

Soil Stabilization Using Crumb Rubber and Cement

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Abstract: *It is not safe to make any constructions on weak soils. The improvement of the load bearing capacity of the soil can be done by a variety of ground improvement techniques. In this experimental study crumb rubber has been opted as reinforcing material and cement as binder which were mixed with the soil at three different percentages, i.e. 5, 10 and 15 percentages by weight of soil. The reinforced soil samples are tested for their strength characteristics. California Bearing Ratio and Unconfined Compression Tests have been performed to the soil samples. The experimental results implied that the addition of crumb rubber and cement improved the strength characteristics of the soil significantly. Since the crumb rubber is a hazardous waste material, its utilization in this method will reduce its impact on the environment and health.*

Keywords— (Crumb rubber¹, Cement²)

1. INTRODUCTION

Solid waste management is one of the main environmental problem which is being faced all over the world. The statistics report that in India the output of waste material is more than 1.5 billion tons, which is the third most in the world. The generation of the scrap tyres is increasing exponentially every year. It is observed that there is a phenomenal increase in the number of vehicles in India which results in production of huge volume of waste rubber tyres. The geotechnical engineers around the world are in the investigation of new alternative materials which are economic solutions for ground improvements and for the conservation of natural resources.

As the use of the waste tyres as a fuel is creating hazardous impacts on the environment, it is prohibited in India since 2006. The common modes of disposal waste rubber by stock piles and fills and burning are considered as a danger to the health of the humans and the ecosystem as well. The poisonous gases that are released by the

burning of waste tyres can harm the health of the people living in the nearby area.

Today constructions are being carried out on the sites having extremely poor ground conditions like soft clays which were earlier considered unsuitable because of their poor strength parameters and high compressibility. Such soils, when

subjected to the loads cause excessive settlements and early failure of structures.

This paper presents a result of the laboratory studies that were conducted on the soil samples reinforced with crumb rubber and cement for the engineering properties of the soil. Crumb rubber passing through 4.75mm sieve and retained on 425micron sieve was used along with cement for the soil reinforcement. Several laboratory experiments are carried out on the soil samples mixed with different percentages of crumb rubber and cement. The proportion in which the crumb rubber and cement are mixed with the soil to stabilize it are 5%, 10%, 15% of crumb rubber and 2%, 4%, 6% of cement respectively by weight of the soil. At last to draw a comparison between the variation of the strength parameters of the reinforced soil at 5% of crumb rubber, the cement is added once in 2% and the other time in 6%.

2. LITERATURE REVIEW

Brajesh Mishra had studied that the soil strength is effectively improved using different percentage of lime contents. The compaction and strength characteristics of the expansive soil were changed when lime is added to it.

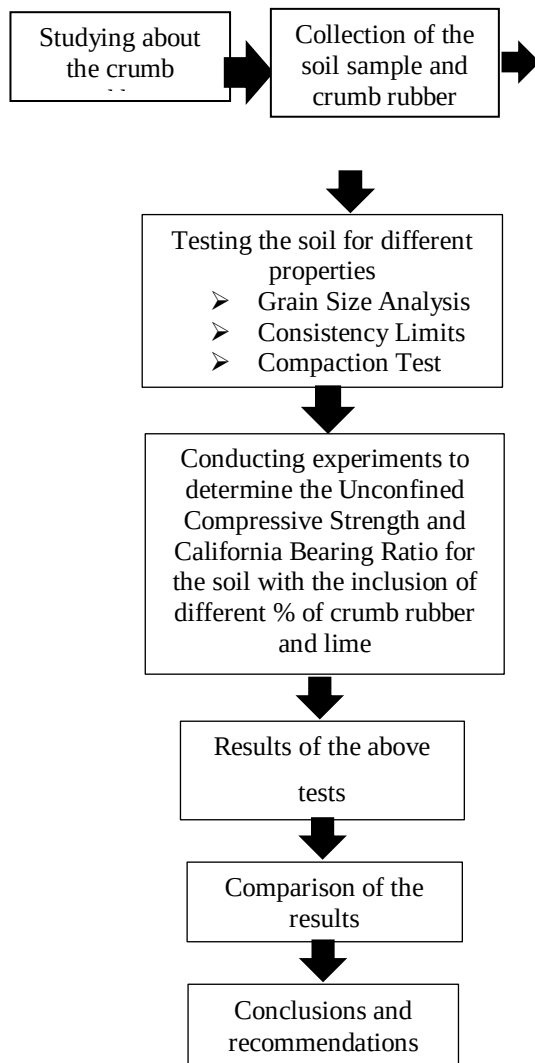
Cabalar blended GTR with sands from two geologic formation, Leighton Buzzard Sand (LBS) and Ceyhan Sand (CS). These sands were selected for their differences in structure and engineering properties. LBS is coarse with sub angular particles, and CS is fine with angular particles. The rubber particles size was not listed but the particles were described as “flaky.” Rubber was blended with each type of sand at 5, 10, 120, and 50% by weight. He concluded that the blends were useful as light weight embankment fill on weak foundation soils and retaining wall backfill material since the

