International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 11 | Nov 2024 www.irjet.net p-ISSN: 2395-0072

A review on soil stabilizations using RBI grade-81

JAVVAJI BHANU KARTHIK[1], [2] Dr.P. BALA KRISHNA, Ph.D.

[1]M. Tech Student, Department of Civil Engineering, MVR College of Engineering and Technology (autonomous) paritala, India.
[2]Associate Professor and Head of the department (HOD), Department of Civil Engineering, MVR College of Engineering and Technology, (autonomous), paritala, India.

Abstract

This study investigates the use of RBI Grade-81, a natural soil stabilizer, in enhancing the engineering properties of black cotton soil for road construction. Black cotton soil, known for its expansive nature, presents significant challenges in road infrastructure due to its tendency to swell when wet and shrink when dry. This behavior leads to cracks, undulations, and structural damage to pavements, necessitating a sustainable solution that addresses these issues. RBI Grade-81, a proprietary soil stabilization additive, offers an environmentally friendly, cost-effective, and durable alternative to conventional materials like cement and lime.

The objectives of this study are multifold: to assess the impact of RBI Grade-81 on the soil's liquid limit, plastic limit, and compaction properties, and to evaluate improvements in the soil's Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) under both soaked and unsoaked conditions. A series of laboratory tests were conducted on untreated black cotton soil and soil treated with varying percentages of RBI Grade-81 (2%, 4%, 6%, 8%, and 10%). The soil samples were subjected to standard tests such as Liquid Limit (LL), Plastic Limit (PL), UCS, CBR, Free Swell Index (FSI), and Specific Gravity, following Indian Standard (IS) and ASTM procedures.

The results indicate that the addition of RBI Grade-81 significantly improves the engineering properties of black cotton soil. The liquid limit of the soil decreased with increasing percentages of RBI Grade-81, showing a reduction in the soil's swelling potential. Similarly, the plasticity index reduced, indicating enhanced soil workability and a lower susceptibility to moisture variations. The UCS values increased notably, with the highest improvement observed at 6% RBI Grade-81, where the UCS value of the treated soil reached 3.63 kN/m^2 compared to the untreated soil's 2.08 kN/m^2. This increase in compressive strength highlights the stabilizer's potential to improve the load-bearing capacity of roads built on expansive soils.

The CBR test results further demonstrated significant improvements. Under soaked conditions, the CBR value of untreated black cotton soil was 4.84%, while the treated soil with 6% RBI Grade-81 showed a remarkable increase to 132.29%. This improvement is crucial for enhancing the durability and performance of pavements subjected to heavy traffic loads. Additionally, the permeability of the soil reduced, with a decrease in the free swell index, suggesting that RBI Grade-81 helps prevent water infiltration, which is essential for maintaining the stability of pavement layers.

In conclusion, RBI Grade-81 offers a promising solution for addressing the challenges associated with black cotton soil in road construction. Its application leads to substantial improvements in soil strength, stability, and load-bearing capacity, while also reducing environmental impact. The study confirms that RBI Grade-81 can effectively reduce construction time, lower maintenance costs, and extend the lifespan of pavements, making it a sustainable and economical alternative to traditional materials. Future research could explore the long-term performance of RBI Grade-81 under various climatic conditions and its applicability to other soil types.

Key Words: RBI Grade-81, Black Cotton Soil, Soil Stabilization, Road Construction, Expansive Soils, UCS, CBR, Sustainable Infrastructure.

1. INTRODUCTION

The Global road networks are crucial for economic growth, yet the construction of durable, long-lasting pavements is often hindered by the limited availability of traditional construction materials such as cement, aggregates, and bitumen. Additionally, the extraction and processing of these materials contribute significantly to environmental degradation, leading to the depletion of natural resources and increased carbon emissions. The demand for more sustainable alternatives has led researchers to explore natural stabilizers, such as RBI Grade-81, which offer promising benefits in terms of reducing environmental impact while improving the performance of pavement materials.

Fig.1 Black Cotton Soil

Black cotton soil, commonly found in tropical and subtropical regions, poses significant challenges to road construction due to its expansive nature. This soil swells when exposed to moisture and shrinks during dry periods, leading to severe structural damage to pavements, foundations, and other civil infrastructure. Traditional methods to mitigate these effects include soil replacement or the use of chemical additives such as lime or cement, both of which are costly and environmentally unsustainable. RBI Grade-81, a natural soil stabilizer, presents a viable alternative for stabilizing black cotton soil, enhancing its load-bearing capacity while reducing swelling and shrinkage.as shown in fig.1

2. OBJECTIVES OF THE WORK

This research aims to investigate the effectiveness of RBI Grade-81 in stabilizing black cotton soil for road construction. The primary objectives include:
a) Evaluating the changes in soil properties such as liquid limit, plastic limit, and compaction behavior upon the addition of RBI Grade-81.
b) Assessing the improvement in Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) under both soaked and unsoaked conditions.
c) Comparing the environmental and economic impacts of using RBI Grade-81 with conventional stabilizers such as cement and lime.

