International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com‖ Volume 2 Issue 2‖ February 2016 ‖ PP 40-48

POTENTIALS OF RICE-HUSK ASH AS A SOIL STABILIZER

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Abstract: Rice Husk Ash is a pozzolanic material that could be potentially used in Soil stabilization ,though it is reasonably produced and freely available. When Rice-Husk is burnt under controlled temperature, ash is produced an about 17% -25% of Rice Husk's weight. This paper presents the results of experimental study carried out by the virgin soil sample was taken alongside the pond of "Jadavpur University"(Jadavpur Campus), Classified as CI(clay of medium plastic) as per **AASTHO** soil classification system and was stabilized with 5%,10%,15% & 20 % of Rice Husk Ash(RHA) by weight of the dry virgin soil. The improvement of the Geo-Technical properties of the fine grain soil with varying percentages of RHA was done with the facilitate of various standardize laboratory tests. The testing program conducted on the virgin soil samples by mixed with specified percentages of rice-husk materials, it is included Atterberg limits, "California Bearing Ratio(CBR)", "Unconfined Compressive Strength(U.C.S)" , and "Standard Proactor test ".It was found that a general decrease in the maximum dry density(MDD) and increase in optimum moisture content(OMC) is shown with increase of the percentages (%) of RHA content and there was also a significant improvement shown in CBR and UCS values with the increase in percentages(%) of RHA.

Key Words: UCS, CBR, RHA,OMC,MDD

INTRODUCTION

It is very common that the soil at a site is not ideal from the viewpoint of Geo-Technical engineering. An attractive approach which is generally employed to avoid many of the settlement and stability problems associated with soft soil, is the " soil stabilization".

The soil improvement with different stabilizer (i.e .treatment materials or chemical additives) is one of the efficient way to enhance the geo-technical properties of virgin soil . In this method, the fine grain soil is mixed with the optimum proportion (i.e. effective dosage) of stabilizers, by the principle of mechanical compaction, in order to increase the durability and strength. Recently, a number of agro-industrial waste materials (Fly ash, sludge ash, bottom ash, rice husk ash etc.) have been very popular for use as soil stabilizer to improve soil characteristics, since they have a good pozzolanic activity with soil particles. In addition, that uses of such waste materials benefits the environment from the perspective of recycling sustainability.

Rice is one of the most cultivated and consumed cereal in the world. In the rice producing countries a traditional waste material known as 'rice husk' is obtained as a by-product in bulk amount from Rice mills. Such rice husk is available in most part of the Indo-gangetic plane in India . Globally, approximately 600 million tones of rice paddy are produced each year. On average 20% of the rice paddy is husk, giving an annual total production of 120 million tones (www.berr.gov.uk). Rice husk is being used in making mud walls from ancient time in many countries. In the majority of rice producing countries like India and China, much of the husk produced from the processing of rice is either burnt or dumped as a waste. However a majority of mills use the rice husk as fuel to generate steam to parboil rice with very low combustion efficiency; and as a by-product rice husk ash is produced. Rice husk ash is being generated in yearly frequency at large quantity and about 20 million tonnes of RHA is produced annually throughout the world (www.ricehuskash.com) and is commonly left as waste materials.

Rice husk ash has many applications due to its various properties. A pozzolan is a powder material , which when added to the cement in a concrete mix reacts with the lime, released by the hydration of the cement, to create compounds which improve the strength or other properties of the concrete (Logicsphere concrete Design Software, 2003; King,2000;Lohita and Joshi,1995). RHA is a highly pozzolanic material; it contain non crystalline silica and high specific surface area that are accountable for high pozzolanic reactivity (Della et al 2002).

Upto now, the utilization of RHA in sub grade soil as a soil stabilizer with conventional additive materials (Lime, Cement) has been research extensively. However, the number of researchers on the usage of it as a soil stabilizer without using any conventional additives for the stabilization of the fine grain soil is rare. So, utilization of such material for improving the engineering properties of fine grain soil needs to be investigated.

