

# Soil Stabilization using Waste Materials in Sri Lanka

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## ABSTRACT

The uses of automobiles are increasing day by day because of that the waste of tyres increases in Sri Lanka. Safer disposal of rubber tyre waste has become a challenging job in Sri Lanka. As a result of the improper way of disposal, there is a great damage to eco-system like air pollution and aesthetic pollution. So that use of their basic properties in engineering applications are become prominent. This investigation has focused on the CBR of soil reinforced with randomly mixed shredded rubber tyre chips and the results will be compared with unreinforced samples. The optimal percentage value of shredded rubber tyre content in soil will be determined using the Standard proctor compaction test and CBR test. Increases in CBR value significantly reduce the total thickness of the pavement and hence the total cost involved in the road projects.

**Keywords:** CBR, MDD, OMC

## 1. INTRODUCTION

This study focuses on the utilization of the waste rubber tyre material as reinforcement to increase the CBR of residual soils. In Sri Lanka, over 15 million metric tonnes of tyres are produced yearly. These tyres, when they reach end-of-life, leads to solid waste management problem. A series of laboratory CBR tests were carried out on soil reinforced with randomly distributed tyre chips to determine its effect on the CBR of residual soils. From results of the experiments, the optimum percentage of tyre chip content for the maximum CBR is determined.

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## 2. Objective

The main objective is to study the effect of Waste Rubber Materials on CBR of Residual Soils. Further the study has focused to determine and compare the CBR values of the soil samples for various percentages of rubber chips and to compare the results of reinforced and unreinforced samples.

## 3. Literature Review

One of the wastes generated in transportation sector is scrap tyre and it causes great damage to eco-system like air pollution and aesthetic pollution. Some researchers showed that strength and other engineering properties of shredded tyre can be used for the engineering requirements. Edil and Bosscher (1992) reported that shredded waste tyres do not show any likelihood of being a hazardous waste material or having adverse effects on ground water quality.

Umar Jan *et al* evaluated the CBR of rubber clay mixtures at various rubber contents as 0%, 4%, 6%, 8%, 10% and various rubber strip size ranges from 15mm to 25mm (Width) and 30mm to 50mm (Length). They obtained CBR optimal value of shredded rubber tyre is 8 % of size 25 mm×50 mm and the percentage enhancement in CBR value of stabilized soil by using the shredded rubber is 66.28 %.

Dukare *et al*. stabilized the black cotton soil (Expansive soil) by various rubber tyre chips content as 0, 2, 4, 6, 8, and 10% which are normally sized from 76 mm down to 13 mm. They obtained the peak CBR value was at 8% rubber shred

content with a CBR value of 6.65% under unsoaked

condition. Further increase in rubber shred percentage causes a reduction in the CBR value to 5.87%.

Ayothiraman and Meena investigated the behaviour of pavement subgrade contain poorly-graded silty sand stabilized with shredded waste tyre chips having size of 10 × 20 mm and 2 to 3 mm thick at various percentage as 1%, 2%, 3%, 5%, 6%, and 9%. It was found that the CBR of stabilized soil is 22 % higher than CBR if un-stabilized soil even in soaked condition.

## 4. Material and Method

### 4.1 Soil

The soil samples were collected within the perimeter of Science Education Resource Centre in University of Peradeniya, Sri Lanka and Series of laboratory tests were carried out to identify its properties.

### 4.2 Tyre chips

Shredded rubber tyre chips was collected from Samson Rubber Industries (Pvt.) Ltd, Colombo, Sri Lanka and the sieve analysis test was carried out to identify particle size.

### 4.3 Testing procedure

The entire laboratory tests were carried out according to BS 1377. The soil sample was prepared in a CBR mould using 6 kg of soil and tyre chips which were randomly distributed with soil. The compaction was done using the Standard

Proctor Compaction method by adding the amount of water which requires for 95% Maximum Dry Density which was found from series of compaction tests. Increase the rubber content with the various percentages (0%, 2%, 4%, 6%, 8% and 10%) of tyre chips. Then, the 4 days soaked CBR tests were done for each samples.

