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Pavement Subgrade Stabilisation with Rice Husk Ash

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ABSTRACT

Several methods of soil improvement have been developed and practiced in civil engineering construction over the years. In recent years use of various waste products have gained considerable importance due to shortage and high cost of conventional stabilizers, increasing cost and environmental constraints of waste disposal. Cement, lime, fly ash, various types of fibers and other non-biodegradable products are used for stabilizing subgrade soils. Rice husk is a major agricultural by-product obtained from milling of rice. Many industries use rice husk as a relatively cheap fuel for boiler feed. The abundant quantity of Rice Husk Ash (RHA) can be effectively utilized for soil stabilization and modifying permeability characteristics of subgrade soil. This paper addresses use of Rice Husk Ash as a potential material for stabilization of subgrade soils. Results and co-relation with optimum utilization of RHA in varying proportions with subgrade soils have been discussed in the ensuing paragraphs.

Keywords : Soil Stabilisation, Rice Husk Ash, Pavement subgrade, California Bearing Ratio, Permeability

INTRODUCTION

Various soil stabilization techniques are adopted for improving the structural and performance properties of road material. The dependency on utilization of industrially manufactured soil stabilizers has kept the cost of stabilization of roads higher. Stabilizers like fly ash are used for improving sub base and subgrade properties by Choudhary et.al. (2005), Prasad, D.S.V, & Prasada Raju , G.V.R. (2008) and Praveen Kumar & Shalendra Pratap Singh (2008). Present paper focus mainly on use of Rice Husk Ash (RHA) for improving subgrade soil properties. The use of agricultural waste such as RHA shall considerably lower the cost of construction and as well reduce the environmental hazards due to disposal problems of such wastes. The substitute of RHA as a stabilizer will replace the proportions of cement and lime apart from conserving the valuable and depleting quantum of naturally available granular substitutes.

Earlier studies carried out [Muntohar (2002), Alhassan (2008)] focused mainly on use of RHA for improving swelling characteristics of expansive soils. Effect of RHA-lime stabilisation on compaction moisture content of California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) of black cotton soils was studied by Ramakrishna, A.N. & Pradeepkumar, A.V., (2008).

Present paper discusses the suitability and effect of rice husk ash stabilisation on Optimum Moisture Content, Maximum Dry Density, Liquid Limit, Plastic Limit, Plasticity Index, Permeability and California Bearing Ratio of subgrade soils. Experimentation is carried out with CL and CL-ML subgrade soils, commonly occurring in northern India. These soils are collected from road construction sites near Chandigarh. Uncontrolled burnt RHA was collected for the study from rice mills in Derabassi near Chandigarh, India.

2.0 EXPERIMENTAL PROGRAMME

The geotechnical properties of CL and CL-ML soils and Rice Husk Ash used for the study are shown in Table 1. Experimentations were carried out with 8%, 12%, 16% and 20% of RHA by weight of soils. Geotechnical properties like optimum moisture content, maximum dry density (Standard Proctor), Liquid limit, plastic limit and plasticity index were determined for CL and CL-ML soils. Permeability and CBR of the soils and RHA were obtained by laboratory experimentations. All the experimental investigations were performed at the Highway Research Laboratory of National Institute of Technical Teachers Training and Research, Chandigarh, India.

Table 1: Geotechnical Properties of Soils and Rice Husk Ash

Property	CL Soil	CL-ML Soil	Rice Husk Ash
Liquid Limit %	26.38	23.17	163.31
Plastic Limit %	15.61	17.51	NP
Plasticity Index	10.77	5.66	NP
OMC(Standard Proctor)	13.1	11.02	67.45
MDD(Standard Proctor) (gm/cc)	1.91	1.98	0.69
Permeability (cm/sec) (Variable head method)	4.34E-08	9.90E-08	3.69E-04
Unsoaked CBR %	11.28	11.44	7.29
Soaked CBR %	2.17	7.65	4.1

NP= Non-Plastic

3.0 MOISTURE DENSITY RELATIONSHIP OF RHA STABILIZED SOILS

Effect of varying percentages of RHA was studied on optimum moisture content and maximum dry density of CL and CL-ML soils. It was observed that OMC increased with addition of RHA. OMC increased from 13.10 to 16.50 for CL soil and 11.02 to 15 for CL-ML soil. Reduction in MDD was reported from 1.91gm/cc to 1.66 gm/cc and 1.98 gm/cc to 1.76 gm/cc for both soils respectively. The variation in OMC and MDD of CL and CL-ML soils is shown in Figure1 and Figure2 respectively.

