International Journal of Civil Engineering Research.
ISSN 2278-3652 Volume 5, Number 1 (2014), pp. 49-54

http://www.ripublication.com/ijcer.htm

Soil Stabilization using Rice Husk Ash and Cement

Aparna Roy

Department of Civil Engineering, University Institute of Technology
University of Burdwan, Burdwan- 713104, W.B., INDIA.

Abstract

Soil stabilization has become a major issue in construction engineering and the researches regarding the effectiveness of using industrial wastes are rapidly increasing. The present experimental work briefly describes the suitability of the locally available Rice Husk Ash (RHA) to be used in the local construction industry in a way to minimize the amount of waste to be disposed to the environment causing environmental pollution. The common soil stabilization techniques are becoming costly day by day due to the rise of cost of the stabilizing agents like, cement, lime, etc. The cost of stabilization may be minimized by replacing a good proportion of stabilizing agent using RHA. It will minimize the environmental hazards also. Soil sample taken for the study is clay with high plasticity (CH) which truly requires to be strengthened. The soil is stabilized with different percentages of Rice Husk Ash and a small amount of cement. Observations are made for the changes in the properties of the soil such as Maximum dry density (MDD), Optimum moisture content (OMC), California bearing ratio (CBR) and Unconfined compressive stress (UCS). The results obtained show that the increase in RHA content increases the OMC but decreases the MDD. Also, the CBR value and UCS of soil are considerably improved with the RHA content. From the observation of maximum improvement in strength, 10% RHA content with 6% cement is recommended as optimum amount for practical purposes. Observing the tremendous improvement of CBR-value of soil, the present soil stabilization technique may mostly be recommended for construction of pavement.

Keywords: Soil Stabilization, Rice Husk Ash (RHA), Cement, Optimum Moisture Content (OMC), California Bearing Ratio (CBR), Unconfined Compressive Stress (UCS).

1. Introduction

Civil engineering projects located in areas with soft or weak soils have traditionally incorporated improvement of soil properties by using various methods. Soil Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Over the times, cement and lime are the two main materials used for stabilizing soils. These materials have rapidly increased in price due to the sharp increase in the cost of energy. Thus the use of agricultural waste (such as rice husk ash -RHA) will considerably reduce the cost of construction and as well reducing the environmental hazards they causes. Rice husk is an agricultural waste obtained from milling of rice. About 10^8 tons of rice husk is generated annually in the world. Hence, use of RHA for upgrading of soil should be encouraged.

The previous works with RHA [1]−[3] have shown that it has promising potentials of improving the engineering properties of soils for sub-grade purposes. Thus, this work focused on investigating the optimum amount of RHA for practical purposes through the observation of effect of RHA on some geotechnical properties of soft clayey soil which are relevant for evaluating the performance of sub-grade soils. However, the RHA can only be used as a partial replacement for the more expensive stabilizing agents (cement/lime) because it has inadequate cementation property required to bind the material to a satisfactory durability [4]−[7]. Hence, in the present study, a small amount of cement was mixed with HRA and the effect of soil stabilization on soil properties like, optimum moisture content, maximum dry density, California bearing Ratio and unconfined compressive stress is observed and the optimum content is found out from the maximum improvement. By paying a small cost for cement, a tremendous improvement of CBR-value of soil is observed which indicates the cost-effectiveness of construction of pavement.

2. Materials

The soil sample used for this study is collected from local area at Burdwan in West Bengal, India at a depth of 1.5m to 2.5m 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 high plasticity (CH) in the IS Soil Classification System.

Table 1: Properties of the natural soil.

Characteristics	Description
Natural Moisture content (%)	21.5
Percent passing IS sieve 75 micron	81
Specific gravity	2.33
Liquid limit(%)	50.4

Plastic limit (%)	27.6
Plasticity index (%)	22.8
Maximum dry density(gm/cc)	1.54
Optimum moisture content (%)	20.0
California bearing ratio, unsoaked (%)	1.46
Unconfined compressive strength (KN/m2)	70

The RHA was collected from Bishalakshi Rice Mill at Burdwan. The RHA was ground and sieved through 0.075mm aperture before use. The oxide composition of RHA is shown in Table 2.

Table 2: Oxide composition of RHA.

