

# Engineering Properties of Clay Stabilized With Admixture (Rubber Tyre Chips)

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**ABSTRACT:** Clay is not readily suitable for construction purposes because of poor engineering properties and thus its engineering properties are improved to a great extent by the process of stabilization with appropriate admixtures so that it can be used as an important construction material. Clay soil supports both the structure and sub-structure and thus acts as an integral part of construction field. Appreciable quantity of rubber tyre chips is available annually widespread in Rajasthan, India. The clay soil is mixed with these rubber tyre chips and its improved properties are evaluated using Standard Proctor Test and Direct Shear Test at various percentage by weight of admixture (rubber tyre chips) into clay soil sample at given maximum dry density.

**KEYWORDS:** Clay, Rubber Tyre Chips, Standard Proctor Test, Direct Shear Test, Stabilization

## I. INTRODUCTION

Soil is the toppest layer of the earth's surface which support the structure & the sub-structure and also the sub base and the base course in the pavements. The existing soil at a particular location may not be suitable for the construction purposes due to poor bearing capacity and higher compressibility. In general, higher clay content in a soil causes higher plasticity, greater shrinkage & swelling potential, higher compressibility and lower shear strength. The improvement of soil at a site is indispensable due to rising cost of the land. In such cases the properties of soil can be improved by soil stabilization.

Stabilization in a broad sense employed for modifying the engineering properties of a soil to improve its engineering performance incorporates various methods. This paper presents experimental results of clay soil stabilized with admixture (rubber tyre chips) for possible use in geotechnical engineering. Scrap tyre generation is on an increasing trend in the world. Tyres are worst when they are burnt as they cause huge environmental pollution and thus utilization of rubber tyre chips is very necessary so as to reduce the environmental impact. This study further discusses about the direct shear test results of clay soil mixed with different percentage by weight of admixture (rubber tyre chips).

## II. RELATED WORK

The alteration of soil properties to meet specific engineering requirements is known as "Soil stabilization." It must also be recognized that stabilization is not necessarily a magic wand by which every soil property is changed for the better. The chief properties of a soil with which the construction engineer is concerned are: volume stability, strength, permeability and durability. Correct usage demands a clear recognition of which soil properties must be upgraded, and this specific engineering requirement is an important element in the decision whether or not to stabilize. Various laboratory studies have been done on clay stabilized using polythene bags, LDP sheets, ceramic tiles powder, bottle glass waste etc. Further work has been done for the stabilization of fine and dune sand using different admixtures.

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## III. MATERIALS USED FOR PRESENT STUDY

### 3.1 CLAY SOIL

The clay soil sample was collected from the Tal Chhapar Sanctuary which is named after the Chhapar village located at 27°50' North and 74°25' East in Rajasthan State. The geology of the zone is obscured by the wind blown over-burden. Some small hillocks and exposed rocks of slate and quartzite are found in the western side of the sanctuary.

### 3.2 RUBBER TYRE CHIPS

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 tyre production. This has generated massive stockpiles of used tyres. Extensive research projects were carried out on how to use used tyres in different applications. In case of fire, waste tyres generate toxic gases such as dioxin that could result in severe pollution problems.

The tyres are made up of mainly by rubber. Rubber consists of a complex mixture of elastomers, polyisoprene, polybutadiene and styrene-butadiene. Stearic acid (1.2%), zinc oxide (1.9%), extender oil (1.9%) and carbon black (31%) are also important components of tyres. The rubber tyres were cut into chips of different sizes varying from 1mm – 25mm in width and 3mm – 50mm in length. Added amount of rubber tyre had been varied in proportions of 4%, 5%, 8% and 10% by weight.



Figure 1: Rubber Tyre Chips

## IV. TEST PROGRAMME

This research paper includes laboratory experimental work consisting of following tests:

- A) **Standard Proctor Test:** Compaction is the process of densification of soil by reducing the air voids. The degree of compaction of a given soil is measured in terms of its dry density. The dry density is maximum at the optimum water content. A curve is drawn between the water content and the dry density to obtain the maximum dry density and the optimum water content.

$$\text{Dry density of soil}(\rho_d) = \frac{M / V}{1 + w}$$

where, M = Total mass of the soil, V= Volume of the soil, and w= water content.

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Equipments used for the test for compaction of soil are as follows: compaction mould of capacity 1000 ml, hammer, detachable base plate, collar(50mm height), oven, dessicator, weighing balance, mixing pan, spatula, jars, tools, spoons and trowels.

