

# Stabilization of Expansive Soil by Crumb Rubber Powder and Gypsum

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**ABSTRACT:** Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. The main objective of the soil stabilization is to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability. The long term performance of any construction project depends on the soundness of the underlying soils. Unstable soil can create significant problems for pavement or structure, therefore soil stabilization techniques are necessary to ensure the good stability of the soil so that it can successfully sustain the load of the superstructure especially in case of soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil. This paper deals with the complete analysis of the improvement of soil properties and its stabilization using crumb rubber Powder (CRP) and gypsum. The percentage of crumb rubber powder is 5%, 10%, 15%, etc and the constant percentage of Gypsum is taken i.e. 2%. The different test is performed like Liquid limit, Plastic Limit, standard Proctor Test, CBR Test. It is found that the properties of soil improve by using Crumb rubber powder and gypsum.

**KEYWORDS:** Crumb Rubber Powder (CRP), Gypsum, Standard Proctor Test, CBR Test, Liquid Limit, Plastic Limit.

## I. INTRODUCTION

Black cotton soil is expansive in nature which is very beneficial for agricultural purposes but not a very stabilized type of soil when viewed from an engineering perspective. Thus, it becomes necessary to stabilise such an expansive type of soil during the construction of any type of structure. As per the Indian Scenario, the output of waste material is more than 1.3 Billion tonnes out of which scrap tyre are 65 million tonnes and increasing year by year. Recycling of Tyres or Rubber is the process of recycling vehicle tyres that are no longer suitable for use on vehicles due to wearing or irreparable damages such as punctures etc. these tyres are among the largest and most problematic sources of waste, due to the large volume produced, their durability and the fact that they contain a large number of components that are ecologically problematic. It is estimated that at least 259 million tyres are discarded annually. The same characteristics that make waste tyres problematic are their cheap availability, bulk and resilience which also make them attractive targets for recycling. Materials recovered from tyres, known as crumb, are generally only a filter material and are rarely used in high volume. They are made to be highly durable and weather proof which causes mass landfill space to be used up by tyres which a non-degradable type of material.

Gypsum is a soft sulfate mineral composed of calcium sulfate dihydrate, with the chemical formula  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . It is widely mined and is used as a fertilizer and as the main constituent in many forms of plaster, blackboard/sidewalk chalk, and drywall. A massive fine grained white or lightly tinted variety of gypsum, called alabaster, has been used for sculpture by many cultures including Ancient Egypt, Mesopotamia, Ancient Rome, the Byzantine Empire, and the Nottingham alabasters of Medieval England. Gypsum also crystallizes as translucent crystals of selenite. It also forms as an evaporate mineral and as a hydration product of anhydrite.

## II. LITERATURE SURVEY

**P. T. Ravichandran et al [1]** He had describe about effect addition of waste tyre crumb rubber on weak soil stabilization. Problematic clay soils stabilized with various percentages of crumb rubber (5, 10, 15 and 20%). Addition of sand 15% to 35% reduces the compressibility of rubber derived aggregate by 50%. Increase in CBR value of stabilized soil can significantly reduces the overall thickness of pavement and hence the total cost involved in the construction of road. 10% addition of crumb rubber shows improvement in CBR value. Soil sample A1 and A2 are collected .they are air dried and pulverized. They contain 97% and 94% of fine grained soils respectively. With increasing proportion of sand in mixture the density unit weight and share strength of mixture increases but the compressibility decreases. Reduction in MDD is due to lower specify gravity of crumb rubber powder which shows the increase in percentage of crumb rubber, decreases the OMC and MDD.

**B. Sri Vasavi et al [2]** In his study he had describe about stabilization of expansive soil using crumb rubber powder and cement. The method of approaches were stabilization of expansive soil using crumb rubber powder and cement at percentages 2, 5, 7 and 9%



and 2, 4, and 6% respectively. Cement added to the soil rubber mix in the percentage 2, 4, and 6% by weight of soil. Cement used for the experimental investigation was 43 grades, Ordinary Portland cement has been used in 2, 4, 6% percentages.

**Deepanshu Solanki et al [3]** In his research he had shown about the stabilization of clay soil mixed with rubber tyre chips for design in road construction. The method of approach were direct shear test using standard proctor test for OMC and MDD of clay soil without using admixture are obtained OMC=16 and MDD= 1.83gm/cc. Direct shear test was conducted on the clay soil and rubber tyre mix i.e. admixture. The value of rubber percentages used 0.05, 0.075, 0.25, 0.5, 0.75, 1%.

