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Enhancing the Engineering Properties of Soil Stabilized With Lime and Rice Husk Ash

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ABSTRACT: Due to massive growth of infrastructure projects, conventional construction materials are diminishing day by day or found short in supply at various locations in the country. On the other hand, large quantity of waste materials produced from the different industries like fly ash, GGBS, Rice husk ash, paper mill slag e.g. creates negative impact on the environment causing air pollution, water pollution, affecting the local eco- system and hence safe disposal of this waste material is required. Utilizing these materials as alternatives materials for the construction in no doubt is a best solution. The objective of this work is to utilize the effectiveness of Rice husk ash as pozzolanic material to enhance the lime treatment of soil. Laboratory test results present the influence of different mix proportions of Lime and rice husk ash on compaction, Permeability and strength properties of soil. It is observed that addition of RHA enhances not only the strength development but also the durability of lime stabilized soil.

KEYWORDS: Medium plastic soil, RHA, Lime, Permeability, Compaction, Strength properties

I.INTRODUCTION

Soil stabilization involves the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification. Stabilizing agents such as cement, lime, fly ash, R.H.A, blast furnace slag etc has been used in soil stabilization.

In recent years, the use of various waste products in civil engineering construction has gained considerable attention in view of shortage and high cost of conventional construction materials, increasing cost of waste disposal, and environmental constraints. Rice husk is one of the waste products to be used for stabilization of soil for road construction. When burnt, the resulting Rice Husk Ash contains high percentage of siliceous compounds, an excellent material for road construction. Lime stabilization has numbers of important engineering properties in soils which include improved strength.

Following are the objectives of this work in this paper:-

1. To study the effect of Rice husk ash and Lime on medium plastic soil in terms of Unconfined Compressive strength,Soaked and Unsoaked CBR & permeability.
2. A comparative study of strength has to be done with the four different proportions of Rice husk ash (10%, 15%, 20% and 25%) along with the fix percent of lime (6%).
3. A comparative study of strength has to be done with the fix percentage of rice husk ash (optimum percentage) along with 3% and 9% of Lime.
4. To study the permeability property of soil after addition of Lime with Rice husk ash through permeability test.
5. To study the suitability of stabilized soil for flexible pavement.
6. To study and compare the other properties of natural soil with stabilized soil.

II. MATERIALS AND METHODS

The materials used in the experiments are Sandy soil, Rice husk ash and lime. The Soil Sample was collected from the construction site of BBM College, Baliapur.The Lime used here was a chemical waste. The rice husk ash (RHA) used as a source of silica was taken from rice mill shaharpura, Sindri.
The following tests were conducted:

- Index properties
- Liquid Limit & Plastic Limit

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- Soaked CBR test
- Unsoaked CBR test
- Permeability test

III. MIX PREPARATION

Soil sample has been stabilized with Lime and Rice husk ash.
Following mix has been prepared with different percentage of Lime and Rice husk ash

1. Soil sample (S)
2. Soil sample + 6% Lime (S1)
3. Soil sample + 6% Lime + 10% Rice husk ash (S2)
4. Soil sample + 6% Lime + 15% Rice husk ash (S3)
5. Soil sample + 6% Lime + 20% Rice husk ash (S4)
6. Soil sample + 6% Lime + 25% Rice husk ash (S5)
7. Soil sample + 3% Lime + 15% Rice husk ash (S6)
8. Soil sample + 9% Lime + 15% Rice husk ash (S7)

IV.RESULTS AND DISCUSSION

1.Physical properties of soil studied:
Based on the particle size analysis and Atterberg's Limit result the soil is clayey sandy soil under unified soil classification system.
Following properties of soil has been checked:

Table: 1 Properties of Soil Sample

Sl No.	Parameters	Values
1.	Specific Gravity	2.521
2.	OMC	11.45%
3.	MDD	1.84g/cc
4.	Cohesion value	0.015
5.	Angle of internal friction	36.24º
6.	% of sand	76.90
	% of silt and clay	10.30
	Coefficient of uniformity	8.46
7.	Liquid Limit	30.800
	Plastic Limit	16.785

2. OMC& MDD Test

From the result shown in Table, when percentage of Lime is fixed as 6% by weight of soil and the percentage of Rice husk ash is increasing 10%, 15%, 20% and 25%,Optimum moisture content is increasing as11.45%, 16.00%, 19.20%, 21%, 25% and 29%. Vice-versa Maximum dry density is decreasing 1.840, 1.755, 1.515, 1.500, 1.490 and 1.360g/cc. When the percentage of Rice husk ash is kept 15% by weight of soil and the percentage of Lime is varied as 3% and 9%, Optimum moisture content is increasing 17.50% and 22.00%.

