

Research Paper

CHEMICAL STABILIZATION OF BLACK COTTON SOIL FOR SUB-GRADE LAYER

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The life of any structure depends on strength of the soil and load on the structure. The soil is not uniform through-out the world. Generally the poor soil having low load bearing strength (CBR) value less than 2% is replaced by good quality soil material. This paper deals with the improvement in various properties of Black Cotton soil for pavement sub-grade by using soil stabilizer. The stabilizer like RBI Grade 81 is used to improve the properties of Black Cotton soil for pavement sub-grade purpose. From CBR test, it is found that the soaked CBR value of soil is improved by 745.54% i.e. 2.02% to 15.06% by stabilizing soil 4% RBI Grade 81. The various mixes of Black Cotton soil: RBI Grade 81 for the different proportions was tested for Atterberg's limit, Shrinkage limit, Free Swelling Index, Compaction (OMC & MDD) and 4 day's soaked CBR value.

Keywords: Black cotton soil, Chemical stabilization, RBI GRADE 81, CBR, Atterberg's limit

INTRODUCTION

Black Cotton Soil or Expansive Soil

Expansive soil or soft bed rock that change in volume due to change in moisture content. Black Cotton soil covers about 30% of the land area in India. They are also commonly known as bentonite, expansive, or Black Cotton soil. In India Black Cotton soil also known as 'regurs' are found in extensive regions of Deccan Trap. They have variable thickness and are underlain by sticky material locally known as "Kali Mitti" in terms of geotechnical Engineering.

'Black Cotton soil is one which when associated with as engineering structure and in presence of water will show a tendency to swell or shrink causing the structure to experience moments which are largely unrelated to the direct effect of loading by the structure.

Black cotton soils are one of the most prevalent causes of damage to buildings and construction. The following damages occur due to change in volume of black cotton soil.

- Severe structural damage,

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- Cracked driveways, sidewalks and basement floors,
- Heaving of roads and highway structures,
- Condemnation of buildings.
- Disruption of pipelines and sewer lines.

Material Used for Study

In RBI Grade 81 stabilization we have taken black cotton soil samples which have following properties.

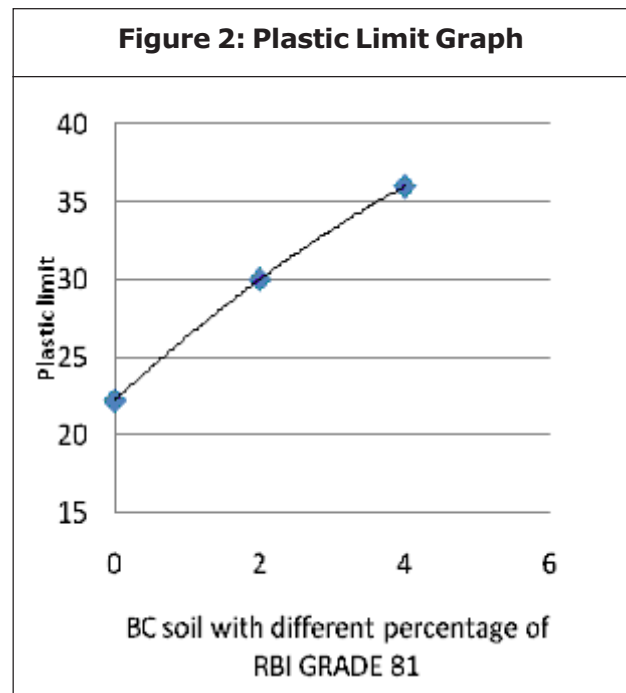
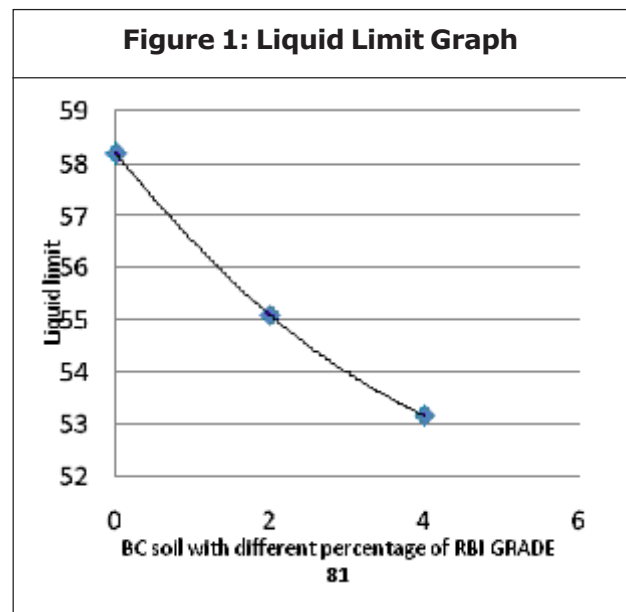
- Liquid Limit = 58.2%
- Plastic Limit = 22.3%
- Plasticity Index = 32.9%
- Shrinkage Limit = 8.89%
- Differential Free Swelling index=40%
- Maximum Dry Density= 1.61 gm/cc
- Optimum moisture content = 21%
- Shrinkage Limit = 8.89%
- CBR= 2.02%