sand rubber mixtures were significantly lighter than 100% sand mixtures.

Based on his investigations **Dr. P.G. Rakaraddi** had reported that CBR value increases with the use of crumb rubber which on a whole helps in reducing the total thickness of the pavement.

Umar Jan and Vinod Kumar Vinpulkerni conducted the stabilization of soil using shredded rubber of tyre and they reported that the load carrying capacity of soil is increased and also the addition rubber reduced the swelling potential.

3. METHODOLOGY



4. DISCUSSIONS

4.1 Crumb Rubber

Crumb rubber is the recycled form of rubber that is produced from automobile and truck scrap tyres.

4.2 Cement

Cement is a binding material which is used in construction because of its setting, adhering and hardening properties.



Fig. 1: Crumb Rubber



Fig. 2: Cement

5. EXPERIMENTS CONDUCTED

- Grain size analysis of the soil by mechanical method.
- Wet sieve analysis of the soil.
- Determination of the consistency limits of the soil.
- Determining the optimum moisture content and maximum dry density of the soil by Standard Proctor Compaction Test.
- Unconfined Compressive Strength test for the pure red soil and with the inclusion of 5%, 10%, 15% of crumb rubber and 2%, 4%, 6% of cement along with 5% of rubber and 6% of cement.
- California Bearing Ratio test for the pure red soil and with the inclusion of 5%, 10%, 15% of crumb rubber and 2%, 4%, 6% of cement along with 5% of rubber and 6% of cement

6. MIX PROPORTIONS

Table 1: Mix Proportions

Sample	Soil (%)	Crumb rubber powder (%)	Cement (%)
1	100	0	0
2	93	5	2
3	86	10	4
4	79	15	6
5	89	5	6

- Toughness Index = 2.5

7. RESULTS

The Specific Gravity of the collected soil was found to be 2.27.

7.1 Grain Size Analysis of the Soil by Mechanical Method

- $D_{60} = 0.84\text{mm}$
- $D_{30} = 0.46\text{mm}$
- $D_{10} = 0.19\text{mm}$
- Coeff. of Uniformity = 4.421
- Coeff. of Curvature = 1.325
- Wet sieve analysis = 40% fines

