ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
(An ISO 3297: 2007 Certified Organization)
Vol. 3, Issue 12, December 2014

# Studies on Black Cotton Soil Stabilization Using RBI Grade- 81

Venugopal G[1], Chetan Fakkerappa Babji[2]

Assistant Professor, Department of Civil Engineering, Dayananda Sagar College of Engineering, Banglore, Visvesvaraya Technological University Belgaum, India[1]

Student of M.Tech, Department of Civil Engineering, Dayananda Sagar College of Engineering, Banglore, Visvesvaraya Technological University Belgaum, India[2].

**ABSTRACT**: Road infrastructure in India is developing at a very fast pace. A good pavement is needed for the safe, comfortable and economical movement of traffic. The thickness of road depends on geotechnical properties of subgrade soil and traffic intensity. The soil having more liquid limit (LL), lower Maximum dry density (MDD) and higher Optimum moisture content (OMC) is suitable for subgrade of road. The black cotton soilis not suitable for subgrade due to its swelling characteristics and causing number of damages to the structures particularly light buildings and pavements. Thus, worldwide these soils are considered to be problematic soils and pose several challenges for engineers.This paper investigates the effect of using a new stabilization product, RBI Grade-81 on black cotton soil to improve the properties of subgrade soil.Atterberg's limit, Compaction, California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS) and X-ray diffractiontests were carried out on the samples of soil and soil with stabilizers.Various samples have been made by taking soil with different percentage 2%, 4%, 6% and 8% ofRBI Grade-81.The comparison of the strength results with or without RBI Grade-81 has been done. The subgrade soil can be improved by using RBI Grade-81 and cost of construction can be reduced to certain extent.

**KEYWORDS***:* Soil stabilization, RBI Grade-81, subgrade, Atterberg's, Compaction, CBR, UCSand X-ray diffraction

## I. INTRODUCTION

Black cotton soil also known as expansive soil is predominantly clay soil that leads to noticeable changes in volume and strength due to change in moisture content. Due to increase and decrease in moisture content, the soil gets expand the pressure increases and subgrade of the structure losses its strength, load carrying capacity, fissures, deformation and undulation thereby pavement failing process starts. All these process decrease the life span of pavement. If the stability of the local soil is not adequate for pavement construction, the engineering properties are enhanced by adopting various soil stabilization techniques. Thus the principle of soil stabilized road construction involves the effective utilization of local soils and other appropriate stabilizing agents.

RBI Grade-81(Road Building International) is an odourless beige powder that is composed of a number of naturally occurring compounds. It improves the structural properties of a wide range of soils. It is particularly effective with silty-clayey soil with low geo-mechanical qualities and it works by hydration reaction. This binding of the soil particle, through both chemical bonds and frictional forces, serves to limit the pore volume of the created rigid stabilized soil system. Black cotton soil stabilized with RBI Grade-81 for different proportions i.e. 2% 4% 6% and 8 % stabilizer and

Laboratory experiments are performed to evaluate the effectiveness of the stabilizer in stabilizing the soil.

**Objectives of the study**:

1. To study the basic properties of untreated and treated soil.
2. To study the compaction characteristics of native soil and soil stabilized with RBI Grade -81 under varying dosages.
3. To evaluate the changes in strength characteristics of treated and untreated soil specimens by California bearing ratio test (CBR) with varied dosages of RBI Grade -81.

DOI: 10.15680/IJIRSET.2014.0312063

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4. To evaluate the changes in compressive strength by unconfined compressive strength test (UCS) with varied dosages of RBI Grade -81.
5. To study the mineralogical characteristics of untreated and treated soils through X-ray diffraction method.

## II. LITERATURE REVIEW

Anitha.K.Ret. al. (2009) have performed test on "Effects of RBI- 81 on Different Types of Subgrade Soil". From the test results it is observed that substantial reduction in plasticity index for soil with RBI Grade 81 viz 42 percent for kaolinite, 4 percent for red soil and 116 percent for laterite. Soaked CBR value increased for all three soils with RBI. OMC increased and MDD decreased with addition of RBI Grade 81 for red soil and kaolinite.