**A. Sathwik et al [4]** In his study, he had behavior of soil by using tyre powder. Their approach method was compaction test by using standard proctor test for OMC and MDD were determined for 0, 4, 8, 12, 16% of soil tyre powder mix as per IS 2720 part7-1980. The dry densities of clayey soil /red soil mixed with tyre powder decreased as the amount of rubber increases.

**Ms. L. Kokila et al [5]** in her study he had described about the experimental investigation on soil stabilization using rubber crumbs on expansive soil. Her method of approach was constant percentage of lime 3% of lime as a constant for stabilizing the soil. Crumb powder usually 5, 10, and 15% along with 3% of lime as constant.

### III. SYSTEM DEVELOPMENT

#### 1. Materials Used:

##### i) Black Cotton Soil

Black cotton soil is one of major soil deposits of India. They exhibit high rate of swelling and shrinkage when exposed to changes in moisture content and hence have been found be most troublesome from engineering consideration. The rate of montmorillonite is more in black cotton soil which causes expansiveness and crack occurs in soil without any warning which is dangerous for construction.

Table 1 Properties of Black Cotton Soil

Sr. No.	Properties of Soil	Value
1	Specific Gravity	2.35
2	Liquid limit	57%
3	Plastic limit	31.05%
4	Plasticity Index	25.95%
5	Maximum Dry Density	1.57 gm/cc
6	Optimum Moisture content	20%
7	California Bearing Ratio	4.29%

##### ii) Crumb Rubber Powder

In recent decades, the worldwide growth of the automobile industry and the increasing use of cars as the main means of transport have tremendously boosted tire production. This has generated massive stockpiles of used tires. Extensive research projects were carried out on how to use used tires in different applications. Waste tires need a larger storage space than other waste due to their large volume and fixed shape. In this project the rubber is used in the form of powder. Crumb rubber powder is used varying percentage like 5%, 10%, 15% with weight with soil.

##### iii) Gypsum

Gypsum is a soft sulphate mineral composed of calcium sulphate dehydrate, with the chemical formula  $CaSO_4 \cdot 2H_2O$ . It is widely mined and is used as a fertilizer and as the main constituent in many forms of plaster, blackboard/sidewalk chalk, and drywall. In this study gypsum is used at constant percentage like 2% by weight with soil.

#### 2. Test Carried Out:

The following test is carried out on black cotton soil with different percentage of Crumb rubber powder and 2% gypsum.

##### i) Specific Gravity Test

Specific gravity is defined as the relative amount of the weight in air of a given volume of a material at a specified high temperature to the weight in air of a same volume of distilled water at a specified temperature.

##### ii) Liquid Limit

The liquid limit is defining the moisture content at which soil begin to behave as a liquid material and soil begins to flow. The liquid limit is determine in the labs the moisture content at which the two sides of a groove shaped in soil come simultaneously and touches a distance of 2 inch after 25 blows.

##### iii) Plastic Limit

The plastic limit is defined as the moisture content where the thread breaks apart at a diameter of 3 mm. PL is Compute the average of the water contents obtained from the three plastic limit tests. The plastic limit (PL) is the average of the three water contents.

##### iv) Standard Proctor Test

Proctor compaction test is a laboratory method of test is to define the optimal moisture content at which a given soil type will specifically. To determine the optimum water content at which soil be able to get to its maximum dry density.



**V) CBR Test**

The California bearing ratio is a penetration test for evaluation of the mechanical strength of road sub grades and base-courses. The test is performed by measuring the pressure required to penetrate soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard crushed rock material.

**IV. RESULTS AND DISCUSSIONS**

**1. Liquid Limit:**

Following graph shows the flow curve for black cotton soil and the value of liquid limit is 52%.