Thus , the problem of shortage of conventional materials and also the depositional problem of these waste may thus be solved by this unique application.

MATERIALS USED

1.0 Soil

Soil used in the present investigation has been collected from alongside the pond of "Jadavpur University"(Jadavpur Campus). On visual inspection it was found to be light grey clayey silt. Evaluated properties of the soil are shown in table-1.1 below. Based on L.L. and P.I. the soil may be classified as CI.

Table-1.1 Evaluated properties of original soil

Sl. No	Characteristics	Value
1	Specific Gravity	2.63
2	Particle Size Distribution(%)	
	a)Sand	9
	b)Silt	81
	c)Clay	10
3	Liquid Limit(%)	48
4	Plastic limit (%)	26
5	Plasticity Index(%)	22
6	Classification of soil	CI
7	Maximum Dry Density (gm/cc)	1.61
8	Optimum Moisture Content(%)	20
9	Unconfined Compressive strength(KN/m^2)	390
10	Unsoaked CBR(%)	8.3

11	Soaked CBR(%)	3.36
12	Swelling Index(%)	14

2.0 RICE HUSK

Rice husk is a major agricultural by product obtained from food crop paddy. It is a most commonly available lignocellulosic materials that can be converted into different kinds of fuels and chemical feed stocks through a variety of thermo chemical conversion processes. Generally it was considered earlier a worthless by product of the rice mills. For every four tons of rice one ton of husk is produced. The husk is disposed of either by dumping in an open heap near the mill site or on the road site to be burnt. Its bulk density ranges from 86 to 114 Kg/m^3. It has high ash content, generally 15 to 24% and the ash has high silica content. The silica content of the available ash ranges from 90 to 97%. Rice husk has a chemical composition as follows in the Table:1.2 and also Rice husk ash used for the present investigation was obtained from a local rice mill at Chandpara, North 24 Parganas the properties of which have been listed in the Table:1.3

Table-1.2- Chemical composition of Rice Husk

(Source-“Utilization of uncontrolled Burnt Rice Husk Ash in Soil Improvement”, Agus Setyo Muntohar. Sept. 2002)

Sl. No	Constituents	% by weight
1.	Cellulose	40 - 45
2.	Lignin	25 - 30
3.	Ash	15 - 24
4.	Moisture	8 - 15

Table 1.3- Properties of Rice Husk Ash (RHA)

Sl. No	Property	Value
1.	Specific Gravity	1.95
2.	Max. Dry Density	8.5
3.	Optimum Moisture Content	31.8
4.	Angle of Internal Friction	38
5.	Unsoaked CBR(%)	8.75
6.	Soaked CBR(%)	8.15

Test Results and Discussion:

In this section the evaluated geotechnical properties of the original soil have been presented in tabular form in Table 1.4 below and the test results which are obtained with varying percentages (%) of RHA content is also placed in Table 1.5 and 1.6.

Table-1.4- Evaluated geotechnical properties of Original Soil

Sl. No	**Characteristics**	**Value**
1	Specific Gravity	2.63
2	Particle Size Distribution(%)	
	a)Sand	9
	b)Silt	81
	c)Clay	10
3	Liquid Limit(%)	48
4	Plastic limit(%)	26
5	Plasticity Index(%)	22
6	Classification of soil	CI
7	Maximum Dry Density (gm/cc)	1.61
8	Optimum Moisture Content(%)	20

Table:1.5

SL NO	**% RHA**	OMC(%)	MDD(gm/cc)	LL(%)	PL(%)	CBR		UCS(KN/m^2)		
						UNSOAKED	SOAKED	0 day curing	7 days curing	28 days curing
1	**0**	20	1.61	48	26	4.3	2.6	130	-	-
2	**5**	23.5	1.43	56.6	37.2	7.35	4.8	93	175	212
3	**10**	25.4	1.39	58.3	39.4	7.9	6.2	99	166	195
4	**15**	28.3	1.35	61.7	43.95	8.2	7.9	125	235	185
5	**20**	30.8	1.29	63.5	45.69	8.8	10.6	143	220	168

