays are not a good material for footings[3].

Use of cement, lime, and or fly ash etc can chemically transform unstable soils into structurally sound foundation. Mixing stabilizers in a particular amount in clay soils induce textural change and give better improved strength[4].

By product of rice milling industry i.e rice husk, after burning it rice husk ash can be obtained. In rice grains only 10% rice husk present by weight. After burning it, about 20% becomes Rice husk ash[5]. Cementitious Value of RHA is very less but it reacts chemically with amount of moisture present and cementitious compounds are formed.

These compounds improve the compressibility characteristics and strength of clay soils. The experimental study has been done to make use of industrial wastes and for the need of improvement in marine clays properties[6].

1.1 Stabilization of Soil using RHA

In[7] observed use of lime and RHA mixture for clayey soil stabilization. The result of study shows that lime and RHA mixture addition to Philippine and Thai soils could not give major increment in strength than only lime is used.

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In[8] concluded the effect on geo-technical properties of lateritic soil with different cement- RHA proportions. Lateritic soils, stabilized with RHA –cement proportions could be used in highway construction.

The recommended mix proportion for base materials was 6% cement-6% Rice husk ash and for sub-base material 3 % cement-6% Rice husk ash.

In[9,10], analyzed the improvement of Malaysian residual soil with use of cement-rice husk ash and lime-rice husk ash . Addition of RHA shows increase in strength of cement stabilized and lime stabilized residual soils.

In[11] experiments confirm that the UCS of cement-stabilized soil; whatever expansive and non-expansive clay; residual soil, raised by RHA addition. Generally, results shows that the mix proportions of 10-15% RHA and 6-8% cement contribute significant increase in engineering properties.

The study objective is to analyze variations in engineering properties of cohesive soil with various proportions of RHA (0%, 5%, 10%, and 15%) and cement (0%, 6%, 8% & 10%) of the dry density of the soil and UCS.

2. Materials

Soil Samples: 200 kg of locally available clayey soil (CL) was obtained and air-dried. Pebbles and vegetative matter were removed by hand sorting. Then soil was sieved through 4.75mm to eliminate gravel fraction. Up to 24 hours oven dried soil was mixed with RHA and cement. Table 1 and Table 2 shows physical properties and grain size analysis of soil respectively.

RHA: For investigation locally available rice husk ash was used which was collected from United Rice Mill, Bahu Samana, NH-1. Table 3 shows physical properties of RHA.

Table 1. Physical properties of soil

S. No.	Parameters	Results
1.	Light compaction test i) MDD (kN/m3) ii) OMC (%)	18.35 14.2
2.	Liquid limit (%)	29.6
3.	Plastic limit (%)	17.8
4.	Plasticity index (%)	11.8
5.	Specific gravity	2.64
6.	Indian soil classification	CL

Table 2. Grain size analysis of soil

Sieve Size (mm)	%age Passing	Test Method
0.6	100	IS: 2720 Part-IV
0.3	100	
0.15	97.6	Sand Content = 8.9%
0.075	91.9	Silt Content = 70.5%
0.06	86.7	Clay Content = 20.6%
0.02	57.3	
0.006	43.2	
0.004	29.2	
0.001	16.2	

Table 3. Physical properties of rice, husk, ash

Sr. No.	Properties	Values
1.	Specific Gravity	1.97
2.	Grain Size Analysis a) Gravel Size Fraction (%) b) Sand Size Fraction (%) c) Silt & Clay Size Fraction (%)	0.00 54.4 45.6
3.	Maximum Dry Density (kN/m^2)	9.25
4.	Optimum moisture content (%)	52.4

3. Test Methods

3.1 Consistency Limits

Consistency is the physical state of fine- grained soil. Degree of firmness of soil can be denoted by consistency. It can be termed as soft, hard or firm. According to Atterberg, soil can be present in four states liquid, plastic, semi solid or solid state. Consistency limit is water content at which soil changes from one state to other state[12].

3.2 Specific Gravity

Pycnometer method[12] was adopted. The method can be used for all types of soils, but is more suitable for medium-grained soils, with more than 90% passing a 20 mm IS sieve and for coarse-grained soils with more than 90% passing a 40 mm IS sieve[12].

3.3 Grain Size Analysis of Soil

Soil is sieved through a set of sieves[13].

3.4 Compaction

To improve the strength of soil, compaction is necessary; especially for the construction of airports, highways and other structures. This test is referred to as the Standard Proctor Compaction Test[14].

3.5 UCS

The Tnconfined Compression Test[15] is one of the conditions of a triaxial testing in which the confining pressure is zero. The sizes of sample were 80mm length and 40mm diameter. The test were conducted at the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) values of natural soil.