A standard mould of 100 mm internal diameter and an effective height of 127.3 mm, with a capacity of 1000 ml is used. The mould has a detachable base plate and a removable collar of 50 mm height at its top. The soil was compacted in the mould in 3 equal layers with each layer being given 25 blows of 2.6 kg hammer falling through a height of 310 mm.

Bulk Mass Density ( $\rho$ ) =  $M/V$  gm/cc

where, M is mass of compacted soil in grams  
V is volume of the mould in cc

**B) Direct Shear Test:** To determine the shear strength of the clay soil, the values of the angle of internal friction and cohesion of the soil are determined with the help of the direct shear test. The test is carried out as per the following steps:

- i) Inner dimension of soil container is checked and its parts are put together.
- ii) Volume and weight of the container is measured.
- iii) The clay soil sample is placed in smooth layers. Now, again weigh the soil container. The difference of the above two weight readings is the weight of the clay soil.
- iv) Density of the soil is calculated by making the surface of the clay soil plane. The upper grating is put on stone and loading block on the top of soil.
- v) Then, the thickness of the soil specimen is measured and the desired normal load is applied.
- vi) Afterwards, the shear pin is removed and the dial gauge is attached which measures the change in volume. The initial reading of the dial gauge and calibration values are recorded. The dial gauge setting is fixed at zero, before starting of the experiment
- vii) Before proceeding to test all adjustments are checked so as to ascertain that there is no connection between the two parts except clay soil.
- viii) The motor is started and the readings of the shear force are then recorded.
- ix) Volume change readings are recorded till failure by applying a normal stress equal to  $0.5 \text{ kg/cm}^2$  at a rate of strain of 1.25 mm/min in accordance with ID 2720 (Part XIII) and continuing the experiment till failure. All the readings are recorded carefully.

## V. INVESTIGATION RESULTS

### 5.1 Standard Proctor Test

Standard proctor test is used to determine the relationship between dry density and water content of a compacted soil sample. The dry density and water content relationship was obtained from Standard Proctor Test. The Optimum Moisture content (OMC) and Maximum Dry Density (MDD) of the plain soil without admixture are obtained from the Figure 4.1 as O.M.C is 18% and M.D.D is 1.67 gm/cc respectively.

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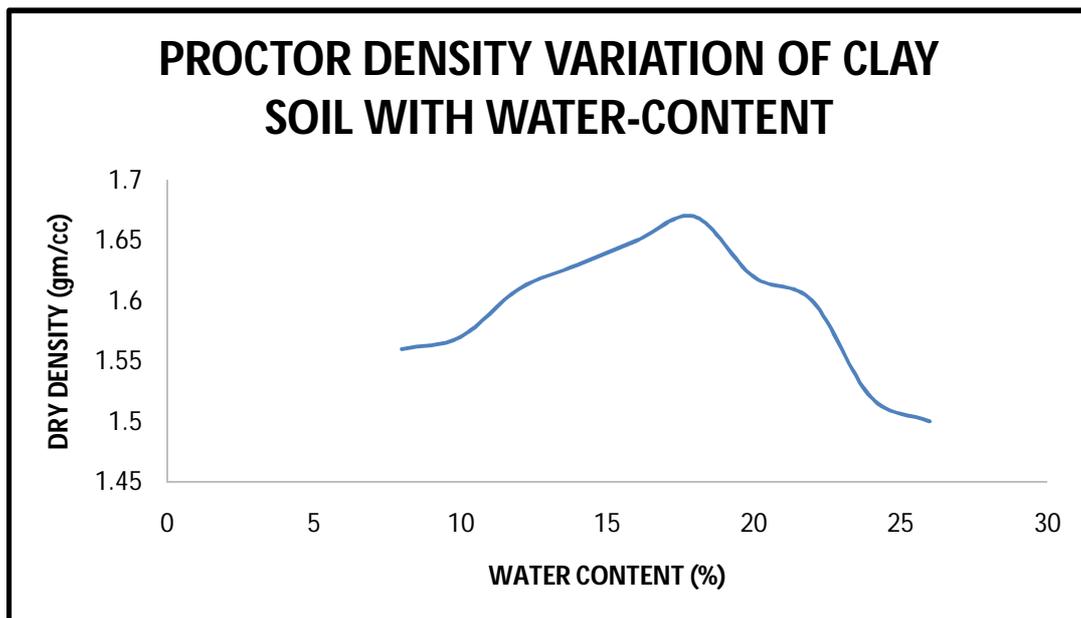
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**Table: 1 -Dry Density Variation with Water Content for Clay Soil**

