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Studies on Properties of Polymer Treated Soil-Cement Mixes

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***Abstract*— The most important features of any highway project are performance and economic feasibility. Construction of roads on weak soils is economically the major problem faced by highway engineers. Stabilization technique is used to strengthen the existing soil. Various stabilizers such as cement, lime, bitumen, geosynthetics, chemicals and so on are used in order to stabilize soils. Bio-enzymes are organic, non-toxic stabilizers which are available in concentrated liquid form are found to improve the soil properties and thus improve the performance of roads. The number of enzymes are available in market such as Fujibeton, Terrazyme and Renolith etc. These Bio- enzymes are to be evaluated on various soils to assess their suitability. In the present study the properties of Black cotton soil typically clayey in nature and Red Soil Silty in nature was considered in order improve its properties, the soil treated with 2.5%, 5%, 7.5% and 10% of Renolith by the 2% and 4% of cement, which is taken by the weight of dry soil and the soil properties were evaluated.**

***Keywords*— Black-cotton and Red Soils, Cement, Renolith, Stabilization.**

INTRODUCTION

The liquid chemical stabilizer (Renolith) is one of the numerous chemical products in the market developed in Germany by Renolith International from a blend of locally produced synthetic chemical products. Renolith is a polymer-based product, composed of latex with cellulose. Its liquid form significantly improves the workability of the cement stabilization process in a variety of road subgrade, rail, embankment, and other construction projects. Renolith is a secondary binder because it cannot produce the stabilizing effects on its own but in the presence of cement or any other activator, it reacts chemically to form cementitious compound that contributes to improved strength of poor soil. The product is a synthetic compound with surface- active properties which has been devised to change the hydrophilic (water adsorption) properties of clay minerals to those of hydrophobic (water repellent) ones, yet maintains the strength characteristics of the cement-stabilized soil.

Objectives

The Objectives of the present study are

1. To study the effect of varying dosages of Renolith on Strength characteristics of the soil-cement.
2. To find out optimum dosage of Renolith for the considered soil-cement.
3. To study the durability characteristics of soil-cement mix treated with Renolith

Experimental Investigations

In the present study, the typical Red soil which is silty soil and Black cotton soil typically clayey in nature is used. Basic properties of the natural untreated soil used in experimental work are determined. The soil is treated with 2.5%,5%,7.5%and 10% of Renolith by the weight of cement. The cement content is fixed for 2% by the weight of dry soil in this study. The experimental work is carried out in three stages, in the first stage basic tests like Visual identification test, Wet Sieve analysis and Atterberg limits tests (Liquid Limit and Plastic Limit) were conducted on soil obtained for investigation. Second stage consists of determining Compaction characteristics of the soil. In the third stage Unconfined Compression test (UCC) and California Bearing Ratio (CBR) test were conducted on the soil treated with varying dosages of Renolith by the weight of cement.

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Physical Properties of soils

The results of various tests conducted on the soil is indicated below in table 1

Soil type	Red soil	Black cotton soil
Particle Size Distribution		
Gravel, %	0	0
Sand, %	29.60	29.40
Silt and Clay, %	70.40	70.60
Atterberg's Limits		
Liquid limit, %	30	51.80
Plastic Limit, %	16.66	26.68
Plasticity Index, %	13.34	25.12
Standard compaction results		
Maximum Dry Density, gm/cc	1.83	1.62
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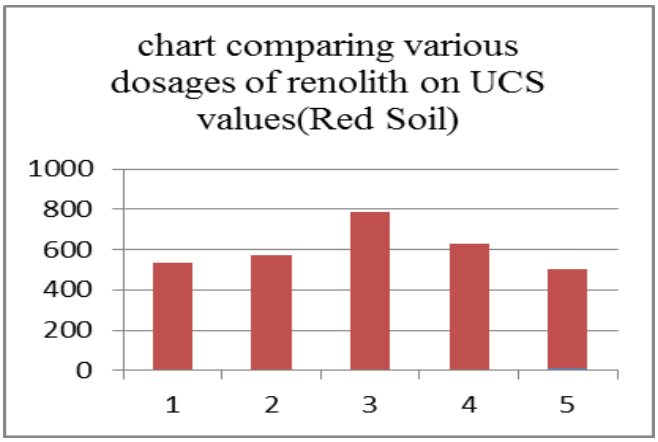
Standard compaction results		
Maximum Dry Density, gm/cc	1.83	1.62