Table-1.6, Consistency Limits of soil with varying percentage of RHA

% of RHA	**Liquid Limit(%)**	**Plastic Limit(%)**	**Plasticity Index(%)**
0	48	26	22

5	56.6	37.2	19.4
10	58.3	39.4	18.9
15	61.7	43.95	17.75
20	63.5	45.69	17.81

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DISCUSSION ON THE TEST DATA:

Effects on Atterberg Limits:

Liquid Limits(LL), Plastic Limits(PI) and Plasticity Index (PI) at different percentages are shown in Fig:2.1(Numerically in the Table: 1.5 & 1.6) the general increase in Liquid Limits(LL) at all Soil –Rice-Husk Ash combinations(0%, 5%, 10%, 15% & 20%) is attributed to the fact that Rice-Husk Ash reaction with the virgin soil forms compounds possessing cementitious properties which has a direct impact to enhance the values of LL and PL . On the contrary "PI" values shows the decrement with the increase in percentages of RHA.

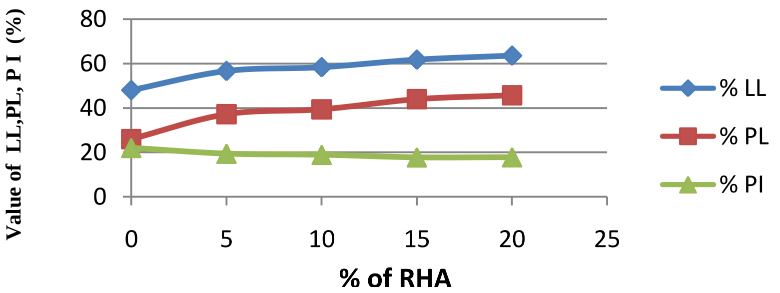

Fig:2.1

Effects on Compaction Characteristics:

As per the data revealed in the "Table-1.5" and the fig:2.2 it can be clearly seen that 'OMC'(Optimum Moisture Content) increases with increase in percentages of RHA, and also 'MDD'(Maximum Dry Density) decreases. The decrease in the maximum dry density(MDD) can be attributed to the replacement of soil by the RHA in the mixture which has relatively lower specific gravity (2.04) compared to that of the soil which is between 2.69 to 2.71 (Ola 1975; Osinubi and Katte 1997). It may also be attributed to coating of the soil by the RHA which result to large particles with larger voids and hence less density (Osula, 1991). The decrease in the maximum dry unit weight may also be explained by considering the RHA as filler (with lower specific gravity) in the soil voids.

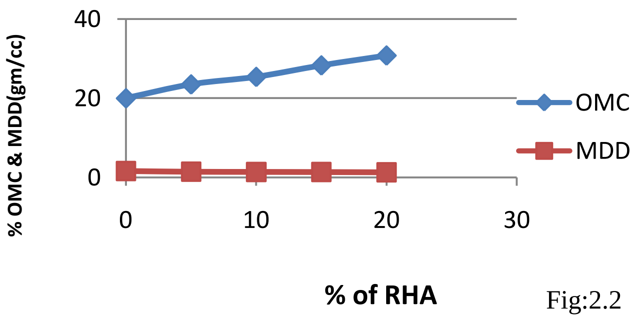

Fig:2.2

Effects on Unconfined Compressive Strength:

Unconfined compressive strength (UCS) is the most common and adaptable method of evaluating the strength of stabilized soil. It is the main test recommended for the determination of the required amount of additive to be used in stabilization of soil (Singh and Singh, 1991). Variations of the UCS with increase in RHA from 0% to 20% are shown in Figures 2.3. The UCS values increase with subsequent addition of RHA . 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. Decrease in the UCS values after the addition of 8% 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. These results are compatible with the findings of Yadu et al. (2011) who studied stabilization of black cotton soil with fly ash and rice husk ash.