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Table: 2 OMC & MDD Test result

S.N	SAMPLE TYPE	OMC (%)	MDD (g/cc)
1.	S	11.45	1.840
2.	S1	16.00	1.755
3.	S2	19.20	1.515
4.	S3	21.00	1.500
5.	S4	25.00	1.490
6.	S5	29.00	1.360
7.	S6	17.50	1.670
8.	S7	22.00	1.490

The varied trend of OMC and MDD has shown in figure:

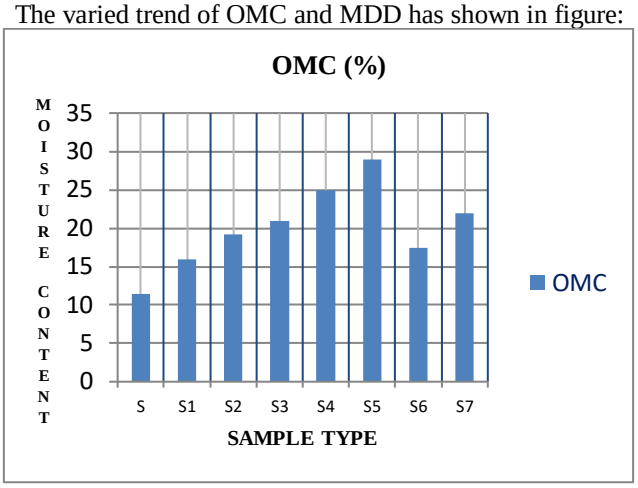

Fig.1 OMC Values of Soil-Lime-RHA mix

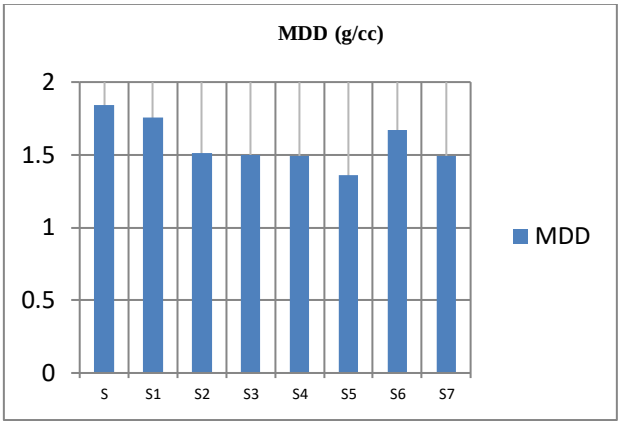

Fig.2 MDD Values of Soil-Lime-RHA mix

3.Liquid & Plastic Limit Test

From the result shown in Table, when percentage of Lime is fixed as 6% by weight of soil and the percentage of Rice husk ash is increasing 10%, 15%, 20% and 25%, the values of Liquid Limit are 30.800%, 33.900%, 43.700%, 41.850%, 44.800%, and 46.800%. Values of Plastic Limit are 16.785%, 14.095%, 23.595%, 26.605%, 25.010%, and 24.400%. When the percentage of Rice husk ash is kept 15% by weight of soil and the percentage of Lime is varied as 3% and 9%, the values of Liquid Limit are 42.100% and 45.800%. Values of Plastic Limit are 27.010% and

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Table: 3 LL.PL& PI index Test result

S.N	SAMPLE TYPE	LIQUID LIMIT (LL, %)	PLASTIC LIMIT (PL, %)	P.I
1.	S	30.800	16.785	14.015
2.	S1	33.900	14.095	19.805
3.	S2	43.700	23.595	20.105
4.	S3	41.850	26.605	15.245
5.	S4	44.800	25.010	19.790
6.	S5	46.800	24.400	22.400
7.	S6	42.100	27.010	15.090
8.	S7	45.800	13.075	32.725

The varied trend of Plasticity index has shown in figure:

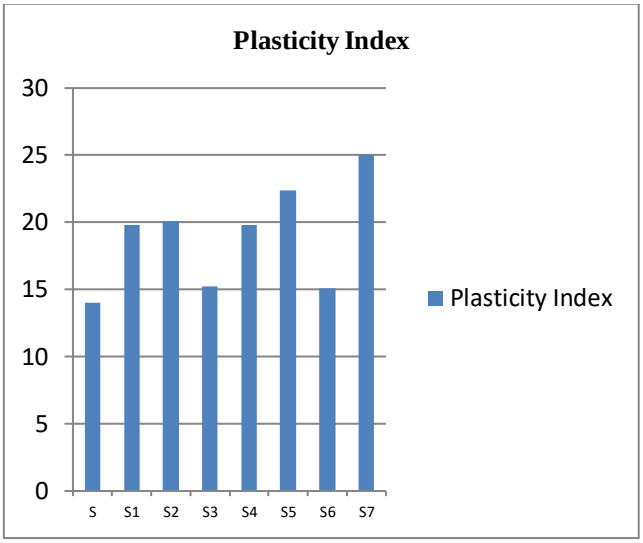

Fig.3 P.I Values of Soil-Lime-R.H.A mix

4.Unconfined Compressive Strength Test

When Lime is fixed as 6% and Rice husk ash is varied 10%, 15%, 20% and 25%, optimum unconfined compressive strength is obtained at 15% Rice husk ash. Again the Lime is varied as 3% and 9% with fixed percentage i.e. 15% Rice husk ash the unconfined compressive strength is decreasing gradually 5.12kn/m^2 and 5.05kn/m^2. While comparing the unconfined compressive strength w.r.t soil, the percentage increment of unconfined compressive strength are 10.00%, 20%, 33.40%, 26.20%, 24.60%, 6.40%, 3.00% gradually.

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Table: 4 Unconfined Compressive Test result

S.N	SAMPLE TYPE	UCS(KN/M^2)
1.	S	5.000
2.	S1	5.500
3.	S2	6.000
4.	S3	6.670
5.	S4	6.310
6.	S5	6.230
7.	S6	5.120
8.	S7	5.050

The varied trend of unconfined compressive strength has shown in figure:

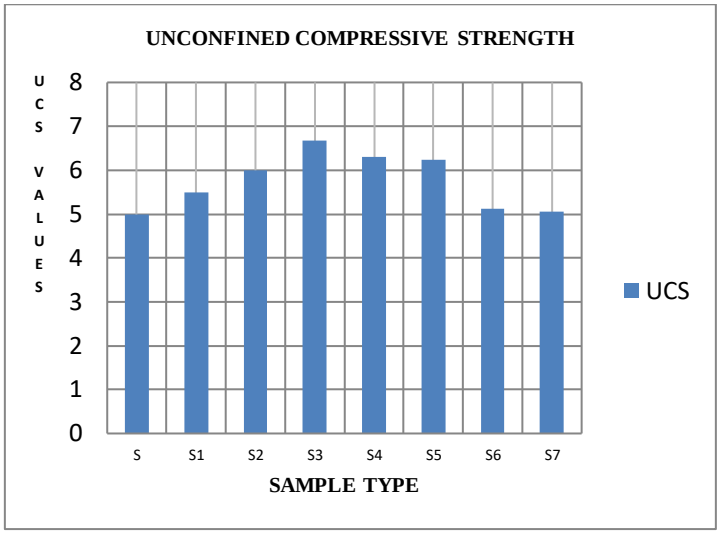

Fig.4 Unconfined Compressive strength values with Soil-Lime-RHA mix

5.CBR Test

From the result shown in Table, when percentage of Lime is fixed as 6% by weight of soil and the percentage of Rice husk ash is increasing 10%, 15%, 20% and 25%, the values of unsoaked CBR are 2.304%, 2.840%, 3.017%, 4.325%, 4.010% and 3.985%. When the percentage of Rice husk ash is kept 15% by weight of soil and the percentage of Lime is varied as 3% and 9%, unsoaked CBR values are 2.412% and 2.410%.

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Table: 5 Soaked and Unsoaked CBR Values

S.N	SAMPLE TYPE	SOAKED CBR (%)	UNSOAKED CBR(%)
1.	S	3.109	2.304
2.	S1	3.931	2.840
3.	S2	4.372	3.017
4.	S3	5.090	4.325
5.	S4	4.378	4.010
6.	S5	4.289	3.985
7.	S6	3.329	2.412
8.	S7	3.117	2.410

The varied trend of Unsoaked& Soaked CBR Values has shown in figure:

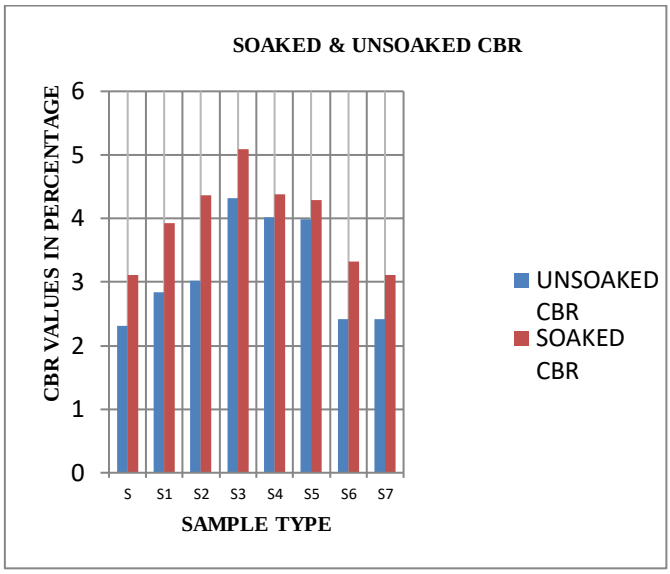

Fig.5 Soaked &Unsoaked CBR Values with Soil-Lime-RHA mix

6.Permeability Test

From the result shown in Table, when percentage of Lime is fixed as 6% by weight of soil and the percentage of Rice husk ash is increasing 10%, 15%, 20% and 25%, the values of permeability are $2.720x10^{-03}$, $1.074x10^{-04}$, $0.097x10^{-05}$,

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1.172x10^{-06}, 1.065x10^{-04} and 1.055x10^{-04}. When the percentage of Rice husk ash is kept 15% by weight of soil and the percentage of Lime is varied as 3% and 9%, permeability values are 1.109x10^{-04} and 1.819x10^{-04}.

Table: 6 Permeability Test result

S.N	SAMPLE TYPE	PERMEABILITY K(mm/sec)
1.	S	2.720x10^{-03}
2.	S1	1.074x10^{-04}
3.	S2	0.097x10^{-05}
4.	S3	1.172x10^{-06}
5.	S4	1.065x10^{-04}
6.	S5	1.055x10^{-04}
7.	S6	1.109x10^{-04}
8.	S7	1.819x10^{-04}

The varied trend of coefficient of permeability has shown in figure

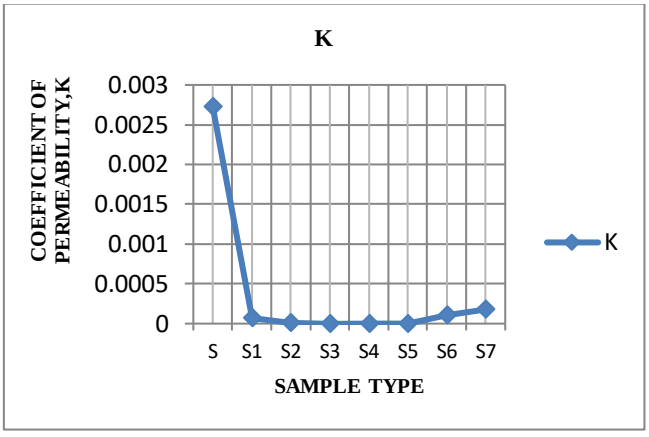

Fig.6 Permeability Values of Soil-Lime-RHA mix

VI. CONCLUSION

The work presented in this thesis is therefore concluded as follows:

I. The soil which is taken for study is not purely cohesion less, based on Atterberg's Limit value it is clayey sand soil i.e. SC.

II. The trend of optimum moisture content increases at 6% Lime and 10%, 15%, 20%, 25% RHA and maximum dry density decreases. When Lime is varied 3% and 9% with constant percentage i.e. at 15% RHA, here also the trend of optimum moisture content increases and maximum dry density decreases.

III. Unconfined compressive strength of soil increases at 6% Lime with 10%, 15% RHA but starts decreasing at 20% and 25% RHA. When Lime varied as 3% and 9% at optimum percentage of RHA, the optimum value of unconfined is at 3% Lime.

IV. Unsoaked and soaked CBR values of soil increases at 6% Lime with 10%, 15% RHA but starts decreases at 20% and 25% RHA. When Lime varied as 3% and 9% at optimum percentage of RHA, the optimum value of CBR is at 3% Lime.

V. Permeability values of soil increases at 6% Lime with 10%, 15% RHA but starts decreases at 20% and 25% RHA. When Lime varied as 3% and 9% at optimum percentage of RHA, the optimum value of CBR is at 3% Lime. The optimum result of permeability is at 6% Lime with 15% RHA, according to the specification given in Table 4.9 of characteristics pertinent to embankments and foundations, when k= 10^{-6} to 10^{-8} soil works as stable impervious cores and blankets, compaction characteristics values lies between fair to good and suitable for sheep foot roller. This stabilized soil with lime and RHA comes under this characteristics.

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