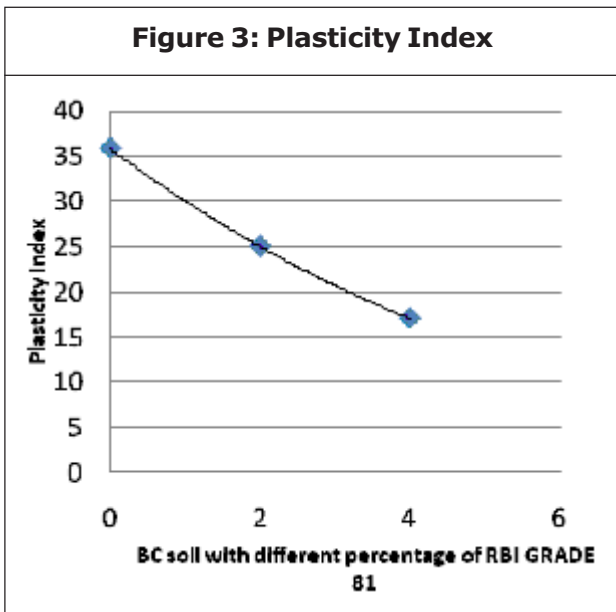
**Chemical Composition of RBI GRADE 81
PROPERTIES % BY MASS**

Ca Cao	52-56
Si SiO ₂	15-19
S So ₃	9-11
Al Al ₂ O ₃	5-7
Fe Fe ₂ O ₃	0-2
Mg	MgO 0-1
Mn, k, Cu, Zn	Mn+K+Cu+Zn 0, 10, 3
H ₂ O	1-3
Fiber (Polypropylene)	0-1
Additives	0-4

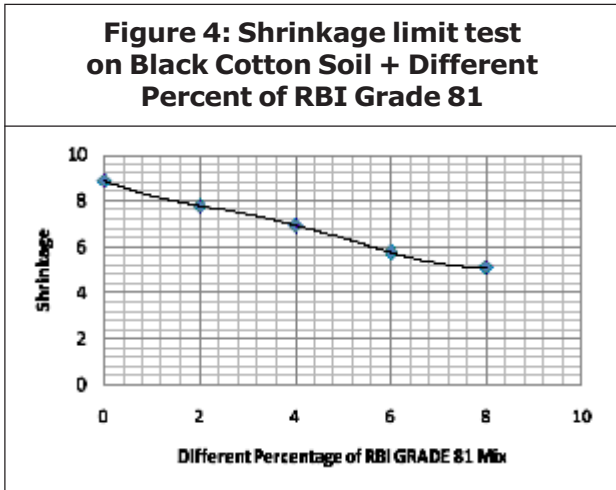
RESULTS AND DISCUSSION

1. It has been seen liquid limit decreases by adding 4% RBI GRADE 81 & further addition of admixtures soil tends to non plastic. And In the same condition of plastic limit increases up to addition of 4% RBI GRADE 81& further addition of admixtures soil tends to non plastic.