Constituent	Composition (%)
SiO_2	75.2
Al_2O_3	5.2
Fe_2O_3	1.02
CaO	1.4
MgO	1.75
Loss on Ignition	15.43

3. Methods of Testing

The laboratory tests carried out first was on the natural soil which include Particle size distribution, Atterberg limits, Compaction, CBR and UCS. The geotechnical properties of the soil are determined in accordance with Indian Standard [8]. Specimen for Unconfined compressive strength (UCS) and California bearing ratio (CBR) tests are prepared at the Optimum moisture contents (OMC) and Maximum dry densities (MDD).

In the second phase of the study, three different percentages of RHA, 10%, 15% and 20% are mixed with soil in three different tests. In each case, 6% cement is mixed with the soil-RHA mix to get adequate cementation property to the mix. For the above three different proportions, tests are carried out to observe the changes in the properties of soil i.e. Maximum dry density, Optimum moisture content, CBR value and Unconfined compressive stress of soil.

4. Test Results and Discussion

4.1. Compaction Characteristics

The variations of MDD and OMC with RHA contents mixed with soil and 6% cement are shown in Figure 1 and Figure 2, respectively. The MDD is decreased while the OMC is increased with increase in the RHA content. The decrease in the MDD can be attributed to the replacement of soil and by the RHA in the mixture The decrease in the MDD may also be explained by considering the RHA as filler (with lower specific gravity) in the soil voids. There is increase in OMC with increase RHA contents. The increase is due to the addition of RHA, which decreases the quantity of free silt and clay fraction and coarser materials with larger surface areas are formed. These processes need water to take place. This implies also that more water is needed in order to compact the soil-RHA mixtures.

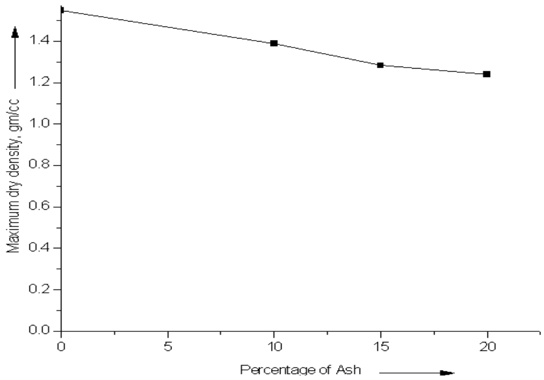

Figure 1: Variation of MDD with RHA Content

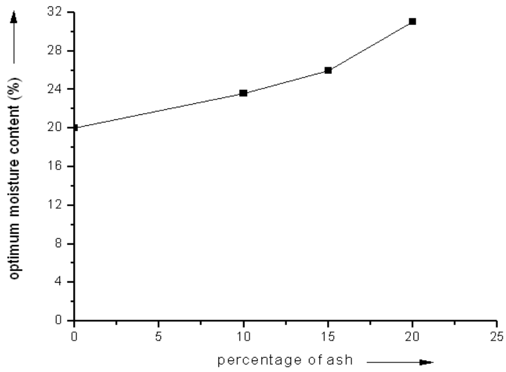

Figure 2: Variation of OMC with RHA Content

4.2. California Bearing Ratio

As an indicator of compacted soil strength and bearing capacity, it is widely used in the design of base and sub-base material for pavement. It is also one of the common tests used to evaluate the strength of stabilized soils. The variation of CBR with increase in RHA from 10 to 20% mixed with soil and 6% cement is shown in Figure 3. For unsoaked samples, the CBR value is increased by 106% for RHA content of 10%. Further the CBR value is slightly decreased for RHA content of 15%. The reason for increment in CBR may be because of the gradual formation of cementitious compounds in the soil by the reaction between the RHA and some amounts of CaOH present in the soil and cement present. The decrease in CBR at RHA content of 15% may be due to extra RHA that could not be mobilized for the reaction which consequently occupies spaces within the sample. This reduced the bond in the soil-RHA mixture.

4.3. 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. Variation of UCS with increase in RHA from 10% to 20% were investigated and the results are shown in Figure 4.