3. SCOPE OF THE WORK

This study evaluates the effectiveness of RBI Grade-81 in stabilizing black cotton soil for road construction, addressing its expansive nature and improving its engineering properties. The research involves laboratory tests such as Liquid Limit, Plastic Limit, Unconfined Compressive Strength (UCS), and California Bearing Ratio (CBR) to compare untreated and stabilized soil. It aims to demonstrate the cost-effectiveness, durability, and environmental benefits of RBI Grade-81 over traditional materials like cement and lime. The practical application of RBI Grade-81 could reduce construction time, lower maintenance costs, and extend road lifespan. The study also highlights its potential to reduce environmental impacts by lowering carbon emissions and conserving resources.

4. THEORY AND METHODOLOGY

Structure Natural black cotton soil was collected, and several tests were conducted to assess its properties before and after treatment with RBI Grade-81. RBI was mixed in proportions of 2%, 4%, 6%, 8%, and 10% of the soil weight. The samples were subjected to the following tests: Liquid Limit and Plastic Limit using IS: 2720 – Part 5 (1985). Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) tests following IS codes. Specific Gravity and Free Swell Index tests to evaluate the soil's stability.

Experimental protocols were followed strictly in accordance with IS codes, including sample preparation, test setup, and curing conditions. Soil samples were compacted and cured for 7, 14, and 28 days to evaluate long-term stability.

Fig. 2 Stabilization of Black Cotton Soil

4.Introduction to software

ETABS 2015 is a specialized software program designed specifically for structural engineering applications. It facilitates both linear and nonlinear static and dynamic analysis, leveraging modern PC capabilities to handle complex, composite models efficiently [15]. The software integrates modeling, analysis, design, and optimization within a single user-friendly interface, fully compatible with Microsoft Windows [15, 16]. ETABS also enhances the visualization of results through advanced graphical presentations, making it easier for engineers to interpret and refine their models [17].

5. RESULTS AND DISCUSSIONS

5.1 Effect of RBI Grade-81 on Liquid and Plastic Limits

The results of the liquid and plastic limit tests show a notable reduction in the plasticity of black cotton soil when treated with RBI Grade-81. The liquid limit decreased from 41% to 35.22% with the addition of 10% RBI Grade-81, indicating a reduction in the soil's susceptibility to water-induced swelling.

Table1 Plastic Limit of Black Cotton Soil

Plastic limit of black cotton soil			
Sample	Plastic Limit	Sample	Plastic Limit
SOIL	21.16%	SOIL+6%	26.22%
SOIL+2%	23.56%	SOIL+8%	27.78%
SOIL+4%	24.54%	SOIL+10%	28.34%

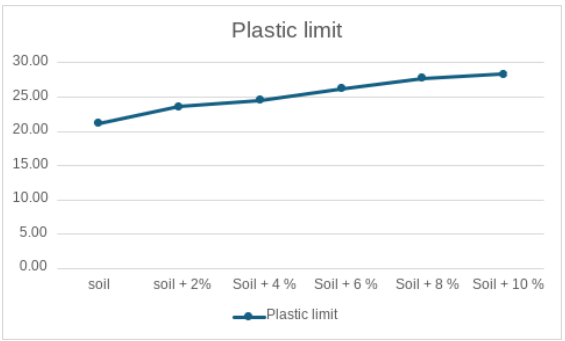

Figure 3 Plastic Limit of Black Cotton Soil

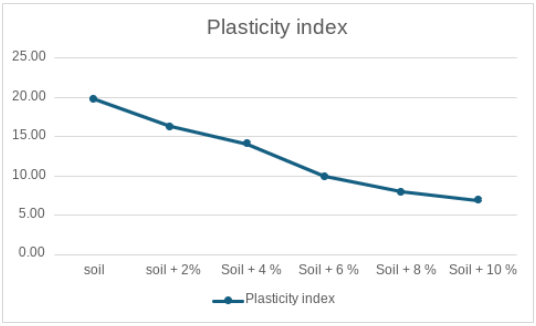

Figure 4 Plastic Limit of Black Cotton Soil

5.2 Unconfined Compressive Strength

The UCS values increased significantly with the addition of RBI Grade-81. At 6% RBI, the UCS value increased from 2.08 kN/m^2 to 3.63 kN/m^2 after 28 days of curing. This improvement is critical for enhancing the load-bearing capacity of roads.Fig.5 and fig.6