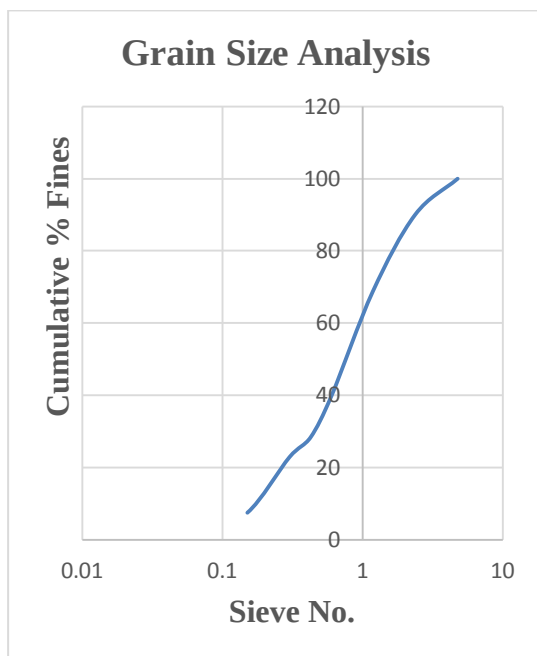


Fig. 3: Plot between Sieve No. and % fines

Consistency Limits

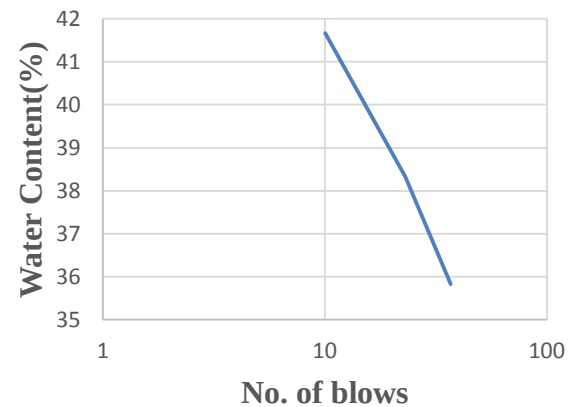


Fig. 4: Plot between No. of blows and Water Content

7.3 Optimum Moisture Content and Maximum Dry Density of the Soil

- Maximum Dry Density (MDD) = 1.93 g/cc
- Optimum Moisture Content (OMC) = 18.18%

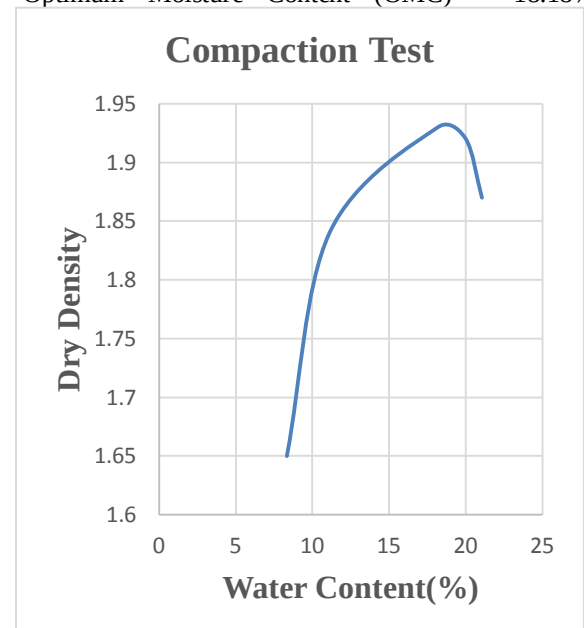


Fig. 5: Plot between Water Content and Dry Density

7.2 Consistency Limits of the Red Soil

- Liquid Limit = 37.5%
- Plastic Limit = 11.74%
- Plasticity Index = 25.76%
- Flow Index = 10.3