C.E.G.Justo and Krishnamurthy (2008) have conducted a study on"laboratory studies on properties of soils treated with Rbi – 81 stabiliser", However there is an increase in the values of plastic limit and therefore a reduction in Plasticity Index (PI). About 35 to 40 % reductions in plasticity index values have been observed with the addition of 6 % stabilizer.. The soaked CBR value of stabilized soils after 7-days curing showed significant increase in all the soils, even with 2% stabilizer content.

K.V. Madurwar1et. al. (2013) have performed test on "Comparative Study of Black Cotton Soil Stabilization with RBI Grade 81 and Sodium Silicate". Liquid limit decreases as the admixture content increases whereas reverse trend observed with plastic limit as it increases with the increase of admixture, results in net reduction of plasticity index. Unconfined Compressive strength, CBR (soaked) values increase with increase in RBI 81 addition suggest its suitability as good stabilizer to improve performance.

B.M.Patil andK.A.Patil (2013) have performed test on "Effect of Fly ash and Rbi grade 81 on Swelling Characteristics of Clayey Soil". This paper deals with stabilization of clayey soil by using fly ash and RBI Grade 81 to improve the geotechnical properties of soil. The results show that, the LL, MDD, OMC and DFS index of clayey soil improved considerably. The LL of untreated soil is 67% and it reduces to 46% for mix of soil: fly ash: RBI Grade 81 for 76:20:04 proportion. The DFS of untreated soil is 65% and it reduces to 40% for addition of fly ash and RBI Grade 81.

Lekha B.M. and A.U. Ravi Shankar (2014) have conducted a study on "Laboratory Performance of RBI 81 Stabilized Soil for Pavements". The collected soil samples were treated with RBI 81 in various mix ratios. Soaked CBR test results indicate that the stabilizer used works well with cohesive soils (such as BC soils). Fatigue life test results indicate a high fatigue life for all treated soils when subjected to repeated loading (considering 1/3rd UCS strength values) as compared to the untreated soils.

Er. Tejinder Singh andEr.NavjotRiar (2013) have conducted a study on "Strengthening Of Subgrade by Using RBI Grade-81 A Case Study". In this study shows that soil can be stabilized with RBI grade 81 and then can be used in Sub grade and also as Sub base and base Layers. The whole Pavement can be constructed by using RBI grade 81 thus reducing energy consumed and placing of unbound granular material (WBM/WMM) without compromising on Strength and durability.

Black cotton soil is one of the most problematic soils an engineer has to face for the construction of structures above this surface. One of the latest trending stabilizers is road building international grade 81 (RBI Grade-81). RBI Grade-81 being an eco-friendly material has many advantages over other various stabilizers used. To summarize, the above studies evade the utilization of RBI Grade -81 towards sustainable and economic development in infrastructure and not much research has been carried on.

## III. MATERIAL

**1. Soils:**The black cotton soil taken for the present study is obtained from Hebsur, Hubli District, and Karnataka state. The typical behaviour of these soils under different climatic conditions has made the construction and maintenance of the roads expensive and difficult.

DOI: 10.15680/IJIRSET.2014.0312063

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Table 1:Properties of black cotton soil

| Properties of black cotton soil | Value |
|---|---|
| Specific gravity | 2.45 |
| Gravel content % | 2 |
| Sand content % | 10.6 |
| clay content % | 12 |
| Silt content % | 75.4 |
| IS classification of soil | CH |
| Liquid limit % | 81 |
| Plastic limit % | 40.60 |
| Plasticity index % | 40.4 |
| Maximum dry density g/cm3 | 1.41 |
| Optimum moisture content % | 18.80 |
| California Bearing Ratio (%) | 2.38 |
| Unconfined Compressive strength (KN/ $M^2$) | 62.63 |

**2. RBI Grade-81(Road Building International):**

This is an odourless powder that is composed of a number of naturally occurring compounds. 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. Pore space is filled by a crystalline growth. This is a natural inorganic soil-stabilizer which re-engineers & modifies the properties of soil to strengthen it for roads and accommodating all vehicular loads.

Table 2:Physical and chemical properties of RBI Grade-81

| Sl no. | Properties | (%) By mass |
|---|---|---|
| 1 | CaO | 52-55 |
| 2 | SiO2 | 15-19 |
| 3 | SO3 | 9-11 |
| 4 | Al2O3 | 5-7 |
| 5 | Fe2O3 | 0-2 |
| 6 | MgO | 0-1 |
| 7 | Polypropylene Fibers | 0-1 |
| 8 | Additives | 0-4 |

## IV. RESULTS AND DISCUSSIONS

Basic Properties of Black Cotton Soil are determined by conducting laboratory tests as per IS code specifications, results are tabulated. Further, soil is stabilized with RBI Grade-81 and the strength parameters like MDD, CBR and UCS are determined by conducting compaction, CBR (California bearing ratio) and UCS (unconfined compressive stress) tests respectively.