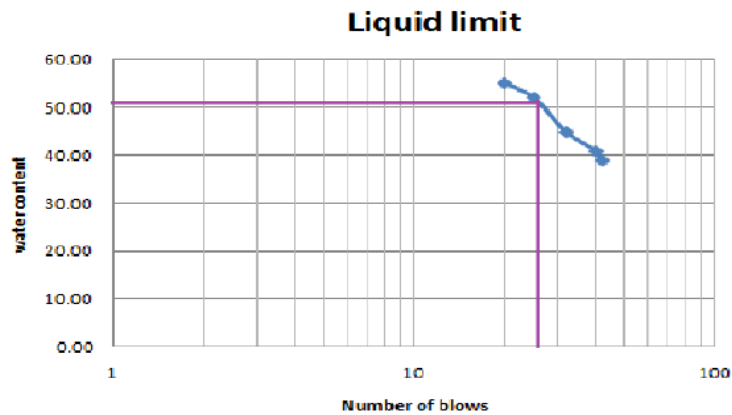


Figure 1. Flow Curve

**2. Standard Proctor Test:**

The following table shows the test result of standard proctor test of black cotton soil with the variation of crumb rubber powder and gypsum with different percentage.

Table 2 Observation of Standard Proctor Test

Sr. No.	Particulars	MDD	OMC
1	Soil	1.57	21.12
2	Soil+ 5% CRP + 2% Gypsum	1.62	20.69
3	Soil+ 10% CRP + 2% Gypsum	1.65	20.19
4	Soil+15% CRP + 2% Gypsum	1.76	19.05
5	Soil+ 20% CRP + 2% Gypsum	1.63	21.21

Following graph shows the variation of maximum dry density of black cotton soil with the variation of crumb rubber powder and gypsum with different percentage.

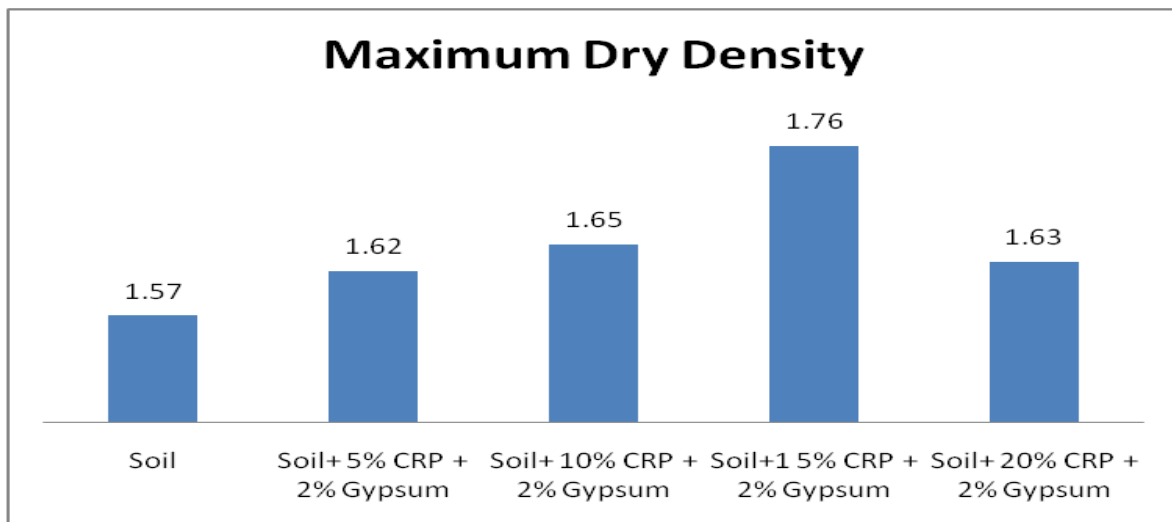


Figure 2. Variation of Maximum Dry Density

Following graph shows the variation of Optimum Moisture Content of black cotton soil with the variation of crumb rubber powder and gypsum with different percentage.