4. Test Results

4.1 Maximum Dry Density

The results observed from the compaction test on various proportions of soil: cement: rice husk ash, MDD of natural soil is 18.35 kN /m^3, which decreases up to 16.7 kN/m3 with 15% RHA addition Figure 1. With an addition of 6%, 8% & 10% cement the value of MDD decreases to 15.7 kN/m^3, 15.25 kN/m^3 and 14.54 kN/m^3 which further decreases to 15.4kN/m^3, 14.2 kN/m^3 and 13.2 k N/m^3 respectively with an addition of 15 % RHA Figure 2,3 and 4 . The results show the decrease in maximum dry density with increase in both cement and RHA content. The decrease in MDD may be due to specific gravity and particle size of soil and stabilizer.

4.2 Optimum Moisture Content

From the results of proctor test, it is concluded that for natural soil OMC was 14.5%, which increases up

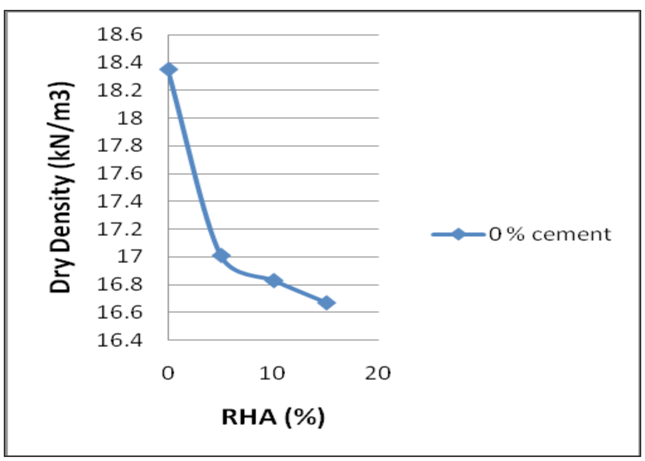

Figure 1. Graph shows decrease in dry density of soil for various proportions of rice husk ash with 0% cement.

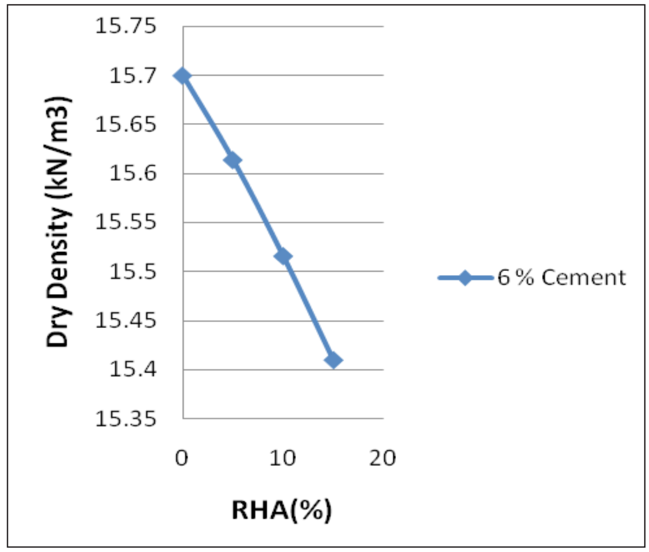

Figure 2. Graph shows decrease in dry density of soil for various proportions of rice husk ash with 6% cement.

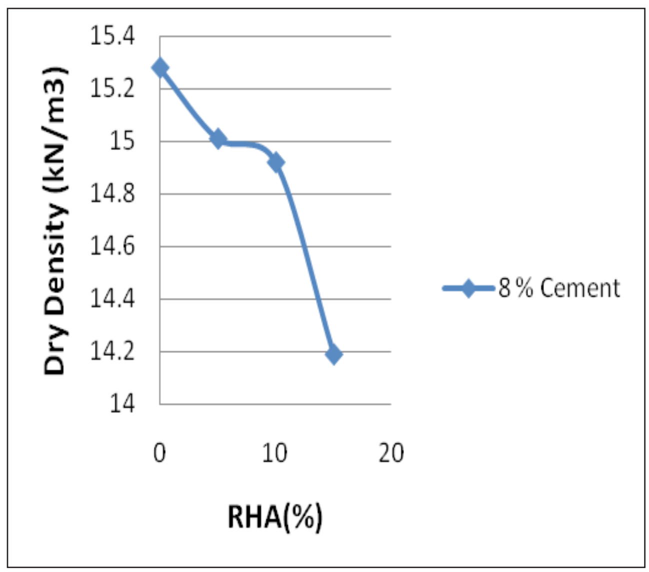

Figure 3. Graph shows decrease in dry density of soil for various proportions of Rice husk ash with 8% cement.

