Stabilizing Soils Incorporating Combinations of Rice Husk Ash and Cement

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***Abstract*— Rice husk ash (RHA) is a pozzolanic material which is readily available in an agricultural country like India. It can be used in soil stabilization, when rice husk is burnt under controlled temperature and 17%-25% of rice husk's weight remains ash. Soil is the basic construction material which supports the loads of superstructure .The existing soil at a particular location may not be suitable for the construction so may need an improvement in basic properties using cost effective practices like treating with industrial wastes and agricultural wastes like fly ash, rice husk ash etc which are having cementitious value. The focus of the paper is to study the effects of various proportions of rice husk ash – cement for enhancing the properties of soil. The objective of this study is to investigate the strength improvement of Soil: RHA: Cement mixtures in terms of strength properties of stabilized soils. Tests were conducted on different test specimens with varying ratios of contents at OMC and MDD. Locally available soil was mixed with 0%, 5%, 10% & 15% of RHA along with 0%, 6%, 8% & 10% cement.**

***Keywords*— RHA, Cement, Clayey Soil, UCS.**

I INTRODUCTION

The existing soil at a particular location may not be suitable for the construction due to its poor load carrying capacity and higher compressibility or even sometimes excessive swelling in case of expansive soils. The improvement of soil at a site is necessary due to rising cost of the land and huge demand for high rise buildings. There is a need to concentrate on improving properties of soils using cost effective practices like treating with industrial wastes and agricultural wastes like fly ash, rice husk ash etc which are in pozzolonic materials.Clays exhibit generally undesirable engineering properties. They tend to have low shear strengths and also lose shear strength further upon wetting or other physical disturbances. Some types of clay expand and shrink greatly upon wetting and drying which is the most undesirable feature. Also clays develop large lateral pressures and they tend to have low resilient modulus values. For these reasons, clays are generally poor materials for foundations. But, the engineering properties of clayey soils can be improved by using different stabilization techniques. Soil stabilization is a technique introduced many years ago with the main purpose to make the soil capable of meeting the requirements of the specific engineering projects (Cook, C.J. et al, (1989),Basha , E.A., Hashim, R. , Mahmud, H.B. &Muntohar , A.S., (2004), Jha, J.N. & Gill, K.S., (2006),Koteswara Rao. D et al., (2012).Several additives, which may be utilized for ground modification such as cement, lime and mineral additives such as fly ash, silica fume, rice husk ash, have been used under various contexts. Rice husk (RH) is one of the by-products obtained during milling of rice. This surrounds the paddy grain. It is reported that approximately 0.23 tons of rice husk (rice hull) is formed from every ton of rice produced. World rice production is approximately 500 million tons. Asian farmers produce rice about 90% of total production with two countries, China and India, growing more than half of the total crop. In certain countries, RH is sometimes used as a fuel for parboiling paddy in the rice mills and to power steam engines. The residual product obtained from burning of rice husk is called rice husk ash (RHA) which contributes to environmental pollution. It would be beneficial to the environment to recycle the waste to produce eco-materialhaving high end value. It is generally reported that in rice husk, silica is predominantly in inorganic linkages, but some of the silica is also bonded covalently to the organic compounds. This portion of the silica is un-dissolved in alkali and can withstand very high temperatures. It has been clear that once the organic part of RH is extracted, the inorganic residue may be relatively pure, forming a better source of silica. Characterizations by scanning electron microscopy (SEM), energy-dispersive X-ray analysis (EDX) etc., suggest that silica is present all over, but is concentrated on Protuberances and hairs (trichomes) on the outer epidermis, adjacent to the rice kernel. There is a significant variation in silica percentage. The silica is in hydrated amorphous form, either opal or silica gel. Disposal of rice husk ash is an important issue in the countries like India which cultivate large quantities of rice. Rice husk has a very low nutritional value and as they take very long to decompose, so are not appropriate for composting or manure. Therefore in the present investigations an effort has been made to utilize RHA for geotechnical purposes after mixing with soil and cement.

II MATERIALS AND METHODS

A. Soil**:** The soil sample used for this study was locally available soil near Rajpura, Punjab, using the method of disturbed sampling. The properties of the soil used in the investigation are given in Table 1. The overall geotechnical properties of the soil classified as Clay with low plasticity (CL) in the IS Soil Classification System. The soil collected from the site was pulverized with wooden mallet to break the lumps and then air dried. Subsequently it was sieved through 2.36mm IS sieve and then dried in an oven at 105^0 C for 24 hours.

B. RH**A**: The rice husk ash (RHA) used in the investigation was collected from Vardhmann spinning Mills, Ludhiana. Processing of RHA was done on similar line as that of soil. Required quantity of soil was weighed and desired quantity of RHA and cement were added to get the uniform mix required for sampling**.**

C. ORDINARY PORTLAND CEMENT 43 GRADE**:** The Ordinary Portland cement obtained from Ambuja Cement Company with grade 43 was used in the study. Cement is a fine, grey powder. It is a material with adhesive and cohesive properties which is capable of bonding mineral fragments into a compact-solid.