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**1. Grain size distributions:**

Wet sieve analysis was done for determining particle size distribution. This gives only the particle size distribution upto that retained on 75 micron sieve. For further classification of soil to silt and clay, hydrometer analysis was done. Grain size distribution curves of the black cotton soil are shown in Fig. 1.

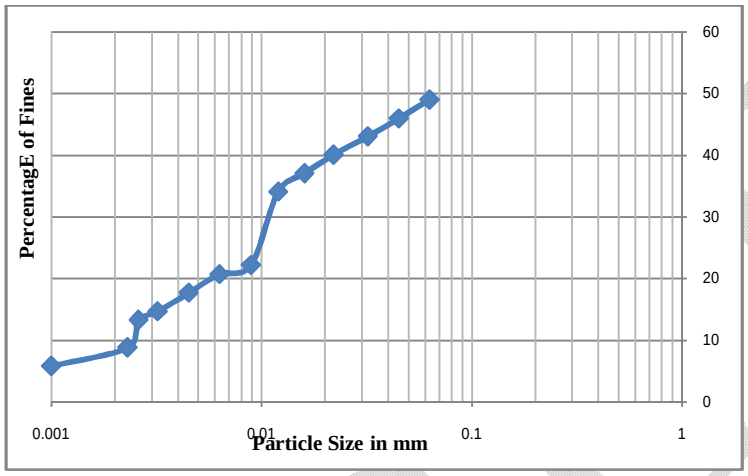


Figure 1: Gradation Curves of Black cotton Soil.

**2. Atterberg test:**

The soil characterization tests were performed on each soil sample in accordance with IS 2720: Part 5. The values of Atterberg limits like liquid limit, plastic limit and plasticity index are as shown in table 3 and figure 2. The result shows fairly significant decrease in Plasticity Index (PI) indicating an improvement in soil.

Table 3: Atterberg limits of Black cotton soil.

| RBI content (%) | LL (%) | PL (%) | PI (%) |
|---|---|---|---|
| 0 | 81.00 | 40.60 | 40.4 |
| 2 | 72.00 | 42.68 | 29.32 |
| 4 | 70.00 | 43.24 | 26.76 |
| 6 | 64.00 | 43.82 | 20.18 |
| 8 | 62.50 | 45.83 | 16.67 |

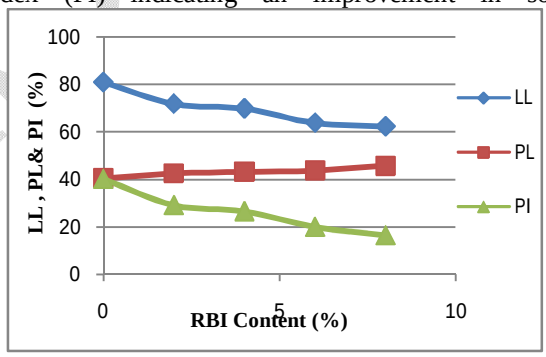


Figure 2: Variation in LL, PL and PI.

**3. Compaction:**

This test was carried out in accordance with IS 2720: Part 8. The results are summarized in Table 4 and presented in figure 3. It can be seen that there is significant changes in the MDD and OMC due to the addition of RBI Grade-81 to the native soil.

Table 4: Compaction properties of RBI Grade-81

| Compaction | 0% | 2% | 4% | 6% | 8% |
|---|---|---|---|---|---|
| MDD (g/cc) | 1.41 | 1.40 | 1.36 | 1.35 | 1.30 |
| OMC (%) | 18.80 | 24.10 | 24.30 | 26.70 | 27.80 |

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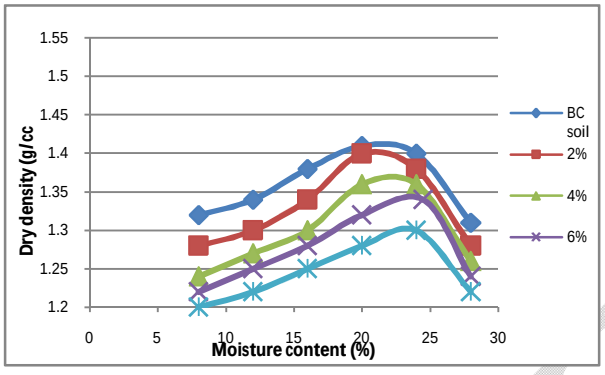


Figure 3: Variations in compaction curves.