S. No.	Percentage of water added by weight	Dry Density
1	8	1.56
2	10	1.57
3	12	1.61
4	14	1.63
5	16	1.65
6	18	1.67
7	20	1.62
8	22	1.6
9	24	1.52
10	26	1.5



**Figure2: Proctor Density Variation of Clay Soil with Water Content**

### 5.2 Direct Shear Test

Direct shear test is used to determine the shear strength parameters (cohesion and friction angle) of clay soil. Direct shear tests were carried out to determine the angle of internal friction ( $\phi$ ) of different mix compositions of clay sand of 1.67 gm/cc dry density mixed with different percentage viz. 0.05, 0.075, 0.25, 0.50, 0.75, 1.0 by weight of rubber tyre chips in accordance with ID 2720 (Part XIII). The results of direct shear tests are as follows:

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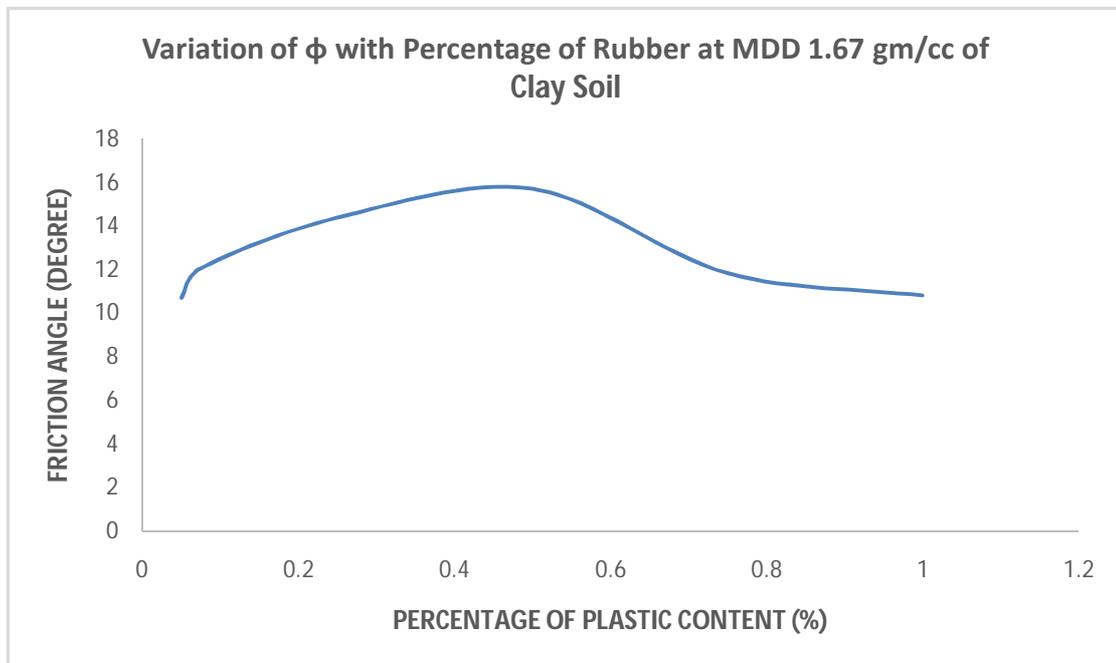
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**Table: 2 - Mix Compositions and Symbols for D.S.T. at MDD 1.67 gm/cc of Clay Soil**

MIX NO.	MIX COMPOSITION	SYMBOL
1	0.05% Rubber + Clay	DA1
2	0.075% Rubber + Clay	DA2
3	0.25% Rubber + Clay	DA3
4	0.50% Rubber + Clay	DA4
5	0.75% Rubber + Clay	DA5
6	1.0% Rubber + Clay	DA6

