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# Effect of RBI-81 on CBR and Swell Behaviour of Expansive Soil

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***Abstract: Many ground improvement techniques have been evolved in the past decade in order to reduce the potential of severity of the expansive soils. Out of those techniques, soil stabilization is the most effective technique. This paper presents results of the investigation carried out to stabilize an expansive soil using RBI grade 81 stabilizer. Free swell index, CBR and SEM analysis were carried out on both untreated and treated soils. There was a considerable reduction in swell potential and an increase in the strength of the soil with the addition of stabilizer.***

**Keywords: RBI grade 81, Free swell index, CBR and SEM.**

## I. Introduction

Stabilization of soil involves the enhancement of soil properties by addition of stabilizer which may be organic or inorganic in nature. Among various ground improvement techniques, soil stabilization is an effective method that enables to re-use the in-situ soil upon application of stabilizer having the potentiality of modifying the existing property of a soil. Generally soils have varying engineering properties that may or may not be suitable for construction. As far as road construction is concerned, cohesive clayey soil is a tough challenge for highway engineers due to its swelling and shrinkage characteristics which are the sole reasons for pavement failures. Stabilization of such Kaolinite and Montmorrillonite soils by means of mechanical or chemical methods helps to re-use the soil instead of road cutting for replacing the in-situ soil with suitable carted earth as subgrade. Conventionally, lime stabilization, bitumen stabilization and cement stabilization were practiced as ground improvement techniques. There are other cementious stabilizers used for soil stabilization in case of soils having very low CBR. Reddy and Moorthy (2004) have shown that pond ash along with small amount of lime when added to poor clayey sub-grade, improves CBR and thereby increases the pavement life and reduces the thickness. In this study RBI grade 81 (Road building international) soil stabilizer is used for improving the soil properties of an A-7-6 (HRB classification) soil. RBI grade 81 is ecofriendly natural inorganic cementious soil stabilizer. Objective of the study deals with the comparison of the strength and microstructural changes of virgin soil sample and RBI grade 81 stabilized soil at various curing days mixed with various dosages i.e., 2%, 4% and 6%.

## II. Literature Review

Utilization of Rice husk with varying percentage of lime in clayey soil was studied (Biswas et al. 2012) and it was reported that 3% dosage of lime on clayey and RHA mixture produced a higher CBR value. Compaction characteristics of the stabilized soil also gave improved results. Various other stabilizing products were experimented with Rice husk on expansive clays. One such study was carried out by Sabat and Nanda (2011) and the study reported a substantial improvement in CBR and UCS test results of the soil stabilized by marble dust with RHA. Venugopal N (2010) concluded from the study that a low CBR soil can be treated with silica fume at 5% to 20% by weight of dry soil. Stabilization of waste by-products like blast furnace slag and fly ash with RBI grade 81 and lime was studied (SushantBhuyan, 2010) for experimenting the influential capacity of unconventional cementious stabilizers over property enhancement of slag and fly-ash. Test samples with different percentages of RBI grade 81 were studied and found that UCS, and compaction characteristics of slag and fly-ash increased with increasing percentage of RBI grade 81 and curing days. Effect of RBI Grade 81 on problematic Kaolinite and lateritic soils at various curing periods was studied (Anitha K.R. et al 2009) and concluded better results of various properties like CBR, Atterberg limits, modified compaction tests. From the study the researchers reported that laterite and Kaolinite soils shows the better performance with the addition of RBI stabiliser of 2% and 6%.

## III. Materials and Properties

Two types of soils and one type of stabiliser were selected for this study. These soils are referred as sample A and sample B in this paper. These samples were collected from a depth of 0.5m below ground level. Both the soils are Highly plastic clay. Grain size analysis on the soil samples as per IS:2720 (Part- 4)1985 showed that sample A had 96% fines (clay 70%+silt 26%) and sample B had 98% fines (clay 66%+silt 32%). The consistency limits of the soil were determined as per the standards IS:2720 (Part -5) 1985 and IS:2720 (Part-6) 1972. The liquid limit and plasticity index of soil sample A are 53% and 22% respectively and that for soil sample B are 69% and 45% respectively. In addition to this specific gravity, standard proctor, UCC and free swell tests are conducted as per the Indian Standards. The soil properties are, Sample A :OMC=20%, MDD=16kN/$m^3$, Differential free swell=110%, Shrinkage limit = 7, Specific gravity =2.36, UCS = 138kPa and Sample B: OMC=24.5%, MDD=15.4kN/$m^3$, Differential free swell=105%, Shrinkage limit = 6, Specific gravity = 2.65, UCS = 122kPa. Based on the shrinkage limit and free swell index the soil sample A and sample B are categorized as an expansive soil of high to very high degree of expansion. RBI grade 81 was used as soil stabilizer.