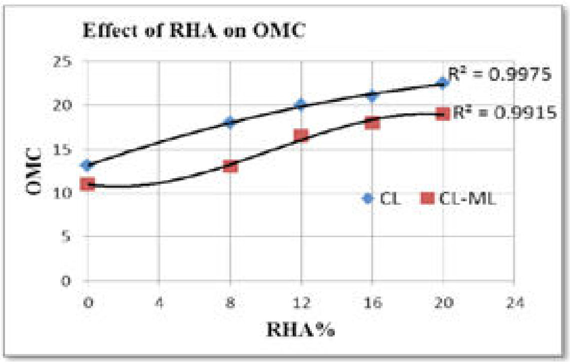

Figure 1: Variation in OMC of RHA stabilised soils

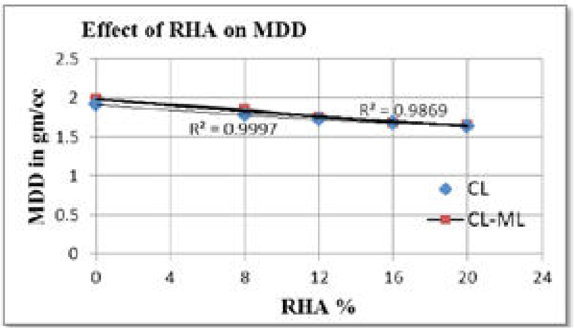

Figure 2: Variation in MDD of RHA stabilised soils

4.0 PLASTICITY BEHAVIOUR OF RHA STABILIZED SOILS

.Rice Husk Ash is non-plastic in nature and the addition of ash increased the liquid limit as well as plastic limit of both soils and reduced the plasticity index of these soils. The variation in plasticity with respect to increased RHA percentage is shown in Figure 3 and Figure 4 for CL and CL-ML soils respectively.

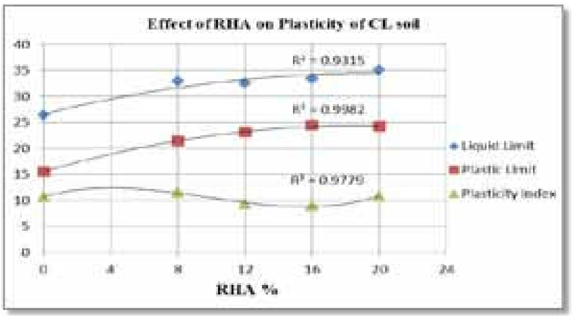

Figure 3: Variation in Plasticity of RHA stabilised CL soil.

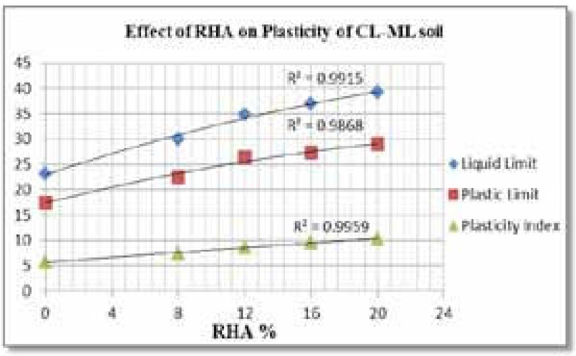

Figure 4: Variation in Plasticity of RHA stabilised CL-ML soil.

5.0 PERMEABILITY OF RHA STABILISED SOILS

Permeability studies on CL and CL-ML soils were carried out to find out the effect of rice husk ash stabilisation. Variable head method of permeability was used to assess the modification in permeability on RHA stabilized soils. Rice husk ash percentage was varied from 8% to 20%.

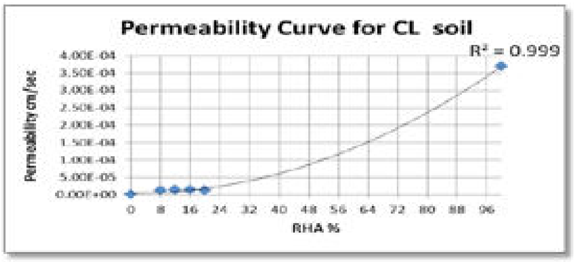

Figure 5: Permeability Variation of RHA stabilised CL soil

The permeability of CL soil varied from 4.34E-08 cm/sec to 1.20E-05 cm/sec for 20% RHA. For CL-ML soil the value increased from 9.90E-08 cm/sec to 6.17E-06 cm/sec for 20 % RHA. The variation in permeability for the soils under investi-