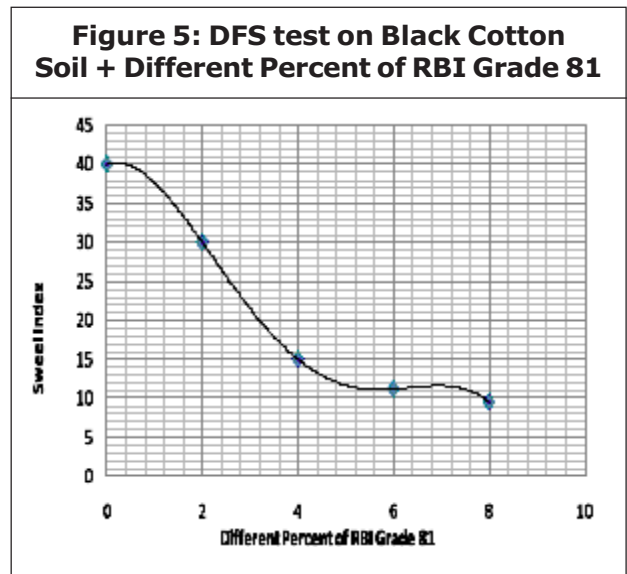




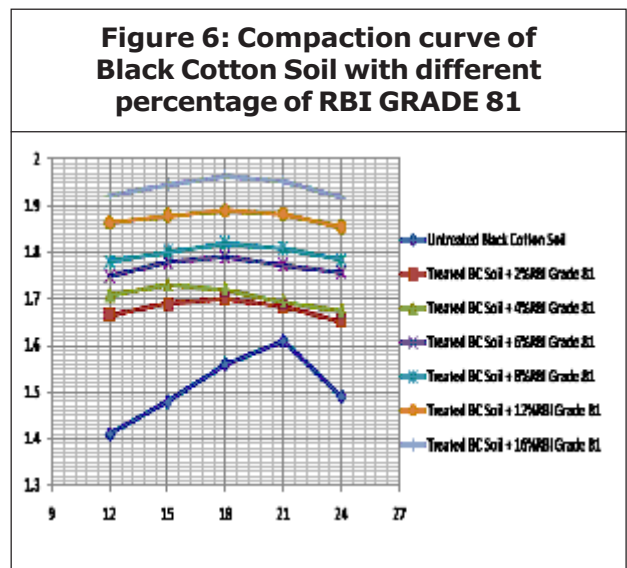
2. The results of shrinkage limit tests on RBI Grade 81 stabilized expansive soil treated with different percentage has been shown in below Figures. It is observed that by addition of 8% RBI Grade 81.



3. The results of differential free swelling tests on RBI Grade 81 stabilized expansive soil treated with different percentage has been shown in above Figures. It is observed that by addition of different percentage of RBI Grade 81, the differential free swelling index of soil decreases.

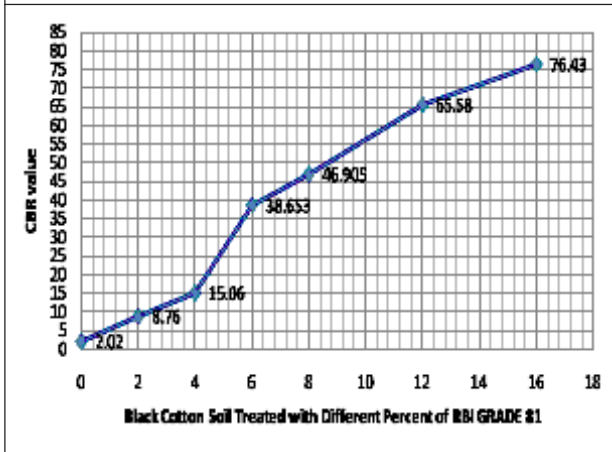


4. It is observed that dry density of Black cotton soil was increased up to addition of 16% RBI Grade 81. This is because RBI Grade 81 gives the binding property to soil.



