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# Study on the Effect of Chebulic Myrobalan Solution on CBR Strength of Sandy Soil

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**Abstract:** ***Efforts in this study were primarily aimed at in making use of natural sand for potential use as road subgrade in the design of flexible pavements. Chebulic Myrolobalan has been introduced to geotechnical engineering to increase the mechanical strength of sand. Soils are strong in compression but weak in tension. The current practice is to modify the strength of the soils by addition of chebulic myrobalan to meet the design specifications.***

**Keywords:** Chebulic Myrobalan; CBR; Field tests; Subgrades ; Flexible Pavement

## 1. Introduction

Reinforcement aids in the strength and stability of soil. Reinforcement of soil with bio polymer is one of the most effective techniques for increasing soil strength. Therefore, a number of laboratory experimental studies have been carried out, wherein soil is mixed with Chebulic myrobalan solution. The present work discusses the behavior of a CBR test on soil specimens mixed with chebulic myrobalan solution under both soaked and unsoaked conditions, gives more strength when compared to a non reinforced soil specimens under similar conditions. In this paper it is shown that the soil reinforced with the chebulic myrobalan solution have more strength than the non-reinforced soil.

**Figure 1:** Natural Sand

## 2. Laboratory and Field Testing Programme

### a) Materials

The soil samples used in the present study were derived from the college campus Bharath Institute of Higher Education and Research, Chennai. The soil are classified as (SP) Poorly graded sand according to the Unified Soil Classification System. The specific gravity of soil is 2.62. The dry density of Soil is 1.45g/cm$^3$ and OMC of 8%. The Solution used in this investigation is Chebulic Myrobalan which was available in powder form.

**Figure 2:** Chebulic Myrobalan (kadukai)

### b) Laboratory Preparation and Testing of Specimens

The compacted soil and the solution mixed laboratory specimens were prepared by hand mixing dry soil, water, and chebulic myrobalan solution when applicable During the mixing process, Visual and microscopic examination of exhumed specimens proved the mixtures to be satisfactorily uniform. The specimens were statically compacted in three layers into a 50 mm diameter by 100 mm high cylindrical mould, to an optimum moisture content of 90% of OMC and maximum dry unit weight of 1.45 g/cc for Soil. These values were obtained from standard Proctor compaction tests carried out on both soil and soil–CM Solution mixtures.

**Figure 3:** Compaction Test

The CBR test is one of the most commonly used methods to evaluate the strength of a sub grade soil, sub base, and base course material for design of thickness for highways and airfield pavement. The California bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement. As per ISI, the CBR test was performed on remolded soil by static compaction. Required amount of fibers as well as soil was first weighed and then the strips randomly mixed with dry soil at obtained moisture content. The soil was compacted in three equal layers by applying 55 evenly distributed blows with 4.89Kg hammer at free fall. Due care was taken to ensure a homogeneous mix. A surcharge weight of 2.5 Kg was placed over the specimen, clamped over the base plate and the whole mould with the weight is placed under the testing machine. The penetration plunger is seated at the center of the specimen and is brought in contact with the top surface of the soil sample. The dial gauge for measuring the penetration values of the plunger is fitted in position. The dial gauge of the proving ring (for load reading) and the penetration dial gauge are set to zero. The load is applied through the penetration reading of 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 4.5, 5.0, 7.5, 10.0 and 12.5mm.

**Figure 4 (a):** CBR Setup

**Figure 4 (b):** Specimen after unloading

## 3. Test Results and Discusssions

Load penetration behavior of reinforced/non reinforced soil samples was examined. The load penetration curve has been plotted for each specimen.

Fig.4 (a),(b) shows the typical plots of load-penetration curves for Chebulic Myrobalan Solution mixed soil at different proportions of un-soaked conditions after 7 and 14 days of Curing. The CBR values have been calculated for the load corresponding to the penetration of 2.5 mm and 5.0 mm. The higher of these values have been adopted as CBR value (IS-2720-16- 1979).