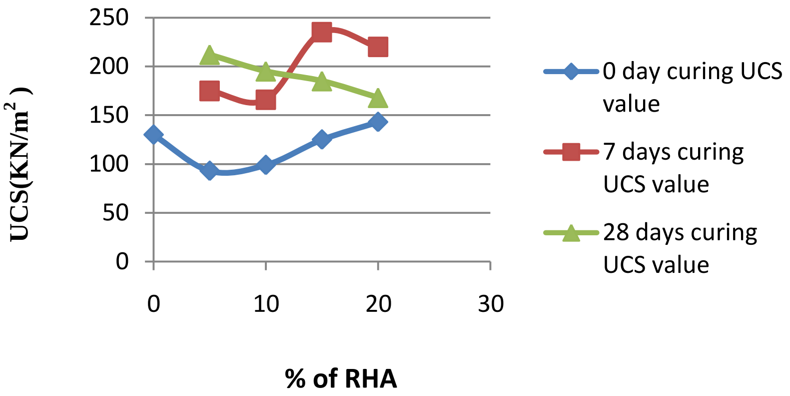

Fig:2.3

Effects on CBR :

Fig 2.4 shows the variation of CBR with RHA content, from the curve it is seen that the Unsoaked CBR value of soil RHA mixture is increasing linearly upto 5% RHA content thereafter the rate of increase of CBR very slow and becomes almost constant even after increase in percentage of RHA content. The increase in CBR due to addition of RHA may be attributed to the gradual formation of cementatious compounds between the RHA and CaOH naturally present in the soil (Alhassan-2008). The decrease in the rate of increase of CBR after 5% RHA content may be due to the excess RHA which was not mobilized in the reaction as the presence of naturally occurring CaOH in soil may be small. The excess RHA occupies space within the specimen and reduces the clay and silt content in soil and hence reduces the bond/cohesion in the soil-RHA mixture.

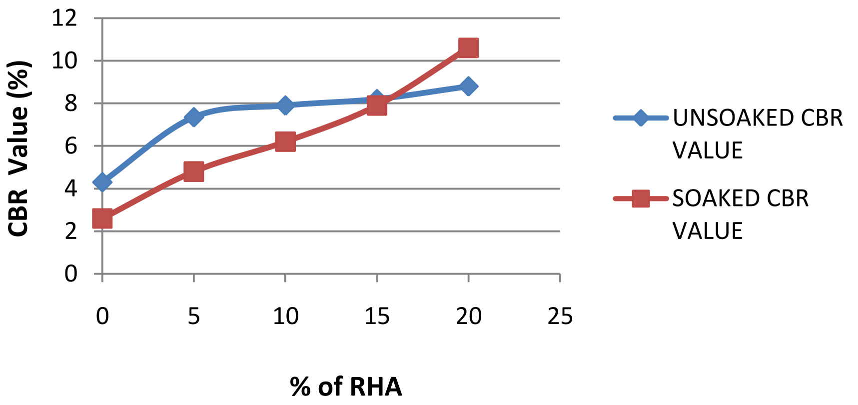

Fig:2.4

CONCLUSION:

RHA itself is a polluting agent for our environment, but as per Geo-technical point of view we can effectively use it as a soil stabilizer for specially fine grain soil . It is very cheap in terms of its availability and financial aspect as well.

- The LL and PL of the virgin soil shown a significant improvement with increase of percentages of RHA, whereas the PI values shown a decrement with increase in percentages of RHA content.
- Treatment with RHA shown a general reduction in MDD with increase in RHA content and the OMC generally increased with increase in the RHA content.
- There is enormous increase in the unconfined compressive Strength(UCS) with increase RHA content .,

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