7.4 UCS values of the Soil with and without the inclusion of Crumb rubber and Cement

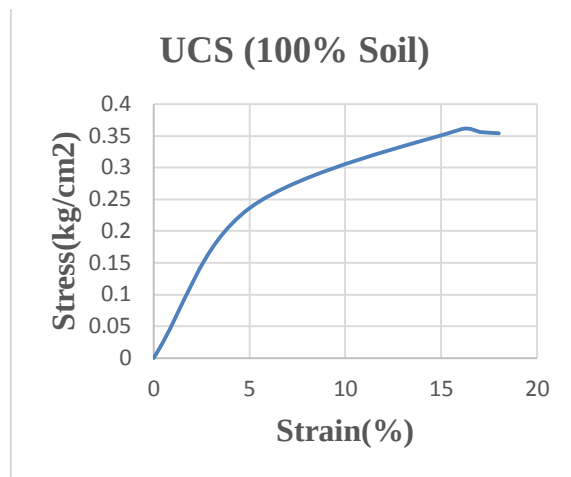


Fig. 6: Plot between Stress and Strain

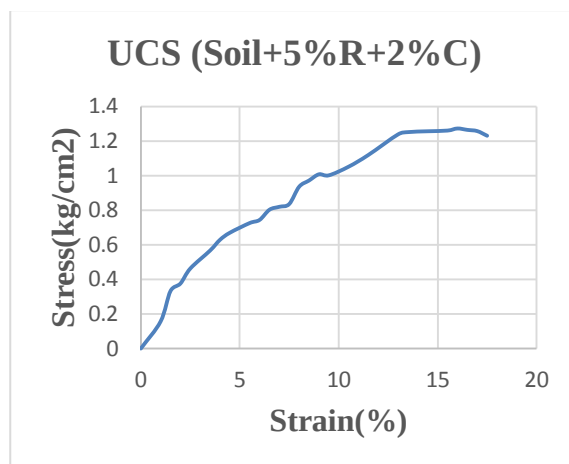


Fig. 7: Plot between Stress and Strain

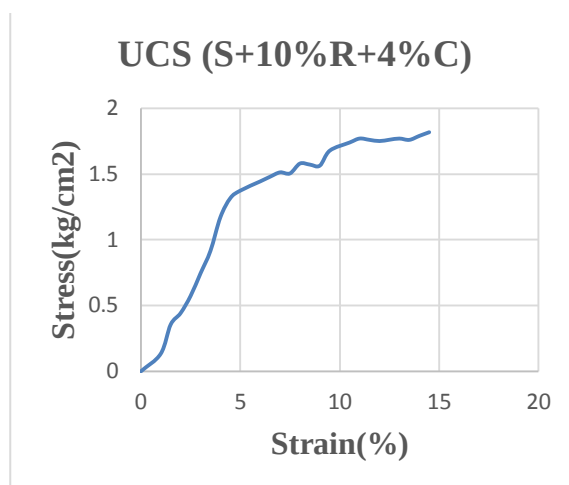


Fig. 8: Plot between Stress and Strain

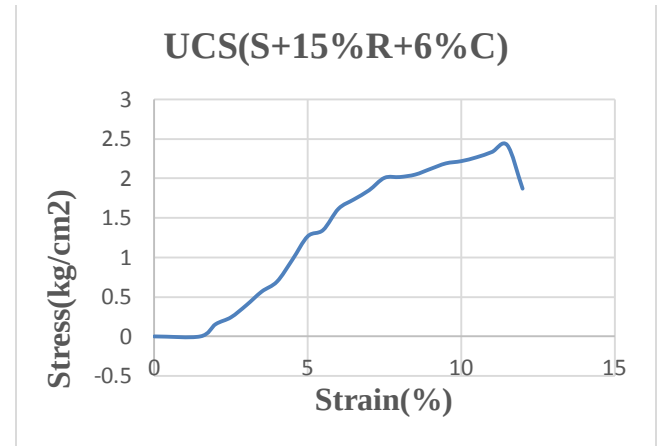


Fig. 9: Plot between Stress and Strain

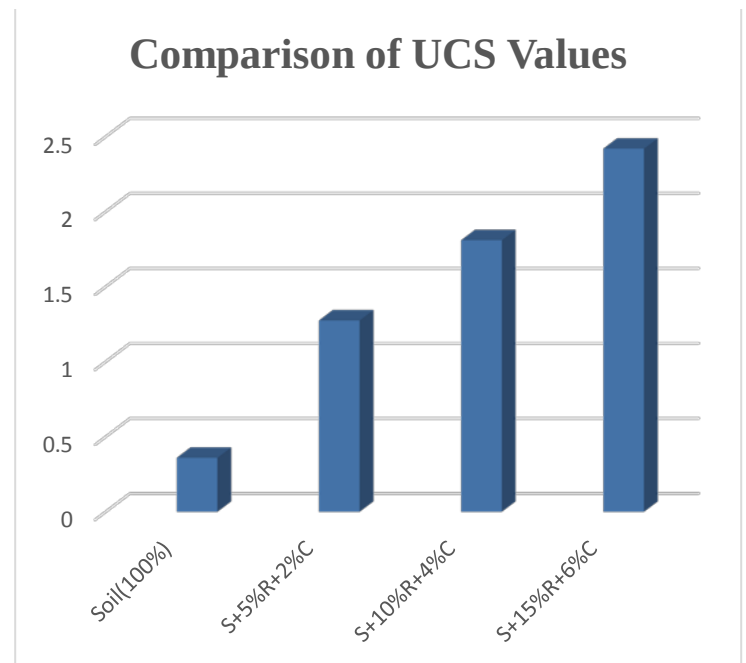


Fig. 10: Comparison of UCS values

Table 2: UCS values for different proportions

Sample	Soil (%)	Crumb rubber powder (%)	Cement (%)	UCS (kg/cm ²)
1	100	0	0	0.36
2	93	5	2	1.28
3	86	10	4	1.81
4	79	15	6	2.42