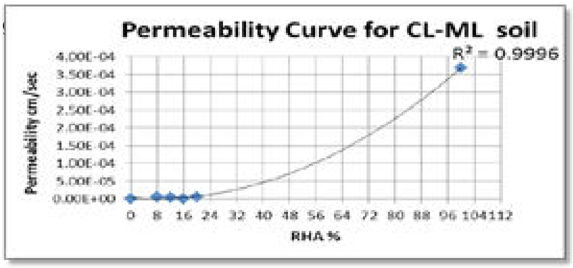

Figure 6: Permeability Variation of RHA stabilised CL-ML soil

6.0 CBR OF RHA STABILISED SOILS

Design of flexible pavement is based on IRC: 37- 2001. The thicknesses of various layers of pavement depend upon the subgrade CBR. Design thickness for various layers of flexible pavement based on laboratory CBR of subgrade soils is adopted as per the recommendation of this standard code. To evaluate the effect of RHA on CBR of soils under investigations soaked CBR and unsoaked CBR tests were conducted as per IS 2720: Part 16. Laboratory tests were performed with OMC and MDD values established for this study as shown in Figure 1 and Figure 2 for the soils under investigations. Proper hand mixing of sample was carried out to obtain a uniform and homogeneous mix of RHA stabilised soil. Soaked CBR at 97% proctor density was determined after 96 hours of soaking of prepared samples. Completely soaked samples represent worst possible moisture condition of soil subgrade. CBR tests were performed with soaked samples with controlled strain rate of 1.25 mm per minute. CBR values were determined after correcting the load penetration curve as per IS 2720: Part 16. Unsoaked CBR tests were conducted immediately after preparing the sample as per the standard procedure.

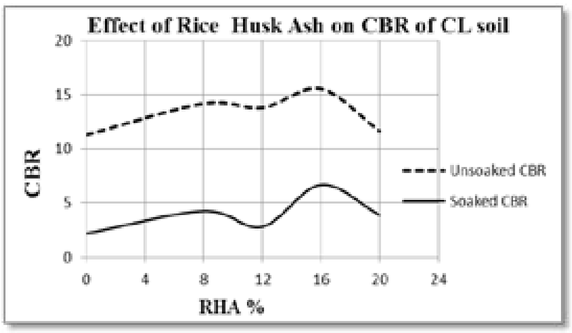

Figure 7: Effect of Rice husk ash stabilisation on CBR of CL soil

Unsoaked CBR of CL soil was reported maximum as 15.52

for 16% RHA and for soaked CBR the maximum value of 6.68 was attained at 16% RHA. Increase in RHA percentage beyond 16% indicated reduction in CBR of both the cases for CL soil. For CL-ML soil the addition of 12% RHA reported maximum increase in CBR in soaked and unsoaked conditions. The variation in CBR at different percentages of RHA is shown in Figure 7 and Figure 8.

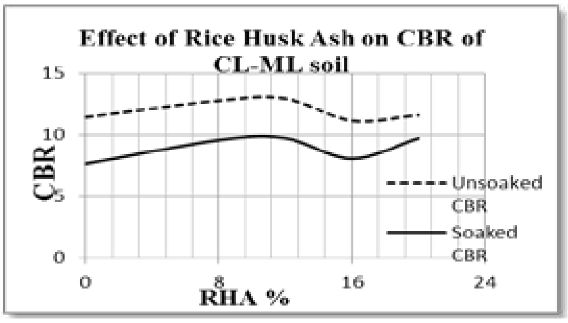

Figure 8: Effect of Rice husk ash stabilisation on CBR of CL-ML soil

Table 2: Effect of Rice Husk Ash on various properties of Soils

Rice Husk Ash %	OMC	MDD	Unsoaked CBR	Soaked CBR	Permeability cm/sec	Liquid Limit	Plastic Limit	Plasticity Index
SOIL : CL								
0	13.1	1.91	11.28	2.17	4.34E-08	26.38	15.61	10.77
8	15	1.94	14.17	4.25	1.17E-05	32.96	21.43	11.53
12	15.6	1.77	13.79	2.8	1.32E-05	32.54	23.14	9.4
16	16.5	1.73	15.52	6.68	1.35E-05	33.48	24.46	9.02
20	16.5	1.66	11.63	3.89	1.20E-05	35.07	24.25	10.82
100	67.45	0.69	7.29	4.1	3.69E-04	163.61	NP	NP
SOIL : CL-ML								
0	11.02	1.98	11.44	7.65	9.90E-08	23.17	17.51	5.66
8	12.5	1.88	12.79	9.56	5.89E-06	30.01	22.54	7.47
12	12.9	1.84	12.95	9.72	3.22E-06	34.91	26.34	8.57
16	14	1.79	11.16	8.07	1.30E-06	36.95	27.36	9.59
20	15	1.76	11.61	9.71	6.17E-06	39.2	29	10.2
100	67.45	0.69	7.29	4.1	3.69E-04	163.61	NP	NP

7.0 CONCLUSIONS

1. Stabilisation with Rice Husk Ash is beneficial in improving various index and structural properties of subgrade soil. Locally available rice husk ash can be effectively utilized to improve the properties of soil suitable for pavement subgrade.

2. Optimum moisture content of the RHA stabilised CL and CL-ML soil increases whereas maximum dry density of these soils decreases with increase in RHA percentage.

3. Permeability of the CL and CL-ML soil increases with the increase of RHA content.

4. Improvement in CBR of subgrade soil is optimum at 16% RHA for CL soil and at 12% RHA content for CL-ML soil

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