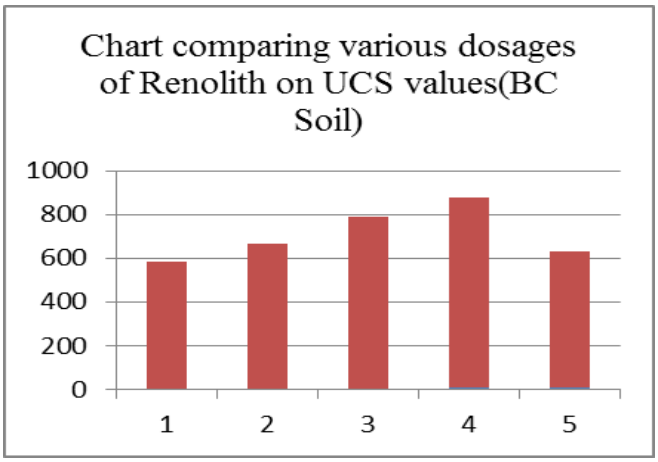
Tests on soil-cement treated with renolith

1. Unconfined compression test

Soil-cement mix is prepared by adding 2% of cement taken by the dry weight of soil and dosages of Renolith is taken as multiples of 2.5% by the weight of cement. As the quantity of Renolith is very small, it is mixed with the water taken at OMC. The prepared specimens are kept inside the polythene covers and allowed for curing in the dessicator for 7 days. After 7 days of curing the specimens are taken out and tested. UCS values of soil with varying dosages of Renolith are shown in the Table 2

Renolith %	UCS, kN/m^2 (Red Soil)	UCS, kN/m^2 (BC Soil)
0	535	586
2.5	569	665
5	782	782
7.5	620	868
10	4.92	620





2. California bearing ratio test

The CBR tests are conducted on the specimens after 7 days curing as per IS 2720 (Part 16)-1987 (reaffirmed 1997). Un soaked CBR values of soil with varying dosages of Renolith are shown in the Table 3.

% of Renolith	CBR %(Red soil)	CBR %(BC soil)
0	14.45	11.69
2.5	18.51	12.66
5	19	14.61
7.5	17.86	16.56
10	12.34	12.18

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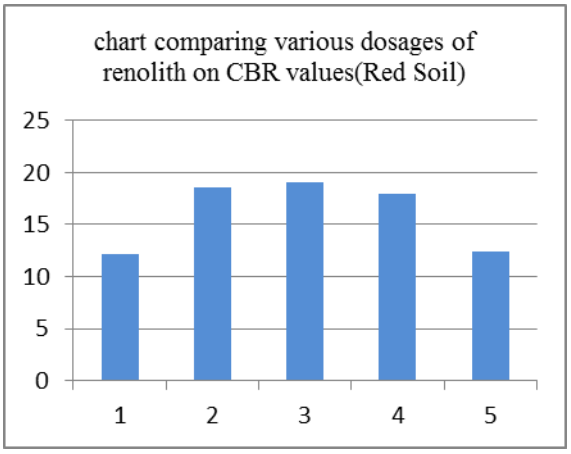

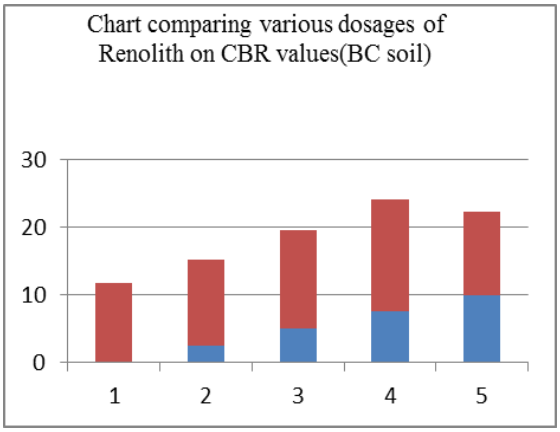

3.Durability test

The subgrade soil present beneath the pavement structure undergoes constant swelling and shrinkage due to the effect of adverse weather conditions. It reduces the properties of soil. Hence it is required to study the Durable properties of soil before the construction of pavement.