After that experimental analysis, the OMC, MDD and CBR were plotted against each rubber content.

Finally, the optimum rubber content for the maximum value of CBR was obtained from the above experimental study.

**5. Results and Discussion**

**5.1 Soil classification**

Sieve analysis test and attereburge limit test were carried

out to identify the type of soil. Cu and Cc values of raw soil are respectively 19.44 and 1.59. Plastic Limit - 31.5% Liquid Limit - 51.0% Plasticity Index - 19.5% According to BS 1377 the soil was classified as Very silty sand (SM).

**5.2 Specific Gravity**

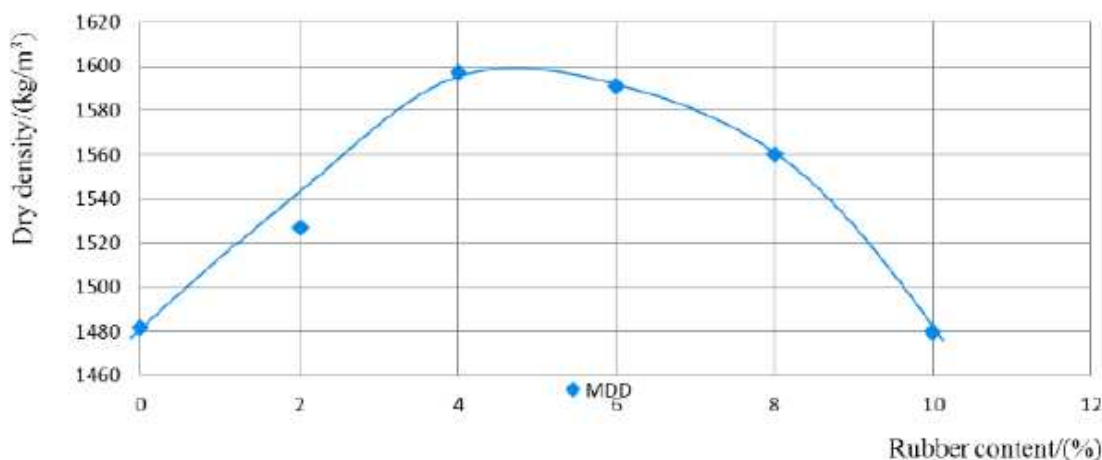
According to Pycnometer method, Specific Gravity of soil sample was obtained as 2.61.

**5.3 Standard Proctor compaction test results**

Compaction characteristics of the soils at different percentages of shredded tyre chips are shown below.

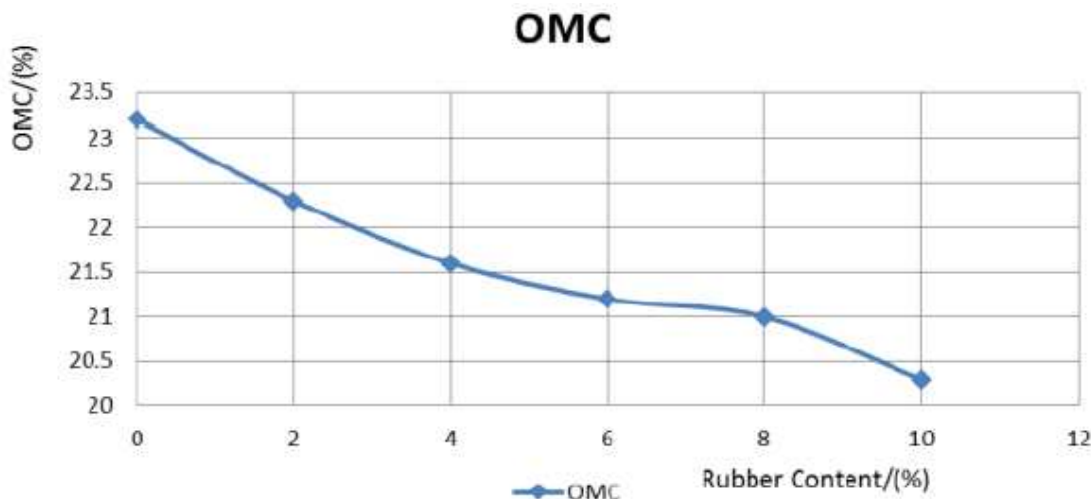
**Table1: Variation of OMC and MDD with rubber content.**

