

Laboratory Investigation on Expansive Soil by using RBI Grade-81

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Abstract— In India approximate 52.6 million hectares of the land region are secured with black cotton soils. The Black cotton soils are hard when dry; however lose its quality totally when in wet condition. Black cotton soils are an overall issue that represents a few difficulties for structural Engineers. Different techniques are adjusted to enhance the building qualities of far reaching soils. The dangerous soils are either evacuated or supplanted by great and better quality material or treated utilizing added substance. The present theory manages the properties of black cotton soils of SATI, Vidisha (M.P.), India. In this study, black cotton soil was stabilized using RBI Grade-81. The locally available Black cotton soil is procured from SATI, Vidisha Campus and used for this investigation. RBI Grade-81 has been used as soil stabilizer in this study. Various Laboratory tests were performed to study the effect of RBI Grade-81 on the soil. It reduced the Plasticity and swelling characteristics of soil. It was also observed from the test results that with the increasing dosage of RBI and with increasing curing periods, it effectively improved the CBR values of soil.

Key words: Black cotton soil, RBI Grade-81, CBR value

I. INTRODUCTION

A. General

India has the population of 125 million (approximate) over the area of 32, 87,240 sq. km needed vast network of structures and roads. The land available for construction is less because of increasing urbanization. Recently various polymer stabilizers have emerged and are being used for soil stabilization. RBI Grade-81 is one of them. It is a natural soil stabilizer. It is a unique and innovative product that was developed for the stabilization of a wide spectrum of soils in an efficient, least-cost manner. RBI Grade-81 is an environmental friendly, inorganic, hydration activated powder-based stabilizer that dramatically improves the soil properties. The properties of RBI Grade-81 encouraging engineers to prefer it over other stabilizer.

B. Properties of Black Cotton Soil

Black cotton soil is a type of expansive soil it is a highly clayey soil, grayish to blackish in color and spread over a wide area of the world, mostly found in the arid and semi arid region. In India it covers about 20% of land area and includes approximately the entire Deccan Plateau, Maharashtra, Madhya Pradesh, Tamil Nadu, Karnataka, Andhra Pradesh and part of Gujarat and Uttar Pradesh. It exhibits low bearing capacity and high volume change due to the presence of montmorillonite clay mineral. The liquid limit and plasticity index value ranges from 40 to 100 percent and 20 to 60 percent respectively. BC soil has a low shrinkage limit between 10 to 15 percent and high OMC of 25 to 30 percent. All these properties of soil makes it to be highly sensitive to moisture changes, highly compressible

and plastic in nature. The strength of soil is extremely low and has a very low bearing capacity.

From the stabilization point of view, the following are the main problems encountered in the Black Cotton soil:-

- It is very difficult to pulverize the soil as the dry lumps are difficult to break due to high dry strength and the wet soil is too sticky and unmanageable.
- With the variation of water content, there is excessive variation in volume and stability of soil.
- The soil shrinks on drying, resulting in the formation of extensive cracks. Black Cotton soil compacted at OMC also shrinks when dried as the shrinkage limit is much lower than the OMC.
- It swells when comes in contact with moisture. The BC soil exerts high swelling pressure on being soaked.

These problems of black cotton soil should be avoided to enhance the engineering properties of soil so it can take the load coming over it safely. These poor engineering properties of soil are enhanced by stabilization techniques. Stabilization of soil is an effective method for improving the strength, stiffness and workability of the soil.

C. Use of RBI Grade-81 Stabilizer

RBI Grade-81 (Road Building International Grade-81) is a natural and chemical soil stabilizer. It is a unique and innovative product that was developed for the stabilization of a wide spectrum of soils in an efficient, least-cost manner. It has ability to react with a wide range of soil types and under different soil conditions. Clay, silt, sand and gravel based soils can all be stabilized with a single product, eliminates the requirement of multiple stabilizers for a given project. RBI Grade-81 is an odourless beige powder, which is insoluble in water, non UV degradable and chemically stable. It forms dust free surface. It is durable, permanent and hardens fast. It is aesthetical and environmental friendly. The volume stability of the soil is increased significantly with the addition of low dosages of RBI grade-81. It reacts with soil by hydration reaction and strength of soil treated with it increases with age.