## IV. Experimental Study

California bearing ratio tests were performed on soil samples as per BIS specifications. CBR test as per IS:2720 (Part XVI) after four days of soaking and free swell test were conducted on untreated and treated samples for both the soils(A and B). The soil samples were mixed with the stabiliser at OMC. The stabiliser dosage on both the soil samples were 2%, 4% and 6%. The samples prepared with the stabiliser were placed over wet gunny bags for curing in order to maintain constant

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temperature. After a curing period of 3, 7 and 14 days the samples were soaked for 4 days. Then the CBR tests were conducted at 7th (3+ 4), 11th (7+4) and 18th (14 +4) day. Surcharge weight of 5 kg, sufficient to produce a load intensity equal to the weight of the base material and pavement was used during soaking and penetration. A metal penetration plunger of diameter 50 mm was used to penetrate the samples at the rate of 1.25 mm/min.

## V. Results and Discussion

The effects of stabiliser dosage and curing period on the soils were studied and are presented in this section. Significant increase in CBR of soil was observed from the test results. The soaked CBR of untreated soil samples A and B were 2 and 2.19% and the low CBR value of the soil is because of inherent low strength due to the dominance of clay fraction. The soaked CBR values of the untreated and treated soil with varying percentage addition of stabiliser for the curing periods of 3, 7 and 14 days are given in Table – 1. The variation of soaked CBR value with the addition of RBI stabiliser on the soil sample B is shown in Figure 1.

**Table - 1 : CBR values of untreated and treated soil sample A and B**

| Stabiliser (%) | Soaked CBR Value (%) | | | | | |
|---|---|---|---|---|---|---|
| | Sample A | | | Sample B | | |
| | Curing Period (Days) | | | Curing Period (Days) | | |
| | 3 | 7 | 14 | 3 | 7 | 14 |
| 0 | 2 | | | 2.19 | | |
| 2 | 9.56 | 16 | 20 | 10 | 15 | 18 |
| 4 | 9.93 | 22 | 34.96 | 10.4 | 22 | 30 |
| 6 | 10.8 | 27 | 53.65 | 11.5 | 26 | 40 |

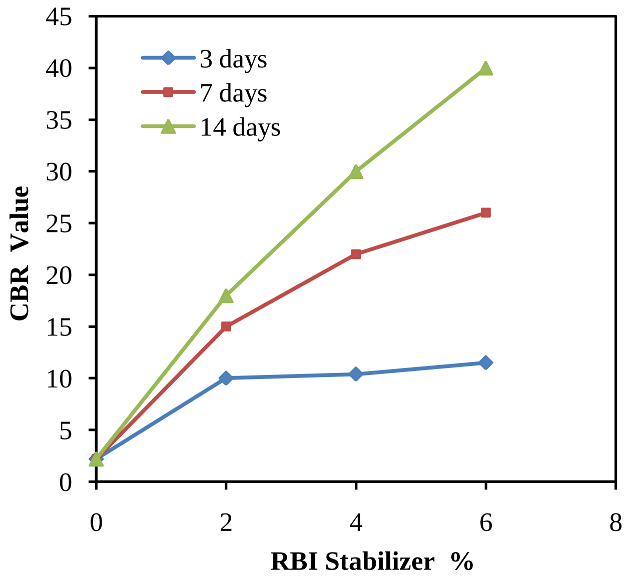



**Figure - 1. Comparison of CBR values with various % of stabilizer for sample B**

CBR value increases with the increase in percentage of RBI and curing period. A satisfactory result with a tremendous increase in the CBR value was observed, the maximum value being 26 times more than that of the untreated soil for sample A and approximately 20 times increase in case of sample B. The minimum increase in CBR value for the addition of 2% and 6% of soil stabiliser at 3 days curing period for the sample A was 3.75 and 4.4 times and for the sample B was 3.56 and 4.25 times. Figure 2 shows the variation of CBR value with curing period on addition of 2, 4, and 6% soil stabiliser.