Fig. 5 Unconfined Compression Test of Soil

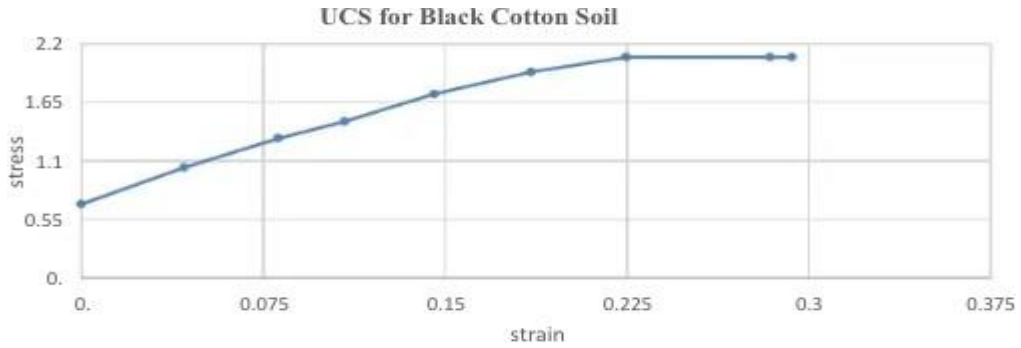

Figure 6 UC for Black Cotton Soil

5.3 California Bearing Ratio (CBR)

The CBR test results demonstrate substantial improvements in the load-bearing capacity of treated soils. Under soaked conditions, the CBR value increased from 4.84% in untreated soil to 132.29% with the addition of 6% RBI Grade-81. This reflects the enhanced ability to withstand heavy traffic loads.

Table 2 CBR Values

%of RBI	Soaked CBR value(%), Cured for7days
0	2.3
2	3.30
4	4.10
6	6.80
8	9.50
10	11.5

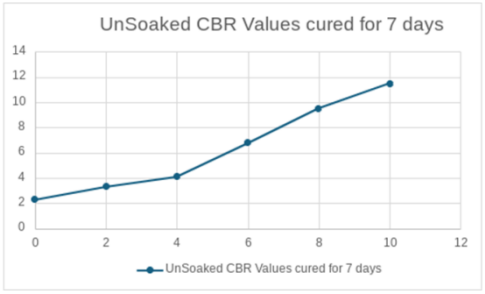

Figure. 7 CBR Values Curve

6. CONCLUSION:

The use of stabilizing agents such as RBI Grade 81 in improving the geotechnical properties of problematic soils, like black cotton soil, has gained considerable attention in civil engineering. Black cotton soil, known for its expansive nature, is characterized by significant volume changes during wetting and drying cycles, leading to structural instability in foundations and pavements. This study examines the effects of adding varying percentages of RBI Grade 81 on the engineering properties of black cotton soil, focusing on specific parameters like liquid limit, plastic limit, plasticity index, specific gravity, optimum moisture content, maximum dry density, and unconfined compressive strength. The results indicate that the addition of RBI Grade 81 enhances the soil's performance, making it more suitable for construction applications.

The liquid limit (LL) is an essential indicator of a soil's ability to hold water and its susceptibility to shrinkage and swelling. Black cotton soil exhibits a high liquid limit, which makes it prone to excessive volume changes with moisture fluctuations. The study shows that with the addition of RBI Grade 81, there is a significant reduction in the liquid limit. Initially, the liquid limit of the untreated black cotton soil is 42%. As the percentage of RBI Grade 81 increases, the liquid limit decreases progressively, reaching 35.22% at 10% RBI Grade 81. This reduction indicates improved stability and a reduced likelihood of shrink-swell behavior, which is critical in regions where expansive soils pose a threat to foundations and pavements.

The plastic limit (PL) of soil is the moisture content at which soil begins to exhibit plastic behavior. Higher plastic limits are desirable in construction because they indicate that the soil can be manipulated and compacted at higher moisture contents without losing its plasticity. In this study, the plastic limit of untreated black cotton soil is 21.16%. With the addition of RBI Grade 81, the plastic limit increases to 28.34% at 10% RBI Grade 81. This increase in plastic limit reflects an improvement in the workability of the soil, making it easier to handle during construction activities. The enhanced workability is particularly beneficial for compacting the soil in situ, as the soil can now be molded at higher moisture contents, allowing for more efficient construction processes.