D. History of RBI Grade-81

The History of RBI Grade-81 is summarized below according to its year wise development.

- 1990: South African scientists set out to develop a unique, environmentally friendly comprehensive and irreversible soil stabilizer for road construction.
- 1998: RBI Grade 81, after 10 years of R&D was granted a South African patent.
- 2001: First production facility set up in Israel, with production capacity of 30 ton/hour.
- 2002: Standards Institute of Israel and the ministry of environment award the facility with a Green Label for the product's environmental benefits.

- 2003: RBI Grade 81 granted an International patent that went uncontested and deemed to offer “a novel and unique technology.”
- 2004: Road Building International sign manufacturing License Agreement with Readers in the United Kingdom, a division of Langley Holding PLC, a multinational engineering group, rated by HSBC as one of the UK's top 250 companies, providing capital equipment technologies worldwide.
- 2005: Portugal, the first EU country to specify RBI Grade 81 in a government tender.
- 2006: Mapei, one of Europe's largest producers of auxiliary materials for building and industry, signs a manufacturing license agreement with Road Building International on an exclusive basis in Italy.
- 2006: European Investment Bank confirms co-operation for future implementation of RBI in infrastructure and environmental projects.
- 2007: Government of Romania sanction the use of RBI Grade-81 for governmental projects.
- 2008-2010: RBI targets India as the Asian market entry point, given the regional potential and scope for use. The technology is currently being manufactured under ISO: 9001. It is repeatedly utilized by the Indian army. In 2009 first specification was given in Government tender of Andhra Pradesh. US Government provide \$1 trillion for repair of existing infrastructure and new road construction in it's 5 year budget plan.

E. The Benefits of RBI Grade-81

- The Benefits of RBI Grade-81 are as follows:-
- It reduces construction time by 40%
- The soil strength increases drastically
- It prevents foundation damage by making soil water-resistant.
- It will reduce cost of transport & earth-moving by 60%
- It reduces the cost of maintenance
- It has longer durability
- It is environment friendly and has a small Carbon Footprint
- It is Applicable under all temperature conditions and soil types

F. Review of Previous Studies on Soil Stabilization Using RBI Grade-81

Anitha. K.R, R. Ashalatha, Arvee. Sujil and Johnson, 2009 studied the effect of a new stabilization product RB1 Grade-81 on kaolinite soil, red soil, & Lateritic soil. The soils were tested for atterberg's limit, compaction test and CBR. The kaolinite soil, Red soil and lateritic soil were mixed with different percentage of RBI Grade-81 (i.e. 0%, 2%, 4%, 6% and 8%) for preparation of specimen. The CBR value of soil at different percentage of RBI was determined at OMC+1% water content and curing was done for 0 days, 7 days and 11 days. After curing the specimen was soaked for 4 days to conduct soaked CBR test. The study revealed that with the addition of RBI with kaolinite soil, Red soil and lateritic soil both soaked and unsoaked CBR were increased. On the basis of experiments the author's concluded that the unsoaked CBR did not changed very much for red soil and lateritic soil but for kaolinite soil it increased 16 times. The soaked CBR increased 16 times, 14 times and 4 times with

the addition of optimum percentage of RBI Grade-81 recommended for red soil, lateritic soil and kaolinite soil respectively.

K.V. Madurwar, P.P. Dahale, A.N.Burile, 2013 led a review on impact of sodium silicate and RBI Grade-81 on dark cotton soil to enhance it's building properties. The test outcomes demonstrated that Liquid breaking point diminished and plastic cutoff expanded with the expansion of admixture, subsequently bringing about lessening of versatility list. The UCS and splashed CBR values expanded with increment in RBI Grade-81, recommend its reasonableness as great stabilizer. Be that as it may, with the expanding measurements of sodium silicate UCS and CBR esteem diminished, which showing the impediment of sodium silicate to be utilized as a stabilizer. at the point when the RBI Grade-81 was added to the dirt the free swell list esteem was diminished however with the option of sodium silicate it was expanded.