7.5 CBR values of the Soil with and without the inclusion of Crumb rubber and Cement

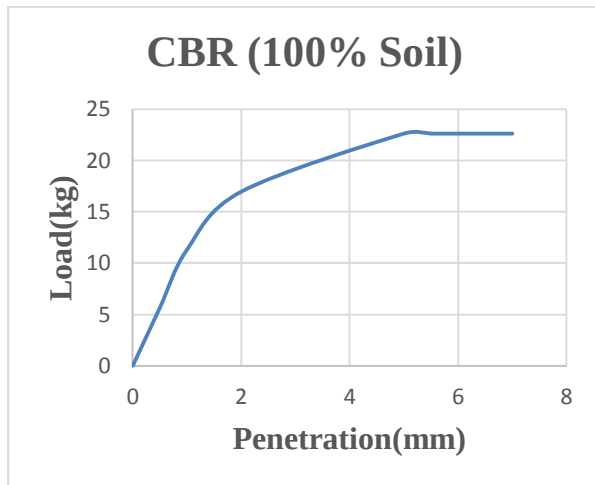


Fig. 11: Plot between Penetration and Load

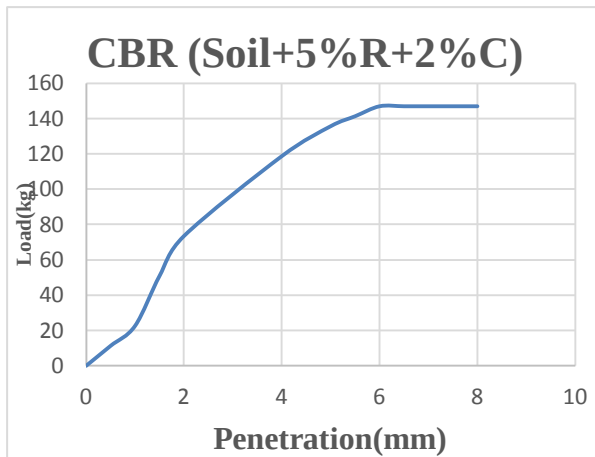


Fig. 12: Plot between Penetration and Load

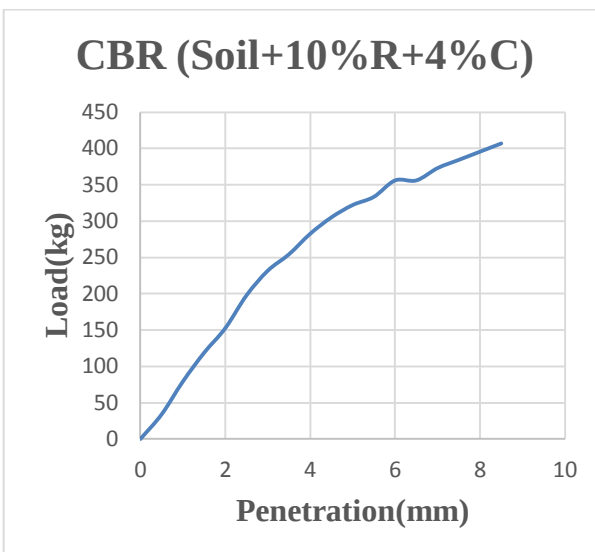


Fig. 13: Plot between Penetration and Load

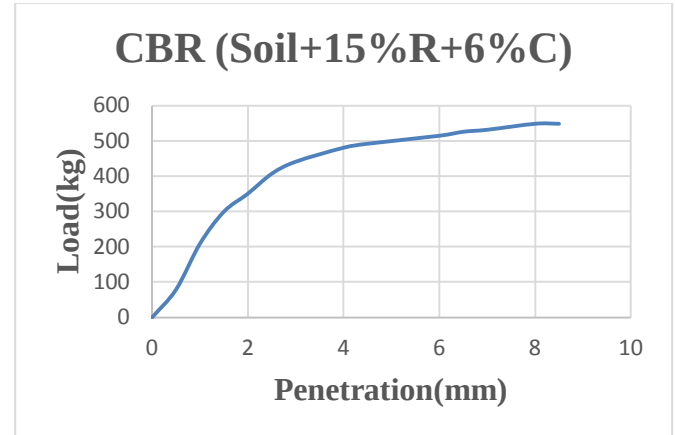


Fig. 14: Plot between Penetration and Load

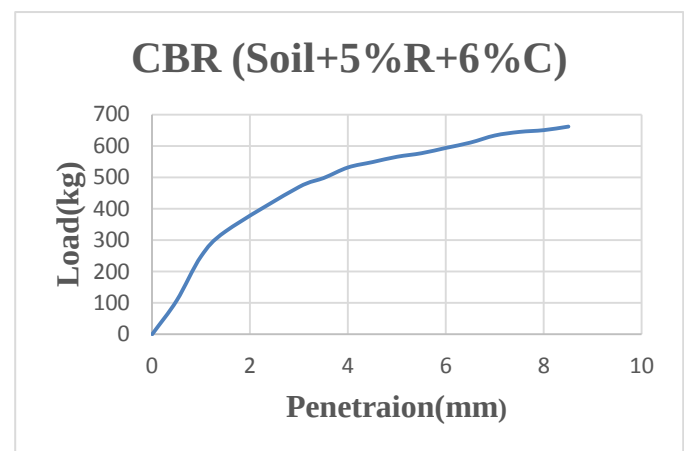


Fig. 15: Plot between Penetration and Load

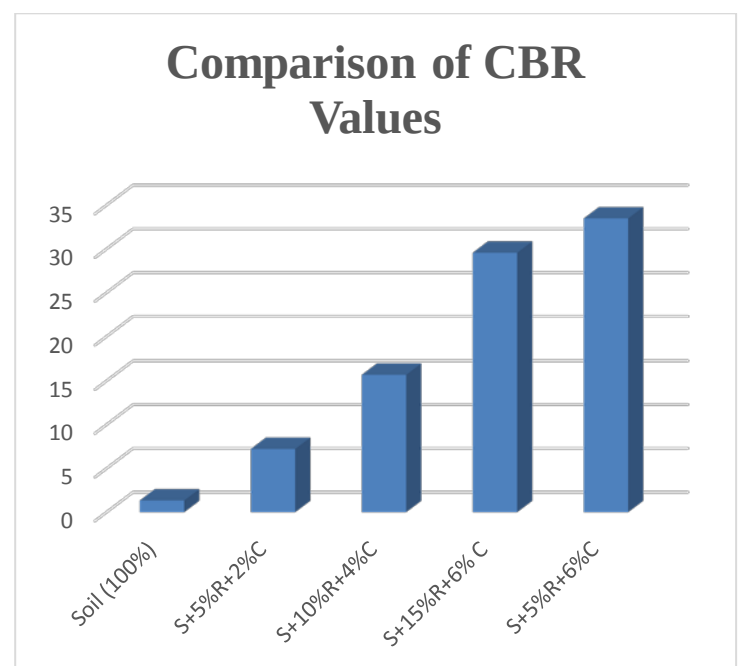


Fig. 16: Comparison of CBR values

Table 3: CBR values for different proportions

Sample	Soil (%)	Crumb rubber powder (%)	Cement (%)	CBR (%)
1	100	0	0	1.34
2	93	5	2	7.23
3	86	10	4	15.69
4	79	15	6	29.04
5	89	5	6	33.48

8. CONCLUSIONS

From the experimental study of results, the following conclusions are made:

- By the addition of cement the unconfined compressive strength (UCS) of the soil increased. The strengthening of the soil is due to the hydration product which is formed in the cement there by increasing the UCS.
- The maximum UCS value was found with a rubber content of 15% and cement content of 6%.
- Also, California bearing ratio of the soil increases with the addition of crumb rubber and cement. This will help in strengthening of the soil.
- The load bearing capacity of the soils that are used in the construction is assessed based on their CBR rating. A harder soil surface will have a higher CBR value.
- The right proportion observed from our experimental results was inclusion of 5% rubber and 6% cement to the soil where the obtained values are more than those obtained with the inclusion of 15% crumb rubber and 6% cement.

9. REFERENCES

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