**Table: 3 - Variation of  $\phi$  with Percentage of Rubber at MDD 1.67 gm/cc of Clay Soil**

S. No.	MIX COMPOSITION	$\Phi$ (DEGREE)
1	DA1	10.72°
2	DA2	12.08°
3	DA3	14.39°
4	DA4	15.70°
5	DA5	11.85°
6	DA6	10.83°



**Figure: 3 - Variation of  $\phi$  with Percentage of Rubber at MDD 1.67 gm/cc of Clay Soil**

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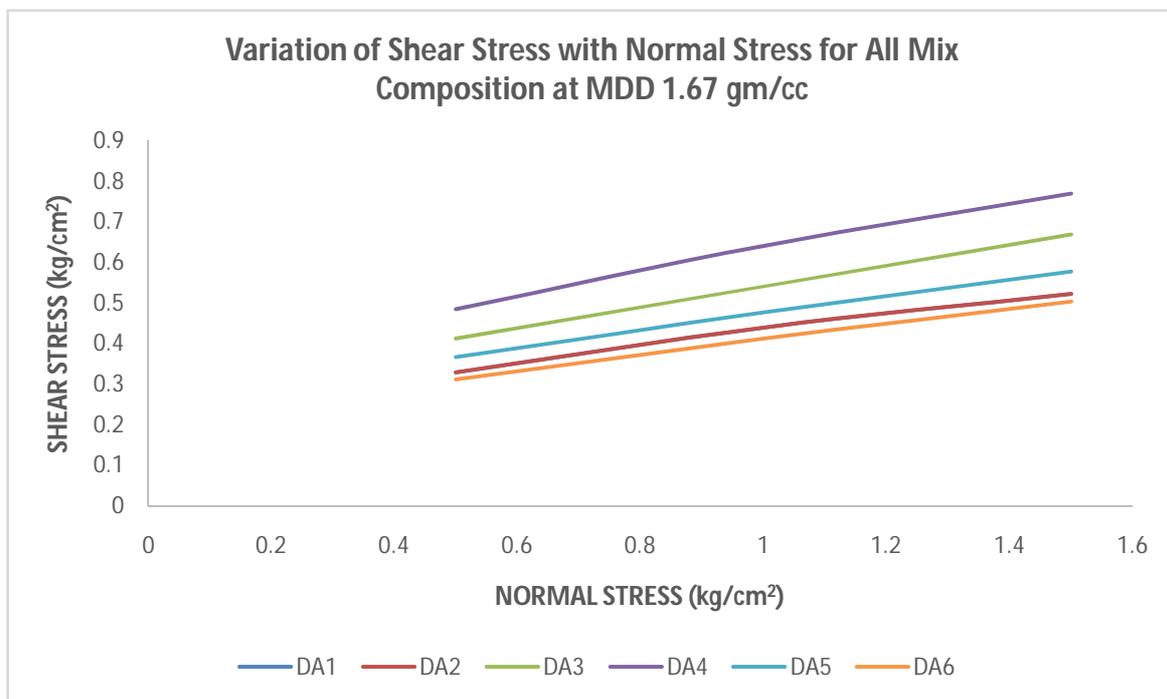
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**Table: 4 - Variation of Shear Stress with Normal Stress for All Mix Composition at MDD 1.67 gm/cc of Clay Soil**

Shear Stress (kg/cm <sup>2</sup> ) for each mix composition at MDD 1.66 gm/cc	Normal Stress (kg/cm <sup>2</sup> )		
	0.5	1.0	1.5
Clay + 0.05% Rubber Content (DA1)	0.330	0.440	0.5225
Clay + 0.075% Rubber Content (DA2)	0.3391	0.430	0.550
Clay + 0.25% Rubber Content (DA3)	0.4125	0.5408	0.6691
Clay + 0.50% Rubber Content (DA4)	0.4858	0.6416	0.770
Clay + 0.75% Rubber Content (DA5)	0.3666	0.4766	0.5775
Clay + 1.0% Rubber Content (DA6)	0.3116	0.4125	0.5041



**Figure: 4 - Variation of Shear Stress with Normal Stress for All Mix Composition at MDD 1.67 gm/cc**

### VI. CONCLUSIONS

After analysis of the test results presented in the above tables and figures, the following conclusion are drawn regarding the performed experimental study:

1. The rubber tyre chips wastage usage in the investigation has the potential to reduce the environmental menace of rubber waste.
2. The study indicates that the angle of internal friction ( $\phi$ ) increases upto 0.50% percentage by weight of rubber tyre chips and then decreases. The maximum friction angle obtained is 15.70° at 0.50% by weight of rubber tyre chips mixed with clay.

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3. Shear strength increases with increasing amounts of rubber up to 0.50% by weight, beyond which the gain in strength is smaller. The smaller grain size provides greater contact area and better surface frictional resistance between clay and fibers. As shown in Table 4, the maximum shear strength is obtained at 0.50% by weight of rubber tyre chips mixed with clay.
4. Results of tests demonstrated that inclusion of rubber tyre chips in clay soil with appropriate quantity improved strength and deformation behavior of sub grade soils.

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