5. The results of soaked CBR tests on black cotton soil with RBI Grade 81 shown in above figures. It is observed that by addition of RBI Grade 81 at different percentage rate of increases in the soaked CBR of soil increases to 3783% from 433% up to addition of 16% RBI Grade 81.

Figure 7: 4 day's Soaked CBR value of BCS with different percentage of RBI GRADE 81 mix



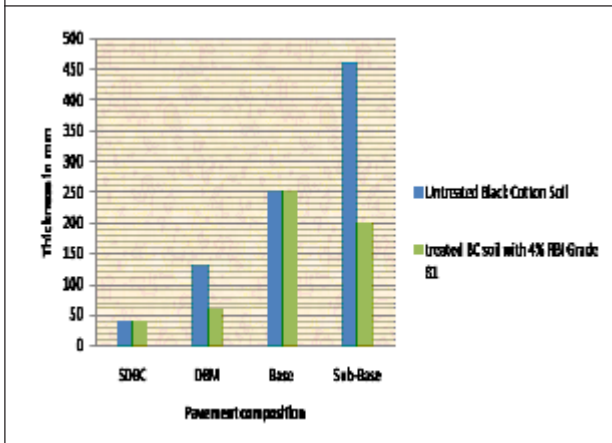
Pavement Design and Cost Analysis

There are two types of Pavement:

1. Pavement design on untreated Black Cotton soil. And the CBR value of Black Cotton soil is 2.02%.
2. Pavement design on treated Black Cotton soil with 4% RBI Grade 81. And the CBR value of Black Cotton soil is 15.06%.

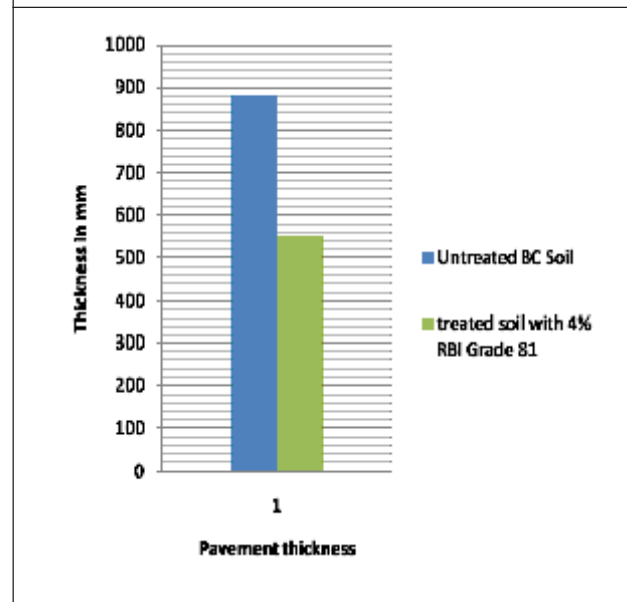
Note:- All the specification taken by IRC: 37-2001, IRC: 37-2012, and latest SSR of MPRRDA.