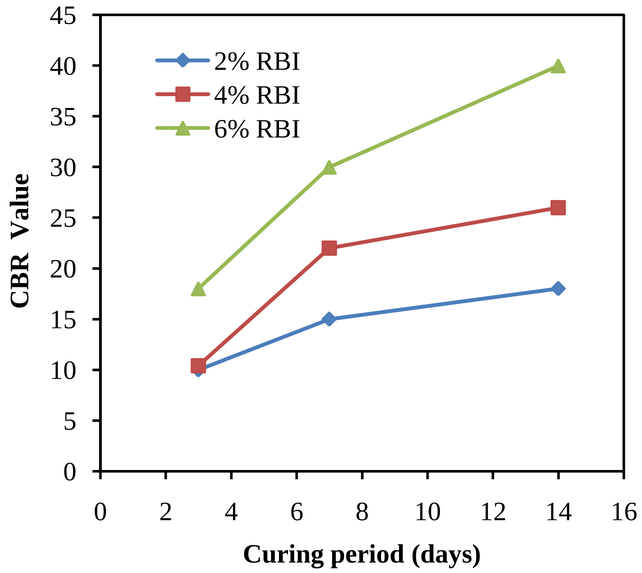



**Figure – 2. Effect of curing period on CBR value for sample B**

Both the soils show a similar trend of increasing strength with increase in curing period for the stabiliser content addition used in this study. The rate of increase in strength is more in the initial period than the later stages of curing period.

***Free Swell Index***

Free swell index test was conducted on both untreated and treated soils in accordance with IS: 2720 (Part – XL). Free swell index shows a decreasing trend with the increase in RBI content and curing period.

**Table - 2: Free swell test results for sample A and B**

| Stabiliser (%) | Free Swell (%) | | | | | |
|---|---|---|---|---|---|---|
| | Sample A | | | Sample B | | |
| | Curing Period (Days) | | | Curing Period (Days) | | |
| | 3 | 7 | 14 | 3 | 7 | 14 |
| 0 | 110 | | | 105 | | |
| 2 | 90 | 85 | 75 | 95 | 90 | 85 |
| 4 | 75 | 70 | 65 | 85 | 75 | 70 |
| 6 | 65 | 60 | 55 | 70 | 65 | 60 |

Figure 3 shows comparison of free swell index values of soil sample A with the addition of varying percentages of stabiliser for the curing periods of 3, 7 and 14 days. It has been observed that the maximum percentage reduction in free swell values for the sample A and sample B were 50% and 75% respectively for the curing period studied.

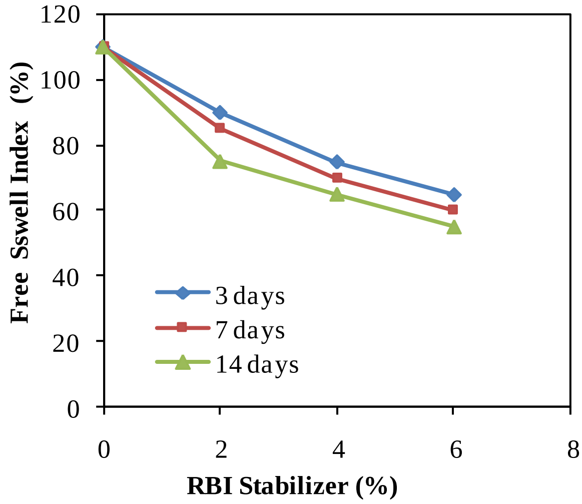
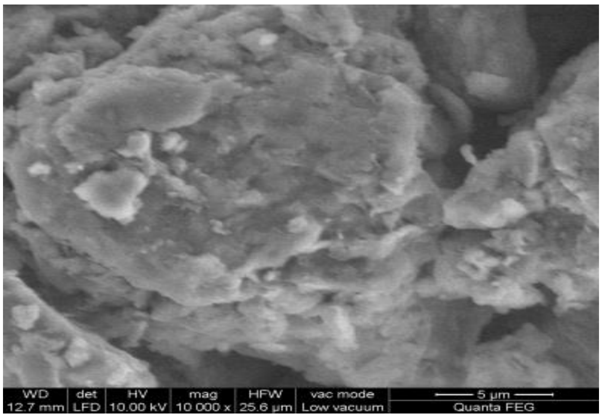


