Soil Stabilization using Crumb Rubber

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***Abstract** - Soil stabilization is a crucial process in various civil engineering projects to improve the properties of soil and improve its load-bearing capacity. The soil stabilization methods often involve the various use of expensive and environmentally detrimental materials. However, in recent years, there has been growing interest in exploring sustainable alternatives that not only enhance soil properties but also contribute to waste management and environmental conservation. This abstract presents an overview of the soil stabilization process using crumb rubber, including various methods of incorporating crumb rubber into soil such as liquid limit, plastic limit, California bearing ratio.*

Key Words – Crumb Rubber, California bearing ratio, stabilization

1. INTRODUCTION

Soil stabilization using crumb rubber is an innovative technique that involves incorporating shredded or granulated rubber derived from discarded tires into soil to improve its engineering properties. This environmentally friendly approach offers numerous benefits and has gained popularity in various construction and civil engineering applications. Crumb rubber is obtained by processing and shredding discarded tires, which are a significant environmental concern due to their non-biodegradable nature. Instead of ending up in landfills or causing pollution, these tires can be recycled and transformed into a valuable material for soil stabilization. When crumb rubber is added to soil, it acts as a stabilizing agent, enhancing the soil's mechanical and physical properties. The rubber particles interlock with the soil particles, creating a more stable and resilient composite material It's worth noting that the effectiveness of soil

stabilization using crumb rubber depends on factors such as the type of soil, rubber content, particle size, and mixing techniques. Site-specific evaluations and engineering considerations are necessary to determine the appropriate proportions and application methods for achieving the desired stabilization results. As this study on soil stabilization using crumb rubber is a sustainable and effective technique for improving soil properties in construction projects. It not only enhances the strength and durability of the soil but also contributes to waste

tire recycling and environmental conservation. By adopting this innovative approach, engineers and construction professionals can achieve stable and long-lasting infrastructure while minimizing the impact on the environment.

2. REVIEW OF LITERATURE

Ghazavi (2004),

investigated the suitability of recycled granular rubber as a lightweight backfill material. He observed that the unit weight of the soil was reduced from approximately 14Kn to approximate l8 KN original for the 70% rubber blend. Ghazavi concluded that
1. Addition of rubber to sand did not improve the shearing resistance of blends. 2. An apparent cohesion of approximately 10 KPa was obtained from blends containing rubber grain. 3. Initial frictional angle decrease with increase in percent of rubber. 4. Unit weight of blend decrease with addition of rubber.

Beena Ajmera Binod Tiwari and Janak Koirala

Shredded rubber tires have been used by various state highway agencies in highway construction. For example, the Minnesota Department of Transportation placed shredded rubber tires at twenty-three different sites. From their work, they surmised that shredded rubber tires may serve as a cost-effect technically feasible technique for ground modification. However, the use of this technique has been limited by a deficiency in the understanding of the mechanical behavior of the soil modified with shredded rubber tires
(Engstrom and Lamb, 1992).

Edil et al. (1990) conducted field experiments using tire chips in embankments with varying side slopes. The embankments were constructed using three different methods that further research of these parameters would improve the feasibility of the use of rubber tire in soil improvement. The Oregon State Department of Transportation found similar results after they attempted to remediate slope stability problems using shredded rubber tires (Reed et al., 1991).

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In this work, the possibility of using crumb rubber powder was an additive to improve the strength of soft soil was investigated. Methods: Two types of problematic clay soils are stabilised with the various percentages of crumb rubber (5, 10, 15 and 20%). The strength properties of stabilized soils were improved by increasing percentages of crumb rubber up to 10% is studied by the CBR tests. In addition to strength development, the influences of this stabilizer type and different quantities on drainage characteristics are also studied. Findings: Addition of crumb rubber in both the soils shows desirable changes in permeability. With the addition of crumb rubber of 10% shows the improvement in CBR value of soil is 161% and 130% in soil A1 and A2. The results obtained shows that both strength and permeability modification results in the better stabilization for clayey soil. Applications: Increase in CBR value of stabilized soil can significantly reduce the overall thickness of the pavement and hence the total cost involved in the construction of road.