to a value of 20.75% with 15% RHA addition. With 6% cement addition to soil the value of OMC raises to 21% which further raises to 22.7% on 15 % RHA addition. By raising the percentage of cement content to 8% and 10% the optimum moisture content increases to 22% & 28% which further increases to 28.2% and 31% respectively on addition of 15% RHA. The increase in OMC is either due to additional amount of held water with flocculent soil structure that is the result of cement interaction or

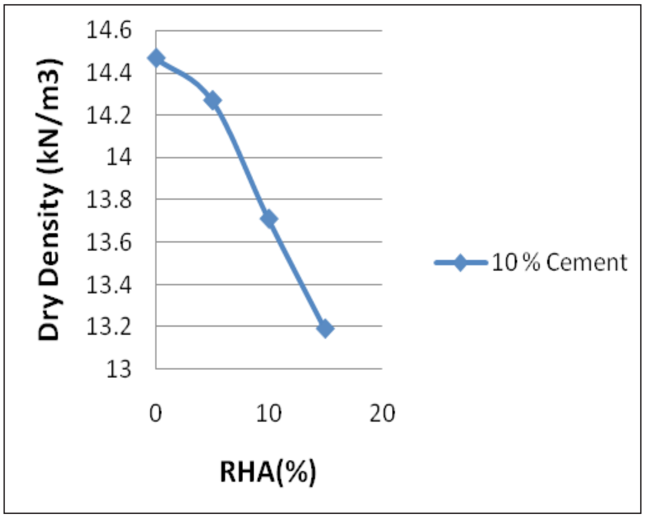

Figure 4. Graph shows decrease in dry density of soil for various proportions of Rice husk ash with 10% cement.

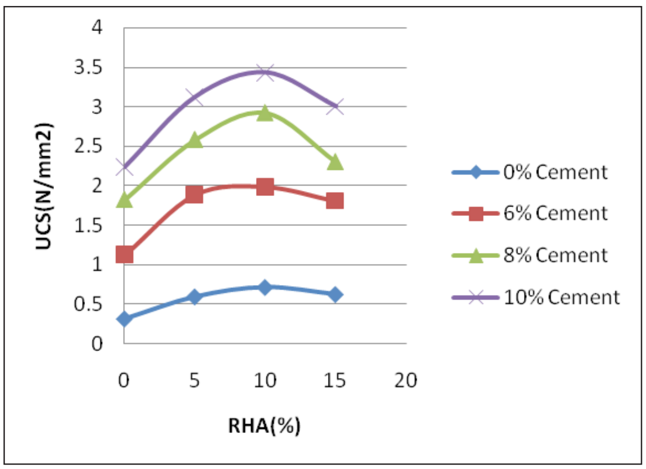

Figure 5. Graph shows the combination of unconfined compressive strength of various mixes of Soil: RHA: Cement at 7 days curing.

exceeding absorption of water by rice husk ash's porous properties.

4.3 Unconfined Compressive Strength

Unconfined compressive strength result at 7 days curing shows that with increase of cement in mix, deformation decreases and unconfined compressive strength increases. The results showed that RHA addition up to 10 % raises the unconfined compressive strength to highest value and after that more RHA addition does not contribute towards strength. Hence the highest value of unconfined compressive strength at 10 % RHA is 0.7 N/mm^2 at 0% cement which decreases to 0.62N/mm^2 at 15% RHA. Similarly at 6%, 8% & 10% cement the values are 1.98N/mm^2, 2.92N/mm^2 and 3.43 N/mm^2 respectively at 10%RHA which further decreases to 1 .8N/rnm^2, 2.3N/mm^2 and 3N/mm^2 on addition of 15% RHA Figure 5.

5. Conclusions

Strength characteristics of soil- cement -RHA proportion have been analyzed in this research. The conclusions of laboratory test results observed from stabilized Cement-RHA cohesive soil are as following:

1. The MDD of soil- RHA-cement decreases with increase in RHA content and OMC increases. The reduction in density continues with addition of 0% cement to a varying proportion of 10% and similar is the trend for optimum moisture content in increasing order.
2. The UCS results for a 7 days cured sample increases up to 10% RHA for different proportions of the cement and after which more addition of RHA does not contribute towards strength. It may be because of pozzolanic reaction between RHA and lime liberated from hydration of cement to form secondary cementitious materials.
3. Soil—RHA samples fail by bulging but soil- cement & soil — cement — RHA samples fail by formation of vertical cracks.
4. Addition of RHA alone to soils decreases the strengths which may be because of reduction in dry density and increment in OMC and also because of properties of RHA.
5. With increase in percentage of RHA the strength tends to increase and it reaches at a particular value and after that it is getting reduced but it is always more than respective soil - cement mixture. Hence RHA is useful to improve the soil properties, even in lesser amounts. At 10% RHA addition, maximum values of strength can be obtained.

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