Durability test consists of two methods
a) Wetting - Drying Method
b) Freeze - Thaw Method

RESULTS AND DISCUSSIONS

A. 1. Effect of Renolith on unconfined compressive strength

From the experimental studies it is found that the soil-cement treated with varying dosages of Renolith has undergone substantial changes in UCS values. The variation of UCS values with Renolith dosages are as shown in Figure 1 and 2.
It can be observed from the below figure, that till 5% there is an increase in strength, After 5% the strength of the soil reduces gradually. Hence we can conclude that 5% is the optimum dosage of renolith by the 2% of cement taken by the dry weight of soil.

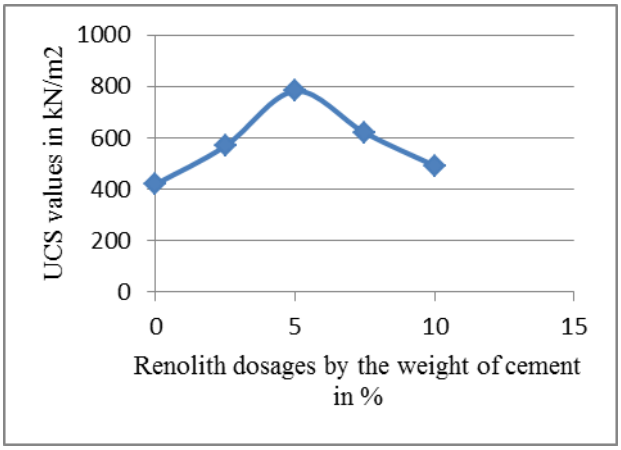

Figure 1- variation of UCS with varying dosages of Renolith for Red soil

It can be observed from the below figure, that till 7.5% there is an increase in strength, After 7.5% the strength of the soil reduces gradually. Hence we can conclude that 7.5% is the optimum dosage of renolith by the 4% of cement taken by the dry weight of soil.

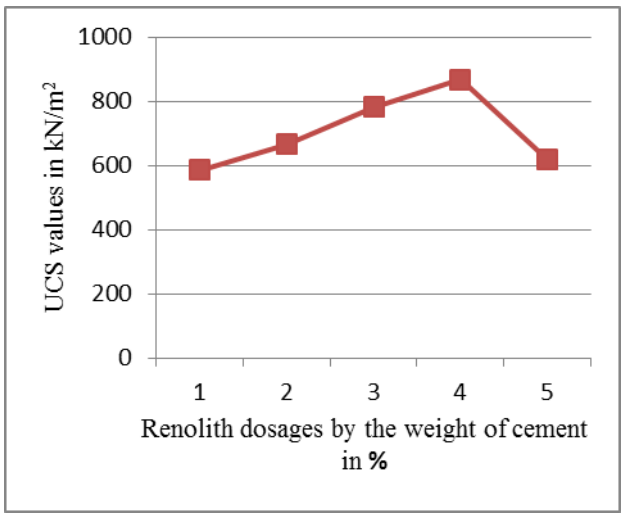

Figure 2- variation of UCS with varying dosages of Renolith for BC soil

2. Effect of Renolith on California Bearing Ratio

The experimental studies on CBR value of the soil with incremental dosages of Renolith shows that the dosage of 5% by the weight of 2% of cement yields maximum unsoaked CBR value . With further increase in Renolith dosage, the CBR value gets reduced. The variation of CBR value with Renolith is as shown in the Figure 3.