**4. California Bearing Ratio (CBR):**

Soaked and unsoaked CBR tests were conducted in accordance with IS 2720: Part 16 for native soil and soil mixed with RBI Grade-81 with varied dosages. RBI Grade-81 samples are soaked for 4 days for the reaction to take place to check the strength properties.The results are summarized in table 5 and presented in figure 4.

Table 5: CBR variations for different RBI Content

| RBI content (%) | CBR (%) Unsoaked | CBR (%) Soaked |
|---|---|---|
| 0 | 2.38 | 1.92 |
| 2 | 4.97 | 2.62 |
| 4 | 8.335 | 4.24 |
| 6 | 17.693 | 10.59 |
| 8 | 18.145 | 11.60 |

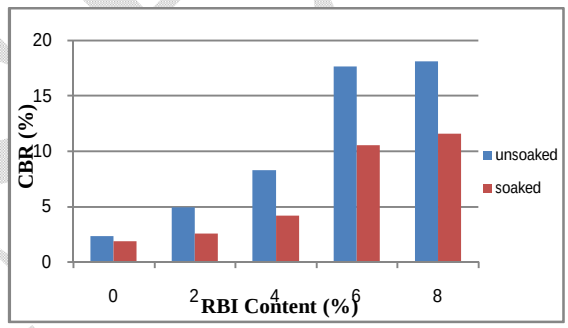


Figure 4: Variations in CBR curves.

**5. Unconfined Compressive Strength (UCS):**

The BCS blend with RBI Grade-81 gave increased value of compressive stress. The results for blend with RBI Grade-81 are shown in following table 6and presented in figure 5.

Table 6: UCS variation for RBI Content.

| RBI CONTENT(%) | UCS (KN/m²) |
|---|---|
| 0 | 62.63 |
| 2 | 75.86 |
| 4 | 93.01 |
| 6 | 131.65 |
| 8 | 142.65 |

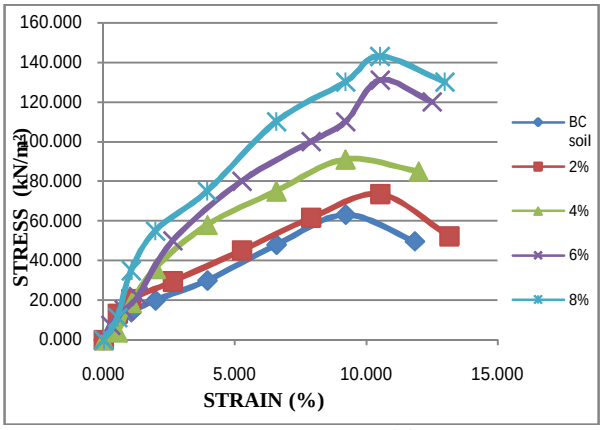


Figure 5: Variations in UCS curve.

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## V. CONCLUSIONS

Based on the above results, the following conclusions are drawn

1. The basic laboratory test results showed that the soil has low permeability, low strength and high volume change properties. Soil belongs to CH group as per IS classification.

2. The specific gravity increased with increase in percentage dosage of stabilizer. Hence, 6% of RBI Grade-81 is considered as optimum percentage for black cotton soil.

3. The soil with the addition of stabilizer has showed the reduction in Plasticity Index of the soil with increased in the % dosage of stabilizer which was found to be encouraging.

4. OMC increased and MDD decreased slightly due to the addition of RBI Grade-81 when compared with native soilis suitable for subgrade of road.

5. There was a drastic change in soaked CBR of treated soil. CBR changes were found to be significant at 6% RBI content for unsoaked and 4 days of soaking as it achieves the required value as per the Indian road congress standards.

6. The increase in UCS value corresponds to the increase in RBI content was found to be significant at 6% of RBI content and further addition makes the UCS value a fairly significant increases.

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