LABORATORY INVESTIGATION OF EXPANSIVE SOIL STABILIZED WITH NATURAL INORGANIC STABILIZER

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Abstract

Soil stabilization has proven to be one of the oldest techniques to improve the soil properties. Literature review conducted revealed that uses of natural inorganic stabilizers are found to be one of the best options for soil stabilization. In this regard an attempt has been made to evaluate the influence of RBI-81 stabilizer on properties of black cotton soil through laboratory investigations. Black cotton soil with varying percentages of RBI-81 viz., 0, 0.5, 1, 1.5, 2, and 2.5 percent were studied for moisture density relationships and strength behaviour of soils. Also the effect of curing period was evaluated as literature review clearly emphasized the strength gain of soils stabilized with RBI-81 over a period of time. The results obtained shows that the unconfined compressive strength of specimens treated with RBI-81 increased approximately by 250% for a curing period of 28 days as compared to virgin soil. Further the CBR value improved approximately by 400%. The studies indicated an increasing trend for soil strength behaviour with increasing percentage of RBI-81 suggesting its potential applications in soil stabilization.

Keywords: *RBI- 81, UCS, CBR.*

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1. INTRODUCTION

Soil stabilization is the modification of one or more soil properties by either means to produce an improved soil system that will remain in place under the design use conditions throughout the design life of the project. Soil varies throughout the world and their engineering properties are equally variable. Highway construction on cohesive/clayey soils has been a challenge to engineers and designers because of its high swelling and shrinkage characteristics due to presence of inorganic clays of medium to high compressibility, which results in cracks in the pavement structure. Well established mechanical and chemical stabilization techniques are often used to improve its engineering properties.

In this work the possibility of stabilizing Black cotton soil with a chemical stabilizer i.e., RBI-81 [Road Building International] is investigated. Black cotton soil used in this study was obtained from a road construction site close to Yelandur (SH-48). The basic properties are provided in Table 2. RBI-81 is a unique, cost effective, ecofriendly and highly effective natural inorganic stabilizer for development and repair. The material was produced from Radical Infrastructures Bangalore. Physical and chemical properties are as shown in Table-1.

Table 1: Properties of RBI stabilizer

Physical Properties of RBI	**Chemical Properties of RBI (% by mass)**
Appearance - Greyish Powder	CaO-55
Odour – Odourless	SiO2-19
Specific Gravity – 2.5	SO3 -11
Shelf Life – 12 months	Al2O3-7
Packaging - 20kg and ton bags	Fe2O3 -3
Storage - Avoid contact with moisture	MgO-2
Bulk Density - 700 kg/m^3	Polypropylene Fibers-2

2. REVIEW OF LITERATURE

Researchers such as Tuncer, Hector and Craig [1] conducted tests to evaluate the effectiveness of self-cementing fly ashes derived from combustion of coal at electric power plants for stabilization of soft fine-grained soils. Addition of fly ash resulted in appreciable increases in the CBR and resilient modulus of the inorganic soils. Other studies found that calcined paper sludge may be used as a binder for the stabilization of soils with contents above 3% by weight of the soil to be stabilized. The mixture of calcined paper sludge and Portland cement leads to mechanical improvements in the stabilization of soils, Lisbona, Vegas, Ainchil and Rios [2].

Radhey, Phanikumar and Varaprasad studied the UCC strength and CBR of rice-husk ash stabilized soil in the presence of either lime or calcium chloride [3].

RBI Grade 81 is a powder that is composed of a number of naturally occurring compounds. It is an odorless beige powder. The pH of saturated paste is 12.5. It improves the structural properties of a wide range of soils. It is particularly effective with silty-clayey soil with low geo-mechanical qualities. RBI Grade 81 works by hydration reaction [4]. Alchemist Touchnology limited [5] conducted field studies and concluded that RBI Grade-81 meets the requirement for a well-proven, reliable and very cost-effective method by creating strong and irreversible impermeable layer resistant to adverse climatic conditions, from very high temperatures to permafrost conditions, and accommodating all types of roads and load requirements.

Application of RBI Grade 81 chemical stabilizer causes the liquid limit to decrease and the plastic limit to increase, thereby decreasing the plasticity index of red soil under investigation. The most significant influence occurs mainly in the expansive soil than in the red clay soil YOTAM Engineering [6].

2.1 Objectives

The objectives of the present study are listed below

1. To evaluate the effect of RBI-81 on the basic properties of soil.
2. To study the influence of RBI-81 on compaction characteristics of the soil.
3. To understand the effect of RBI-81 on California Bearing Ratio (CBR) of the soil.
4. To study the effect of RBI-81 on the unconfined compressive strength of the soil.