D. Water**:** Locally available tap water was used for investigation.
The composition along with the physical properties of materials used is outlined in Table: 1, Table: 2, Table: 3 and 4 respectively.

TABLE 1 Physical properties of soil

S. No.	**Parameters**	**Results**
1.	Light compaction test	
	MDD (kN/m^3)	18.35
	OMC (%)	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 Physical properties of RHA

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

TABLE 3 Chemical Properties of RHA.

S. No	**Component**	**%**
1.	Silica (SiO_2)	91.58
2.	Alumina (Al_2O_3)	1.95
3.	Iron Oxide (Fe_2O_3)	0.48
4.	Lime (CaO)	0.78
5.	Magnesia Oxide (MgO)	0.58
6.	Potassium (K_2O)	2.92
7.	Other oxides	1.71

TABLE 4 Physical Properties of Cement used

Properties	Value
Grade	43
Initial Setting time (min)	30
Final Setting time (min)	300
Compressive strength	
3Days strength (MPa)	25.5
7Days strength (MPa)	36.7
28Days strength (MPa)	41.5

Specimen Preparation

The soil collected from the site was pulverized with wooden mallet to break the lumps and then air dried. Subsequently it was sieved through 2.36mm IS sieve and then dried in an oven at 105^0 C for 24 hours. Processing of RHA was done on similar line as that of soil. Required quantity of soil was weighed and desired quantity of RHA and cement were added to get the uniform mix required for sampling. A set of 16 specimens were prepared according to Indian Standard specifications. All the desired tests were conducted as IS methods. The test results reported are the average of three tests.

Method of Testing

In the strength tests, cylindrical specimens were prepared according to codal provisions for soil and soil + RHA + cement mixtures. One of the popular methods of evaluating the effectiveness of stabilization is unconfined compressive strength, the better the quality of stabilized material; higher will be the compressive strength. Each specimen used was compacted at optimum moisture content and dry density. Specimens were cured in groups of three in a controlled chamber before being tested in compression a curing period of 7 days was adopted and at least three specimens were tested for each case.

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III TEST RESULTS & DISCUSSION

Compaction Characteristics

Fig. 1 & Fig. 2 shows the effect of the addition of cement, RHA, and cement–RHA mixtures on the compaction characteristics of the soil tested. The figure depicts that adding cement and RHA increased the OMC and diminish amount of the MDD correspond to increasing of cement and RHA percentage. The decrease in the MDD can be due to the replacement of soil by the RHA in the mixture. Also the decrease in the MDD may be considered due to RHA acting as filler in the soil voids with lower specific gravity. The increase in OMC is due to the addition of RHA, which decreases the quantity of free silt and clay fraction and coarser materials with larger surface areas. These processes need water to take place which implies that more water is needed in order to compact the soil-RHA mixtures as reported in Zhang et. al (1996).

Unconfined Compressive Strength

The effect of the addition RHA and cement on the unconfined compressive strength is shown in Fig.- 3.Unconfined compressive strength (UCS) results after 7 days curing for different mixes shows that with increase of cement, deformation goes on decreasing and unconfined compressive strength goes on increasing. The subsequent increase in the UCS is attributed to the formation of cementitious compounds

between the CaOH present in the soil and RHA and the pozzolans present in the RHA. The results showed that addition of RHA up to 10 % increases the UCS to maximum value and thereafter further addition does not contribute towards strength. The decrease in the UCS values after the addition of 10% RHA may be due to the excess RHA introduced to the soil and therefore forming weak bonds between the soil and the cementitious compounds formed.