Haricharan T. S. at. al., 2013 conducted laboratory investigation of expansive soil stabilized with natural inorganic stabilizer. In laboratory they have conducted the atterbergs limit test, compaction test, CBR test and UCS test with the addition of 0.5%, 1%, 1.5%, 2% and 2.5% RBI with black cotton soil. The CBR test were performed after 1 days, 3 days and 7 days of curing and UCS test were performed after 0 days, 7 days, 14 days and 28 days of curing period. The plasticity index of soil and OMC value were decreased and MDD increased with the increase of RBI percentage. The CBR of untreated soil was 1.34% which increased to 14% with addition of 2.5% RBI-81 after 7 days of curing period. The UCS of untreated soil was found to be 208 kN/m² which increased to 1032 kN/m² at 2.5% RBI addition with 28 days of curing. With the investigation of test result the authors concluded that RBI Grade-81 is a good stabilizer to stabilize the black cotton soil.

Parijit jain and H. S. Goliya, 2014 conducted a study on stabilization of black cotton soil for sub-grade layer with the chemical stabilizer. The soil and RBI Grade-81 were mixed in different proportions for different tests. For atterberg's limit test, they mixed the RBI with soil varying from 0% to 4% and found that liquid limit was decreased and plastic limit was increased and thus plasticity was decreased with the addition of RBI Grade-81. For DFS test RBI was mixed with soil varying from 0% to 8%. With the addition of RBI Differential Free Swell value was reduced. For compaction and CBR test, the RBI was mixed with the soil ranging from 0% to 16%. It was found that MDD was increased with the increase of RBI proportion and OMC increased up to 6% addition RBI and further more addition of RBI didn't showed any change in OMC. The CBR value at 0%, 2%, 4%, 6%, 8%, 12% and 16% RBI were found to be 2.02%, 8.76%, 15.06%, 38.65%, 46.90%, 65.58% and 76.43%. The CBR value increased 645% with the addition of 4% RBI. They also compared the total thickness of pavement and cost of pavement at 4% RBI. The total thickness of pavement reduced from 890 mm to 525 mm and cost of pavement reduced from 8499937.5 to 6935879.91 at 4% RBI Grade-81. Hence at 4% RBI content, the total thickness of pavement reduced 37.5% as compare to thickness of pavement on untreated soil and cost of

pavement reduced to 18.5% as compare to original cost of pavement on untreated soil.

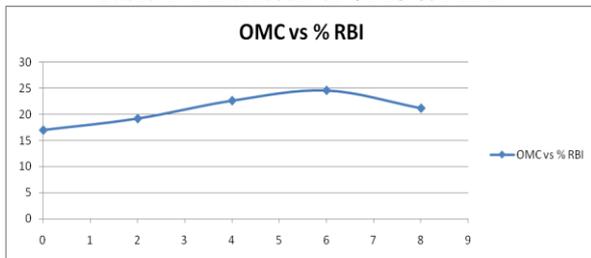
Name Of the Project	Category of Work	State	Remarks
Paniganda-Bamunigam-Daringbadi Road	Village Road	Orissa	Ongoing
Amlaren –Muktapur road (10Km)	MDR	Meghalaya	Ongoing
JBRC- Jalaphet (17Km)	MDR	Meghalaya	Ongoing
Mynska- Mynt Siang (10Km)	MDR	Meghalaya	Ongoing

II. TEST RESULTS

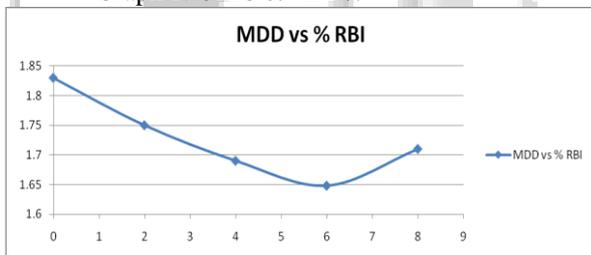
A. Compaction Test Result:

RBI Grade-81 %	OMC	MDD
0	17.01	1.83
2	19.22	1.75
4	22.66	1.69
6	24.63	1.648
8	21.21	1.71

Table 1: Final result of OMC & MDD



Graph 1: OMC & RBI %

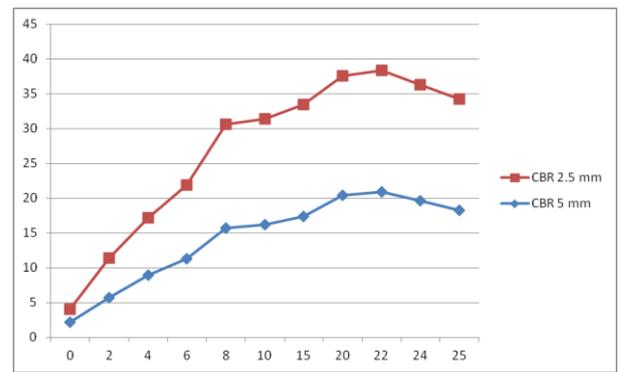


Graph 2: MDD & RBI %

B. California bearing ratio (CBR) Test Results:

RBI Grade-81 %	CBR results after 4 days soaking	
	CBR at 2.5 mm	CBR at 5.0 mm
0	2.19	1.87
2	5.74	5.66
4	8.98	8.18
6	11.34	10.51
8	15.72	14.89
10	16.2	15.18
15	17.35	16.13
20	20.4	17.2
22	20.9	17.4
24	19.6	16.7
25	18.3	15.9

Table 2: California bearing ratio (CBR) test results



Graph 3: California bearing ratio (CBR) test results

III. CONCLUSIONS

Based on the test conducted in the laboratory on untreated and treated soil the following conclusions have been drawn.

A. Compaction Test

With the increase in RBI Grade-81 proportions from 0% to 8% the Optimum Moisture Content of the soil increases continuously and it is increased by 42.35% after 8% addition of RBI Grade-81. But this trend is not followed by Maximum Dry Density (MDD). The MDD of the soil decreases with increasing percentage of RBI Grade-81. When RBI proportion increases from 0% to 8%, the MDD of soil decreased by 10.02%. Hence, from the test results it can be concluded that RBI Grade-81 is not effective in improving the compaction values as it increases the OMC and decreases the MDD.

B. California Bearing Ratio (CBR) Test

It can be observed from the test results that RBI Grade-81 is very effective in improving the California Bearing Ratio value. The CBR value of the soil increases with increasing proportion of RBI Grade-81 from 0% to 25%. The maximum increment in CBR value is obtained at 22% RBI Grade-81 and after 4 days soaking and then its value is decreased at 24% and 25%. The value of CBR of untreated soil was 2.19% which is increased by 2379.90% at 22% RBI and after 4 days soaking. Thus it can be concluded that RBI grade-81 is very effectively improve the CBR value of the soil.

IV. SCOPE FOR FUTURE WORK

There is a lot of scope for research work in the future with RBI Grade-81. It is economical, eco-friendly, durable and significantly improve the Geotechnical properties of soil. It can be used with approximately all type of soils. It is a newly emerging stabilizer which came in India in 2008 and becoming popular day by day as compare to other stabilizers. Indian army is regularly using this material from 2009. There is still no proper standards or codes available for use of this stabilizer for different type of soils. Some of areas in which research can be done in the future are:

There are lots of waste materials like plastic waste, quarry waste which has problems of dumping. A study can be carried out on the stabilization of soil by using these waste materials with RBI Grade-81. It will be economical and eco-friendly.

The suitability of using waste material like demolition waste, all types of slag, marble, granite, stone dust, fly ash, etc. to be stabilized with this RBI Grade-81 technology along with soil and used in road construction.

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