Rubber content %	OMC / (%)	MDD/(kg/m <sup>3</sup> )
0	23.2	1482
2	22.3	1527
4	21.6	1597
6	21.2	1591
8	21	1560
10	20.3	1480



**Figure1: Variation of MDD with rubber content**

The maximum dry density of raw soil is 1482 kg/m<sup>3</sup>. The MDD of soil rubber chips mixture increased up to 1497 kg/m<sup>3</sup> at 4% rubber content and there onwards decreased with further increase of tyre content. It may due to rubber replaced voids first and soil particles later and light weight nature of the rubber.



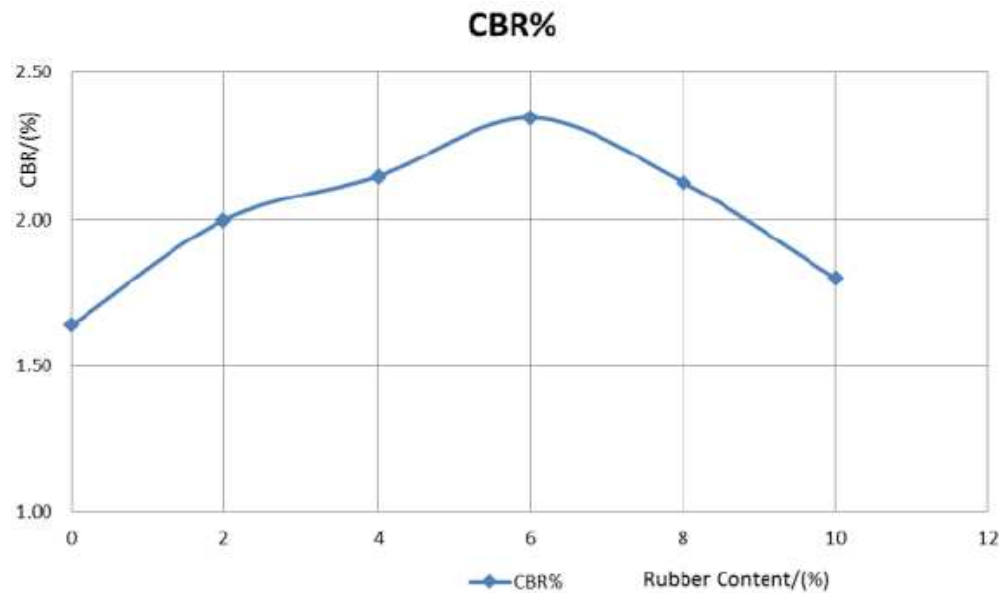
**Figure2: Variation of OMC with rubber content**

The OMC of soil-tyre chips mixtures decreases with an increase of percentage of shredded tyres chips. The vulcanized rubber has low water absorption capacity and it replaced voids appeared in soil may be the reason for the results.

#### 4.4 CBR test results. (4 days soaking)

**Table2: Variation of CBR with rubber content**

Rubber content %	CBR Value/(%)
0	1.64
2	2.00
4	2.15
6	2.35
8	2.13
10	1.80

**Figure 3: Variation of CBR with rubber content.**

The CBR value of raw soil was obtained as 1.64%. Tyre chips mixed with soil showed improvement in CBR value with its addition up to 6% (maximum CBR as 2.35%) and there onwards decreased with further increase in tyre chips content. This result may due to strength of rubber-soil bond greater than rubber-rubber bond and number of rubber-rubber bond increased with addition of rubber chips.

#### 6. Conclusions

Tyre chips mixed with soil showed maximum CBR as 2.35% at 6% rubber chips content. It shows that the percentage improvement in CBR value in stabilized soil is 43.3% in soaked condition. An increase in CBR value can significantly reduce the total thickness of the pavement and hence the total cost involved in the project

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