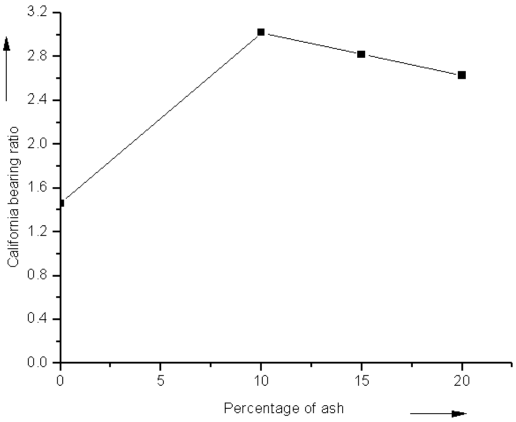

Figure 3. Variation of CBR with RHA Content

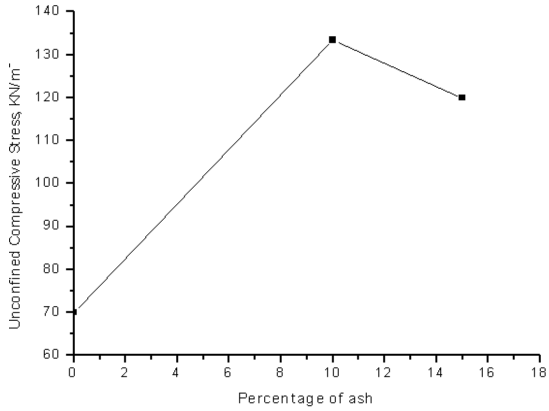

Figure 4. Variation of UCS with RHA Content

The UCS is increased by 90.6% for RHA content of 10%. Further the value of UCS is slightly decreased for RHA content of 15%. This decrease may be due to earlier reason given in the case of CBR. The UCS values increase with subsequent addition of RHA to its maximum at 10% RHA after which it dropped. 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 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.

5. Conclusion

From the results of this study, the following conclusions can be downed:

i. The soft soil is identified to be clay of high plasticity (CH) according to IS Soil Classification System. It has very low CBR-value (1.46) and Unconfined compressive stress (70 KN/m^2). The soil is required to be stabilized before doing any construction work.
ii. 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.
iii. There is also an improvement in the unsoaked CBR (106% at 10% RHA content) compared with the CBR of the natural soil.
iv. A similar trend is obtained for UCS. The UCS value is at its peak at 10% RHA (90.6% improved).
v. For maximum improvement in strength, soil stabilization using 10% RHA content with 6% cement is recommended as optimum amount for practical purposes.

6. Recommendation

Observing the tremendous improvement of CBR-value of soil, the present soil stabilization technique may mostly be recommended for construction of pavement.

References

[1] F O Okafor and U N Okonkwo (2009), Effects of rice husk ash on some geotechnical properties of laterite soil, *Leonardo Electronic Journal of Practices and Technologies*, **15**, pp. 67-74.

[2] E B Oyetola and M Abdullah (2006), The use of rice husk ash in low-cost sandcrete block production, *Leonardo Electronic Journal of Practices and Technologies*, **8**, pp. 58-70.

[3] Ali F Haji, A Adnan and Chew K C (1992), Geotechnical properties of a chemically stabilized soil from Malaysia with rice husk ash as an additive, *Journal of Geotechnical and Geological Engineering*, **10**, No. 2, pp. 117-134.

[4] E A Basha, R Hashim, H B Mahmud and A S Muntohar (2005), Stabilization of residual soil with rice husk ash and cement, *Construction and Building Material*, **19**, Issue 6, P 448-453.

[5] R M Brooks (2009), Soil stabilization with fly ash and rice husk ash, *International Journal of Research and Reviews on Applied Science*, **1**, Issue 3, pp. 209-217.

[6] A Hossain and M Khandaker (2011), Stabilized soils in incorporating combinations of rice husk ash and cement kiln dust, *Journal Of Materials In Civil Engineering*, **10.1061**/(ASCE)MT.1943-5533.0000310.

[7] J N Jhaand and K S Gill (2006), Effect of rice husk ash on lime stabilization, *Journal of The Institution Of Engineers (India)*, **87**, Issue 28, pp. 33-39.

[8] IS 2720 (Part1 – 5, 7, 10,16), *Indian Standard Methods of Tests for Soils*.