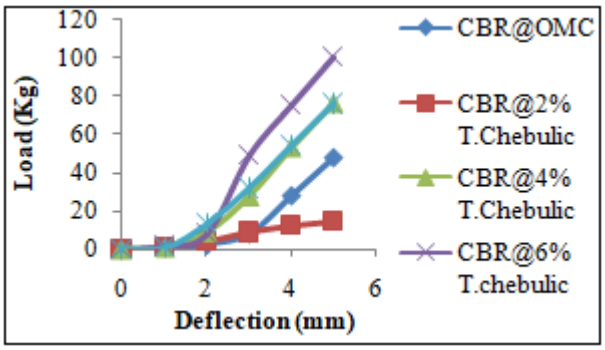


**Figure 4 (a):** CBR Curve for soil at Different Proportions of Fiber Mixed after 7 days of curing

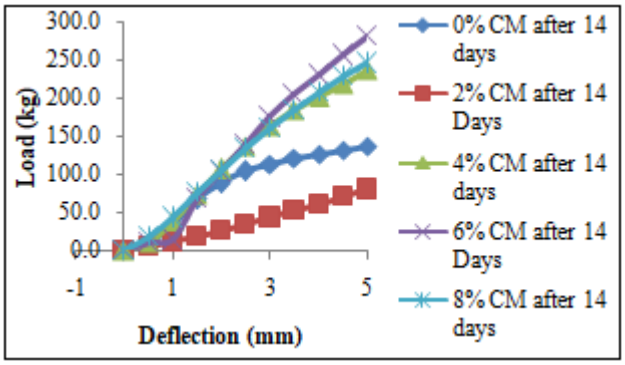


**Figure 4 (b):** CBR Curve for soil at Different Proportions of Fiber Mixed after 14 days of curing

**Table 1:** CBR Values at 6% of Chebulic Myrobalan Solution

| CBR Values at 6% of Chebulic Myrobalan Solution | | |
|---|---|---|
| Penetration in mm | Load in Kg (7days) | Load in Kg (14days) |
| 2.5 | 100 | 140 |
| 5 | 201 | 282 |

**Comparison of Load at Allowable Settlement**

A comparison of the Load intensity of various cases is made to understand the behavior of Chebulic Myrobalan Solution in Sandy Soils. For this comparison an allowable Penetration of 5 mm is considered and the corresponding allowable loads are determined and tabulated in table 2 and 3 for 7 days and 14 days respectively .

**Table 2:** Comparison of Load at allowable settlement

| | 0% CM | 2%CM | 4%CM | 6%CM | 8%CM |
|---|---|---|---|---|---|
| Load (Kg) | 48.19 | 14.22 | 76.3 | 100.33 | 75.85 |
| Increase/Decrease % | | -70.5 | 58.34 | 108.2 | 36.45 |

**Table 3:** Comparison of Load at allowable settlement

| | 0% CM | 2%CM | 4%CM | 6%CM | 8%CM |
|---|---|---|---|---|---|
| Load (Kg) | 138.3 | 80.7 | 237.8 | 282 | 246.6 |
| Increase/Decrease % | | -41.5 | 71.9 | 104.05 | 78.3 |