The plasticity index (PI) is a measure of the soil's plasticity and is calculated as the difference between the liquid limit and plastic limit. It indicates the range of moisture content over which the soil remains plastic. In the case of black cotton soil, a high plasticity index is associated with significant volume changes during wetting and drying. This study reveals that the plasticity index of the untreated soil is 19.84%, indicating high plasticity and potential for expansion. However, with the addition of RBI Grade 81, the plasticity index decreases significantly, dropping to 6.88% at 10% RBI Grade 81. This reduction implies that the soil becomes less prone to volume changes due to moisture variations, which is a critical factor in improving the soil's performance in construction applications. The lower plasticity index also indicates better resistance to deformation, making the soil more stable under varying weather conditions.

Specific gravity is a fundamental property of soil that influences its strength, compressibility, and compaction characteristics. In this study, the specific gravity of black cotton soil increases with the addition of RBI Grade 81 up to a certain percentage, after which it decreases. The untreated soil has a specific gravity of 2.29. As the RBI Grade 81 content increases, the specific gravity peaks at 2.75 when 6% of RBI Grade 81 is added.

REFERENCES:

[1] Anitha.K.R, R.Ashalatha, ArveeSujil Johnson, “Effects Of RBI 81 On Different Types Of Subgrade Soil.”,10th National Conference on Technological Trends (NCTT09] 6-7 Nov 2009.

[2] C.E.G.Justo, Krishnamurthy, "laboratory studies on properties of soils treated with rbi – 81 stabiliser", RASTA Center for raod technology, 2008.

[3] K.V. Madurwar1, P.P. Dahale, A.N.Burile, "Comparative Study of Black Cotton Soil Stabilization with RBI Grade 81 and Sodium Silicate", Vol. 2, Issue 2, February 2013.

[4] B.m.Patil, K.A.Patil,"Effect of Fly ash and Rbi grade 81 on Swelling Characteristics of Clayey Soil", Volume-2, Issue-2, 2013.

[5] Lekha B.M. and A.U. Ravi Shankar ,"Laboratory Performance of RBI 81 Stabilized Soil for Pavements", Volume 5, Number 2 (2014), pp. 105110.

[6] Er. Tejinder Singh &Er. NavjotRiar ,"Strengthening Of Subgrade by Using RBI Grade-81 A Case Study". Volume 8, Issue 6 (Sep. - Oct. 2013), PP 101-106.

[7] Akshaya Kumar Sabat , Radhikesh P. Nanda, "Effect of marble dust on strength and durability of Rice husk ash stabilised expansive soil", International journal of civil and structural engineering, Volume 1, No 4, 2011 PP 939-948.

[8] Pankaj R. Modak, Prakash B. Nangare, Sanjay D. Nagrale, Ravindra D. Nalawade, Vivek S. Chavhan, "Stabilisation of Black Cotton Soil Using Admixtures, International journal of civil and structural engineering" , Volume 1, Issue 5, May 2012 pp 01-03.

[9] Kiran R.G, Kiran L, "Analysis Of Strength Characteristics Of Black Cotton Soil Using Bagasse Ash and additives as Stabilizer", International Journal of Engineering Research & Technology, Vol. 2 Issue 7, July – 2013 pp 2240-2246.

[10] NoorinaTarannum, R.K. Yadav, "Influence of Blast Furnace Slag on the Consistency Limits of the Black Cotton Soil", International Journal of Scientific & Engineering Research, Volume 4, Issue 4, April-2013 pp 456-458.

[11] Amu, O.O., Ogunniyi, S.A. and Oladeji, O.O, "Geotechnical properties of lateritic soil stabilized with sugarcane straw ash", American journal of scientific and industrial research, (2011) pp 323-331. [12] A. SreeramaRao, G. Sridevi, M. Rama Rao, "Heave Studies on Expansive Clays with Stabilized Granulated Blast Furnace Slag Cushion", Indian geological congress, 2009 pp 109-112.

[13] HosseinMoayedi, Bujang B. K. Huat, FatemehMoayedi, AfshinAsadi, AlirezaParsaie, "Effect of Sodium Silicate on Unconfined Compressive Strength of Soft Clay", Vol. 16 [2011], pp 289-295.

[14] K.V. Madurwar et al. (2023). 'Properties of Black Cotton Soil with RBI-81.' Journal of Soil Stabilization.

[15] B.M. Patil et al. (2019). 'Improvement of Sub grade Soil with RBI Grade 81.' Lecture Notes in Civil Engineering.

[16] IS: 2720 (Part 40) (1977). Methods of Test for Soils: Determination of Free Swell Index of Soils, Bureau of Indian Standards, New Delhi, India.