3. METHODOLOGY

After retrieving samples, laboratory testing was undertaken to assess the material suitability. Initially material classification tests such as grain size analysis, liquid limit, plastic limit, plasticity Index were undertaken, followed by assessment of strength parameters such as compaction, California bearing ratio (CBR) and unconfined compressive strength (UCS). All the tests have been performed in accordance to Bureau of Indian Standards (BIS).

Table 2: Properties of black cotton soil

PROPERTIES	VALUE
1. Specific Gravity	2.45
2. Grain Size Distribution	
a) Gravel (%)	1.4
b) Sand (%)	31.8
c) Silt + Clay (%)	66.8
3. Liquid limit (%)	55
4. Plastic limit (%)	31
5. Plasticity Index (%)	24
6. IS classification of soil	CH
7. HRB classification	A-7-5
8. Maximum Dry Density (g/cc)	1.73
9. Optimum Moisture Content (%)	17
10. California Bearing Ratio (%)	1.34
11. Unconfined Compressive strength (kN/m^2)	208

3.1 Atterberg Limits

The Atterberg limits of native soil and the soil-RBI 81 mixtures have been performed in accordance to IS 2720: Part 5. The results are summarized in Table-3. The tests indicated a marginal increase in plastic limit and liquid limit which resulted in marginal reduction in plasticity index indicating a significant improvement in soil.

Table 3: Atterberg properties with increase in RBI-81 content

%, RBI-81	LL (%)	PL (%)	PI (%)
0	55	31	24
0.5	55	31.8	23.2
1.0	54.7	32.3	22.4
1.5	55.5	34.7	20.8
2.0	55.8	35.3	20.5
2.5	56.5	37.1	19.4

3.2 Compaction

The test was carried out in accordance to IS 2720: Part 8, the results have been summarized and presented in Fig 1. It can be seen that as the percentage of RBI added increases, the maximum dry density and optimum moisture content increase and decrease respectively, indicating the behavior of expansive soil associated with the addition of stabilizer.

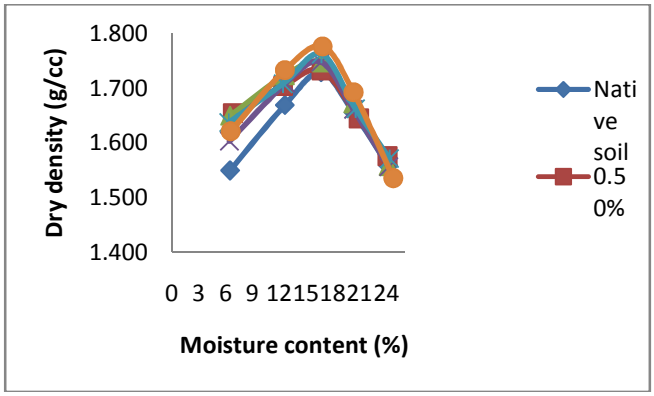

Fig.1: Variations in compaction curves.

3.3 California Bearing Ratio (CBR)

The test was performed in accordance with IS 2720: Part 16 and the results are summarized in Table 4. It can be observed that there is a significant improvement in CBR value after 7 days of curing. The increase in CBR value after one week duration of curing was found to be approximately 400%, indicating its benefits in road construction.

Table 4: CBR Variations in moist curing and RBI content

Days	CBR (%) with respect to RBI Content				
	0.5	1	1.5	2	2.5
1	2	2	3	3	3
3	3	4	8	10	10
7	6	7	10	13	14

4. UNCONFINED COMPRESSIVE STRENGTH TEST

This test was performed in accordance with IS 2720: Part 10. The results on the effect of varied dosages of RBI 81 on Unconfined Compressive strength for a curing period of 7, 14 and 28 days are summarized and presented in the Table 5. It was found that the changes in UCS were significant up to 2% of RBI content after 28 days of curing. Further increase in RBI content had no significant contribution in the UCS. The increase in UCS value was approximately 250%.

Table 5: UCS variations in moist curing and RBI content

Days	UCS (kN/m²) with respect to RBI content (%)				
	0.5	1	1.5	2	2.5
0	270	281	322	337	339
7	309	331	428	551	530
14	406	474	459	638	656
28	501	521	625	1011	1032

CONCLUSIONS

The relevance of RBI 81 as a stabilizer for black cotton soil is clearly supported by the current findings,

1. The reduction in Plasticity Index of the RBI treated soil was found to be encouraging.
2. The increase in CBR value of treated soil increased by 400%.
3. The increase in UCS value corresponds to the increase in RBI content after 28 days of curing was found to be 250%.

Further the suitability of RBI-81 stabilizer needs to be ascertained with repeated load Fatigue test, semi field test track studies and field performance studies.

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