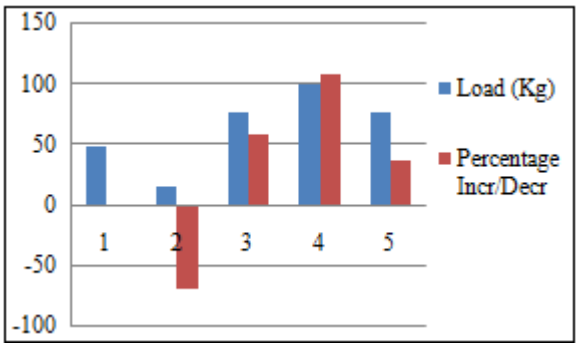


**Figure 5 (a):** Increase or decrease in the load intensity at 5mm allowable settlement

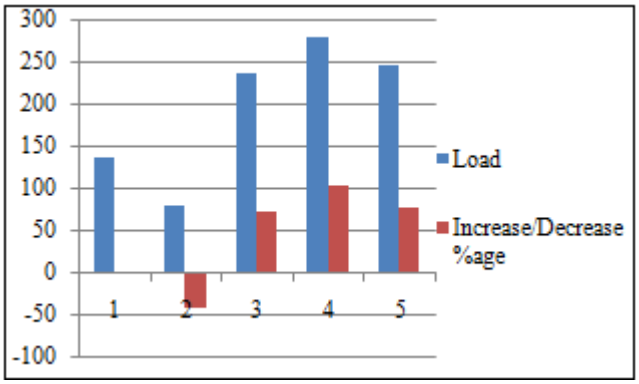


**Figure 5 (b):** Increase or decrease in the load intensity at 5mm allowable settlement

Comparison Between $PU_{max}$ after 7 days and 14 days of curing

**Table 4:** Comparison between Pumax after 7days and 14 Days of Curing

| | |
|---|---|
| $Pu_{max}$ after 7 days of Curing | 100.3 kg |
| $Pu_{max}$ after 14 days of Curing | 282 kg |
| Increase/decrease Percentage | 181.1% increase |

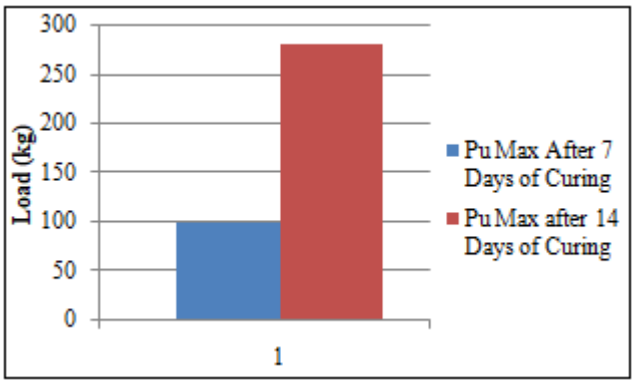


**Figure 6 (a):** Increase or decrease in the load intensity after 7 and 14 days.

## 4. Conclusion

The following observations and conclusions are made regarding the engineering properties and behavior of Chebulic Myrobalan Solution Mixed/Non Mixed specimens of a sandy soil from CBR tests carried out in the Soil Mechanics Laboratory, Bharath Institute of Science and Technology, Chennai TN. A comparison of the Loads of various cases of soil specimen mixed with Chebulic Myrobalan Solution in varying percentages of 0%, 2%, 4%, 6% and 8% is made in the table 1. For this comparison an allowable penetration of 2.5 mm and 5 mm is considered and the corresponding CBR values are determined and tabulated in table 1. From the table 1 it can be seen that the 6% of Chebulic Myrobalan Solution added with soil has given maximum load corresponding to 5mm allowable settlement.

- There is decrease of load by 70.5% in the case of 2%
- There is an increment of load by 58.34% in case of 4%.
- In the case of 6% of there is increase of 108.2% of load.
- In case of 8% there is increment of 36.45% of load.

Finally this shows that on 6% of Chebulic Myrobalan solution added with soil the load carrying capacity remains the maximum when compared with 2%, 6% and 8% in Sandy soil.

A comparison of the Loads of various cases of soil specimen mixed with Chebulic Myrobalan Solution in varying percentages of 0%, 2%, 4%, 6% and 8% is made in the table 6. For this comparison an allowable penetration of 2.5 mm and 5 mm is considered and the corresponding CBR values are determined and tabulated in table 6.2.2. From the table 6.2.2 it can be seen that the 6% of Chebulic Myrobalan Solution added with soil has given maximum load corresponding to 5mm allowable settlement.

- There is decrease of Load by 41.5% in the case of 2%
- There is an increment of load by 58.34% in case of 4%.
- In the case of 6% of there is increase of 108.2% of load.
- In case of 8% there is increment of 36.45% of load.

Finally this shows that on 6% of Chebulic Myrobalan solution added with soil the load carrying capacity remains the maximum when compared with 2%, 6% and 8% in Sandy soil.

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