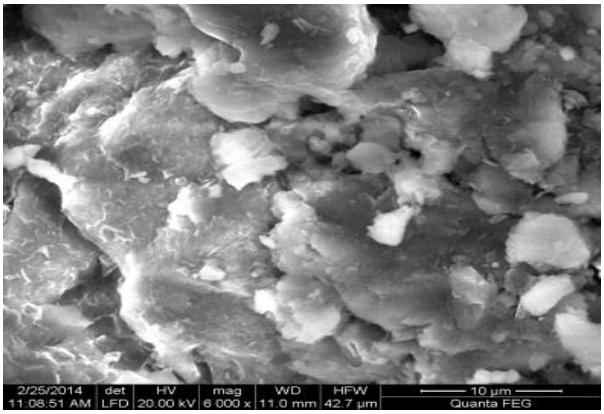

**Figure- 3. Comparison of free swell test with the percentage of stabilizer for sample A**

***Scanning Electron Microscopy***

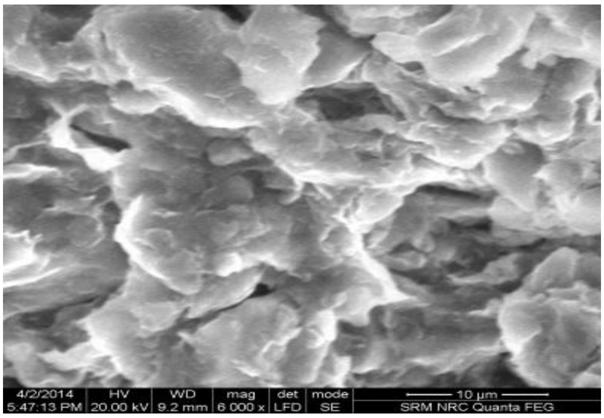
SEM analysis was carried out on untreated soil samples and 14 days cured treated samples using Field Emision Scanning Electron Microscopy (FESEM) images taken using FEI Quanta 200 FEG. Figure 4(a) and (b) shows SEM micrographs of untreated samples 1 & 2 and figure 4 (c) and (d) shows 14 days cured soil samples A and B with 6% stabilizer. The SEM micrographs 4 (c) and (d) clearly shows the reduction in pore spaces and change in microstructure of soil on treatment.



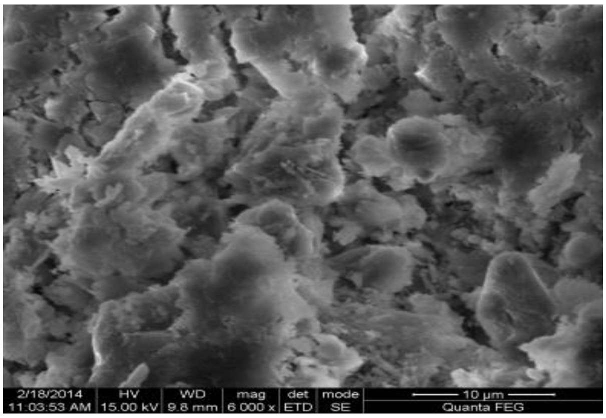
(a) Untreated sample A



(b) Untreated sample B



(c) Sample A treated with 6% stabilizer
(14 days cured)



(d) Sample B treated with 6% stabilizer
(14 days cured)

**Figure – 4. SEM micrographs of untreated and treated soil samples**

## VI. Conclusions

1. RBI grade 81 stabilizer gives satisfactory results for both the soils interms of strength and swelling.

2. The minimum increase in CBR value for the addition of 2% and 6% of soil stabiliser at 3 days curing period for the sample A was 3.75 and 4.4 times and for the sample B is 3.56 and 4.25 times as that of the untreated soils.

3. There was a considerable decrease in the swelling potential in both the soil samples with increase in stabiliser dosage and curing period studied.

4. Reduction in pore spaces and change in microstructure of the soil can be observed from the SEM micrographs, which gives a clear indication for the increase in strength of CBR and reduction in swelling potential.

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