Figure 8: Comparison of Pavement Composition Thickness



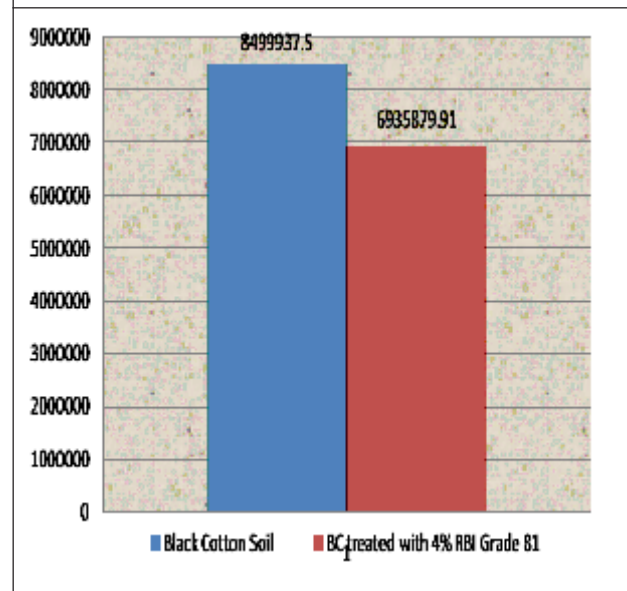
Pavement total Thickness Comparisons

Figure 9: Comparison of Pavement Thickness



Cost of Pavements

Figure 10: Comparison of Approximate Cost of Pavement



Pavement cost of Untreated BCS

Layer	Rate	Quantity in M (meter)			Total Quantity	Cost in Rupees
		L	W	H		
SDBC	8606	1000	3.75	0.04	150	1290900
DBM	8353	1000	3.75	0.13	487.5	4072087.5
Base (WMM)	1591	1000	3.75	0.25	937.5	1491562.5
Sub-Base	947	1000	3.75	0.46	1725	1633575
Compaction	21	1000	3.75	0.15	562.5	11812.5
Total Cost						8499937.5

Pavement Cost of treated BCS with 4% RBI GRADE 81

Layer	Rate	Quantity in M (meter)			Total Quantity	Cost in Rupees
		L	W	H		
SDBC	8606	1000	3.75	0.04	150	1290900
DBM	8353	1000	3.75	0.085	318.75	2662518.75
Base (WMM)	1591	1000	3.75	0.25	937.5	1491562.5
Sub-Base	947	1000	3.75	0.2	750	710250
4% RBI Grade 81 (kg)	30	1000	3.75	0.2	25950	778500
Placing + mixing + Compaction	207				10.38	2148.66
Total Cost						6935879.91

CONCLUSION

The present study can serve as an effective method to utilize RBI GRADE 81 in the stabilization of expansive soil. Conclusions are based on the tests carried out on various percentage of RBI GRADE 81 mix with soil.

1. Liquid limit decreasing by adding 4% RBI GRADE 81 & further addition of admixtures soil tends to non plastic. But in the case of plastic limit, its increase up to addition of

4% RBI GRADE 81 & further addition of admixtures soil tends to non plastic.

2. The shrinkage limit and differential free swelling index of the Black Cotton Soil treated With RBI GRADE 81 is decreasing with the increasing percentage of RBI GRADE 81 mix.
3. Moisture content was found decreasing by adding 6% RBI GRADE 81 and further addition of RBI GRADE 81 does not show

any change in moisture content.

4. The ratio of Soaked to Un-Soaked CBR value of the black cotton soil treated with 2%, 4%, 6%, 8%, 12% and 16% RBI GRADE 81 are 1.67, 2.5, 2.65, 2.67, 2.36 and 2.53 respectively. Result shows the Soaked CBR is about 150% to 300% more than the Un-soaked CBR.
5. Design the road treated with 4% RBI GRADE 81 which having 15% CBR respectively found that reduction in sub-base layer by 56.5% and reduction in DBM layer by 53.84% respectively in comparison to pavement design on Untreated Black Cotton.
6. Design pavement on treated black cotton soil with 4% RBI GRADE 81, pavement thickness reduces by 37.50% to the pavement design on untreated Black Cotton soil and the cost of the pavement reduced by 18.50% to the original cost of pavement cost of untreated black cotton soil.

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