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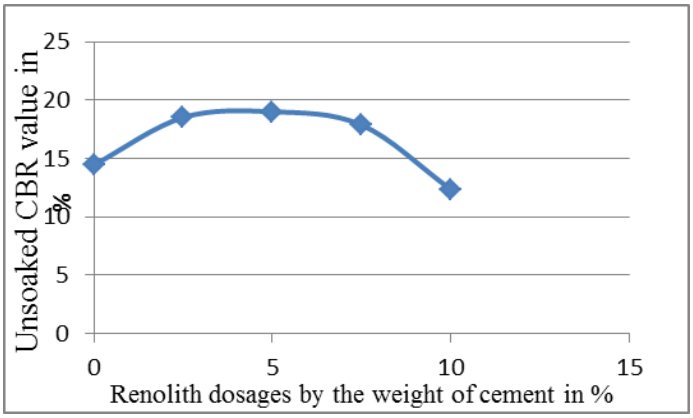


Figure 3- variation of CBR% with varying dosages of Renolith for Red soil

The experimental studies on CBR value of the soil with incremental dosages of Renolith shows that the dosage of 7.5% by the weight of 4% of cement yields maximum unsoaked CBR value . With further increase in Renolith dosage, the CBR value gets reduced. The variation of CBR value with Renolith is as shown in the Figure 4.

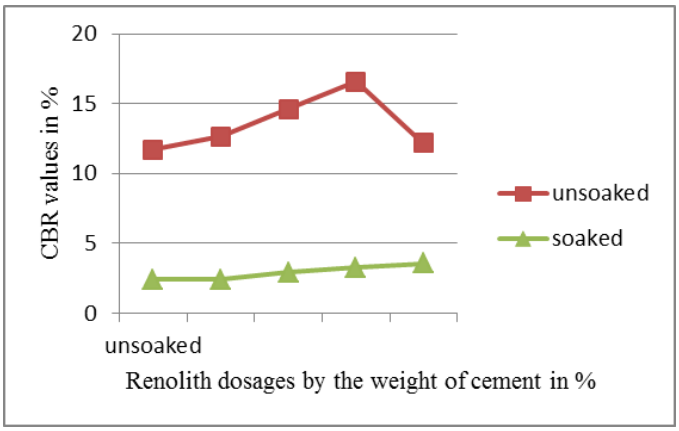
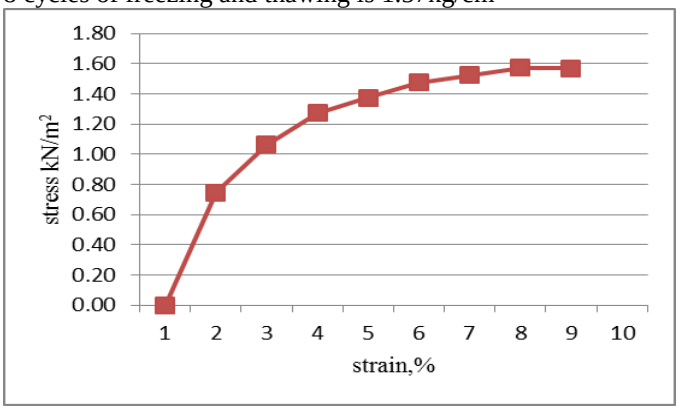


Figure 4 - variation of CBR% with varying dosages of Renolith for BC soil

B. 3.Effect of Renolith on Durability characteristics

The soil-cement specimens treated with renolith successfully completed the 2 cycles of wetting-drying test and 8 cycles of Freeze and thaw test.

The Unconfined compressive strength of the specimens after 8 cycles of freezing and thawing is 1.57kg/cm^2



CONCLUSIONS

1. Based on grain size analysis and plasticity characteristics, the soils belongs to A-6 group as per HRB classification system.
2. The stabilised UCS value shows maximum increase in strength when Cement is 4.0% and Renolith is 7.5% for BC Soil.
3. The unsoaked CBR value shows maximum increase in strength when Cement is 4.0% and Renolith is 7.5% for BC Soil.
4. Optimum Renolith dosage of BC Soil is 7.5%.
5. The stabilised UCS value shows maximum increase in strength when Cement is 2.0% and Renolith is 5.0% for Red Soil.
6. The unsoaked CBR value shows maximum increase in strength when Cement is 2.0% and Renolith is 5.0% for Red Soil.
7. Optimum Renolith dosage of Red soil is 5.0%.

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