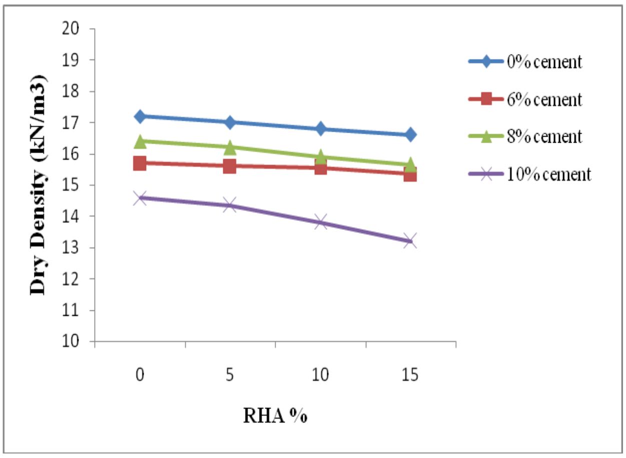

Figure 1: Variation of MDD with RHA Content

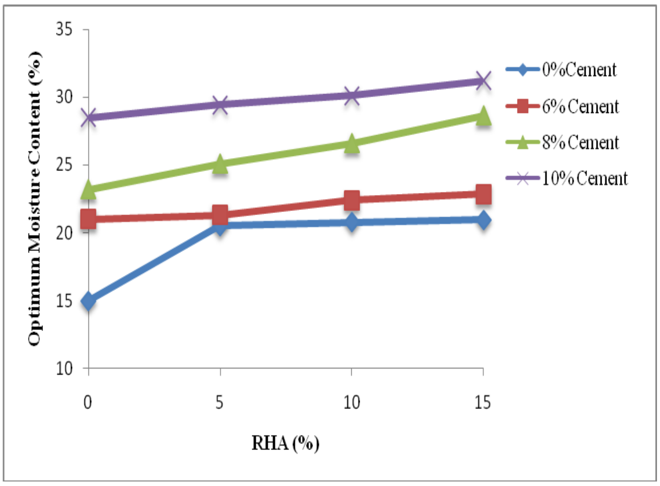

Figure 2: Variation of OMC with RHA Content

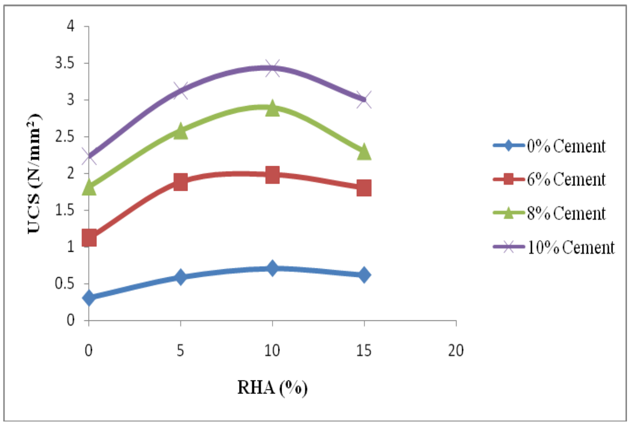

Figure 3: Combined Graph showing UCS of different proportions of Soil: RHA: Cement at 7days curing period

IV CONCLUSIONS

The following conclusions can be made on the basis of test results obtained from cement-RHA stabilized clayey soil:

1. Treatment with RHA and a small percentage of cement shows a general decrease in the MDD and increase in OMC with increase in the RHA content.
2. The UCS of 7 days cured samples shows an increasing trend up to 10% RHA for various proportions of cement and further increase in RHA content does not contribute much towards strength. It may be due to pozzolanic reaction between lime liberated from hydration reaction of cement and RHA to form secondary cementitious materials.
3. With increase in percentage of RHA the strength tends to increase and reaches a certain value and thereafter it starts decreasing but it is always higher than respective soil – cement mixture. Hence even in smaller amounts, RHA is beneficial in improving the properties of soils. The maximum value is obtained at an addition of 10% RHA.
4. RHA when used as an alternative or as a partial replacement along with cement in stabilizing clayey soils reduces the cost of material for construction as well as solving the disposal problem.

REFERENCES

[1] Arora, K.R "Soil Mechanics & Foundation Engineering" 4th Edition, 2013.
[2] Alhassan, Musa & Mohammed, Alhaji, "Effects of Rice Husk Ash on cement stabilized laterite Leonardo Electronic Journal of Practices and Technologies,April 2008, 11, 47-58.
[3] Basha, E.A., Hashim, R., Mahmud H. B & Muntohar, A.S., "Stabilization of Residual soil with Rice husk ash and cement. Original research article construction & Building Material, Volume -19, 2005, Pp.448-453.
[4] Cook, C.J. et al, "Use of rice husk ash to enhance lime treatment of soil." Canadian Geotechnical Journal, 1989, pp. 843-852.
[5] Datta, R.K., et al, "Some alternate binders Based on Rice Husk & other cheap materials". National seminar on Building materials & science & technology, Institute of Engineers (India), Roorkee, April, 1982.
[6] I.S.4332, Test for determination of moisture content-dry density for stabilized mixtures.
[7] Jha J.N. & Gill, K.S., "Effect of Rice husk ash on lime Stabilization". Journal of the Institution of Engineers (India), 2006, Volume 87, page 33-39.
[8] Koteswara Rao. D et al.,"The Effects of ferric chloride and RHA in the stabilization of expansive soils for pavement subgrades."International Journal of Engineering Science & Technology. Volume 2, 2012, Page-146-153.
[9] Zhang MH, Lastra R, Malhotra VM., "Rice husk ash paste and concrete: some aspects of hydration and the microstructure of the interfacial zone between the aggregate and paste. Cement Concrete Research, 1996, vol. -26(6):963–77.