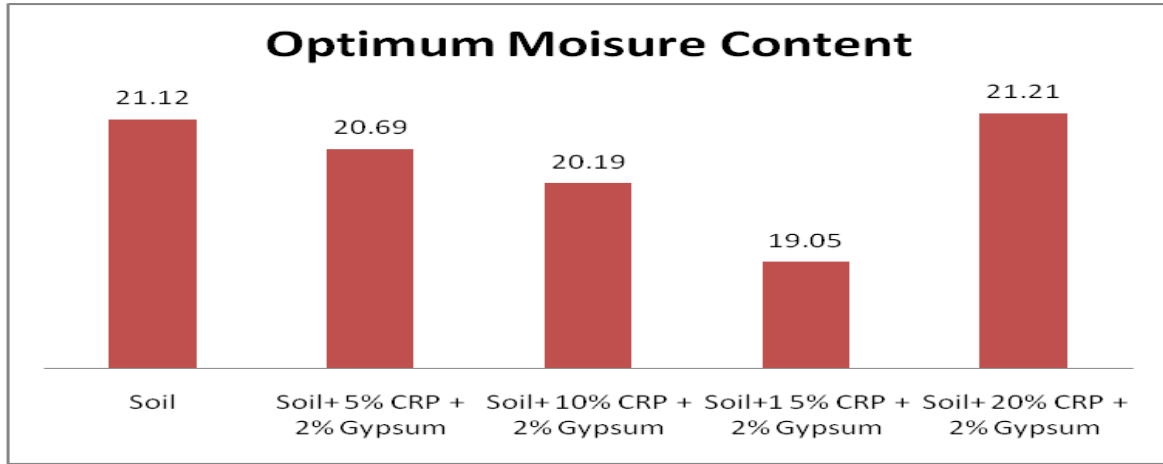


Figure 3. Variation of Optimum Moisture Content

### 3. CBR Test:

The following table shows the test result of CBR Test of black cotton soil with the variation of crumb rubber powder and gypsum with different percentage.

Table 3 Observation of CBR Test

Sr. No.	Particulars	CBR Value
1	Soil	4.29
2	Soil+ 5% CRP + 2% Gypsum	4.67
3	Soil+ 10% CRP + 2% Gypsum	6.07
4	Soil+15% CRP + 2% Gypsum	6.78
5	Soil+ 20% CRP + 2% Gypsum	5.74

Following graph shows the variation of CBR value of black cotton soil with the variation of crumb rubber powder and gypsum with different percentage.

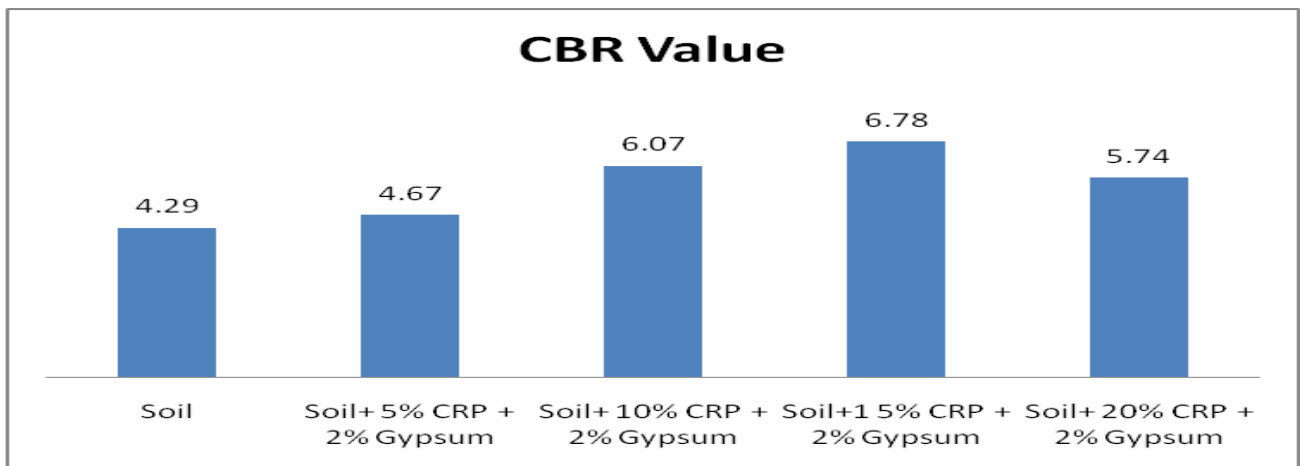


Figure 4. Variation of CBR Value

### VI.CONCLUSION

These tests were taken for the stabilization of expansive soil with crumb rubber powder and gypsum which gave good results. On the basis of experimental study the following conclusion are drawn,

1. The addition of CRP and Gypsum in expansive soil which have varying percentages of CRP and Constant percentage of gypsum which increases the MDD from 1.57 gm/cc to 1.76gm/cc. at 15% of CRP and 2% of gypsum. Similarly the moisture content decreases.
2. The liquid limit for black cotton soil is 52 %.
3. With the addition of CRP and Gypsum percentage in the soil the maximum dry density in increasing order and the optimum moisture content start decreasing.
4. The CBR value is increases from 4.29% to 6.78% with addition of 15% of CRP and 2% Gypsum afterwards the CBR value decreases with further addition in CRP and Gypsum.
5. Hence the properties of black cotton soil are improved by using crumb rubber powder and gypsum.

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