I Juliana, A R Fatin R Rozaini

In this study, soil stabilization using crumb rubber is the alteration of subgrade soil as the properties of crumb rubber are lightweight and high shear strength. Moreover, it can also reduce the improper tyre's disposal problem and pollutions. The soil used are collected from a landslide site located near to Mengkuang Dam in Seberang Perai Tengah, Penang in order to investigate the performance of subgrade soil stabilized with 2%, 4%, 6% and 8% of Crumb Rubber (CR). A series of laboratory testing of unsoaked and soaked (4 days) California Bearing Ratio (CBR) test have been performed to evaluate the best percentage of CR which fulfilled the JKR specification for subgrade. The results show that all mixtures; M2 (2% CR), M3 (4% CR), M4 (6% CR), and M5 (8% CR) are fulfilled the subgrade requirement according to the Public Works Department Malaysia (JKR) standard specification for road works where the CBR value must achieve more than 5%. The mixture with 4% CR (M3) shows the highest unsoaked and soaked CBR values, thus, the 4% CR is recommended to be implemented for subgrade soil stabilization.

3. METHDOLOGY

MATERIAL USED

1. Soil

In this study, subgrade soil is used. Locally available clayey silt soil was collected from the fields of Loni Kalbhor Pune at a depth of 1-2 foot below the ground surface by using technique of disturbed sampling and thoroughly hand sorted to eliminate the vegetative matters and pebbles.

2. Crumb powder

For improving the engineering properties of the clay, crumb rubber was chosen as an additive. Crumb rubber is a term usually applied to recycled rubber from automotive and truck scrap tires. During the recycling process steel and fluff is removed leaving the rubber with a granular consistency. Continued processing with a granulator and/or cracker mill, possibly with the aid of mechanical means, reduces the size of the particles further. The crumb rubber powder, which is used as an additive in the present study for getting the desired engineering properties in the available problem in soil.

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Fig 1. Crumb Rubber

Testing on soil

The following test are conducted on the soil in the two ways such that the testing with the parent soil and the testing with addition of crumb rubber

- Specific gravity by pycnometer
- Liquid limit
- Plastic limit
- Water content
- CBR Test

The test conducted on soil with the 2% and 4% amount of crumb rubber for the liquid limit and CBR test. The test on CBR is done with the 2% of crumb rubber and test without crumb rubber.

The California Bearing Ratio (CBR) test is commonly used to determine the strength of subgrade soil, subbase and base materials for road and airfield pavement design. In order to achieve the objective of this study, the CBR test is carried out to evaluate the strength of subgrade soil at ratio of the load sustained by the specimen at 2.5 & 5.0 mm penetration. CBR is performed for unsoaked condition.

The CBR mould has an internal diameter of 152 mm and the mould is fitted with a detachable normal or perforated baseplate and a removable extension collar. For compaction purpose, a mechanical hammer of 2.6 kg with 310 mm drop height is used. The CBR test is carried out on materials that passing 19 mm sieve size and the value of moisture content added to the sample is adopted from compaction test that have been conducted before Then, the samples are compacted in 3 layers with 56 blows per layer. The mould with CBR sample and surcharge weights were placed in a CBR testing machine as illustrated in Figure and measured at 2.5 mm and 5 mm displacement. The penetration readings are taken at top and bottom of the sample and then the CBR value can be calculated.

The percentage mixture of soil and crumb rubber

Mixture	soil	crumb rubber
Sample 1	100	0
Sample 2	98	2

Figure 2 . CBR Test

4. RESULT

I. Specific gravity of soil

Soil sample	Specific gravity
Surface soil	2.52
Soil at 1 feet	1.65
Soil at 2 feet	3.11

II. Water content

Soil sample	Water Content
Surface soil	1.56
Soil at 1 feet	2.66
Soil at 2 feet	3.67

III. Liquid Limit

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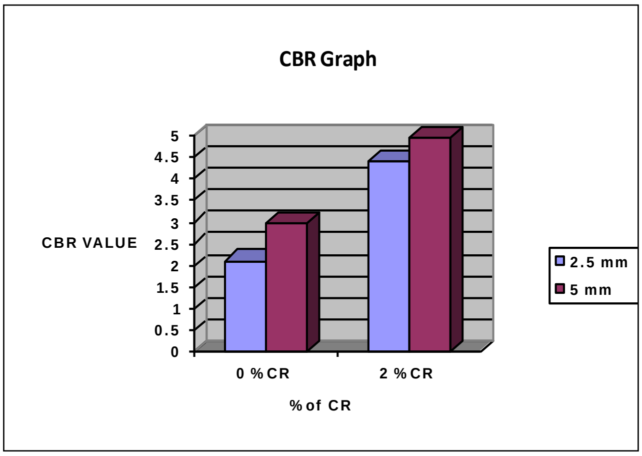
IV. Plastic Limit

Soil sample	Plastic limit
Surface soil	20
Soil at 1 feet	28.57
Soil at 2 feet	33.33

V. California bearing ratio

Soil sample without crumb rubber		
Soil sample	**Penetration (mm)**	**CBR value (%)**
A1	**2.5**	**2.1**
	5	**4.4**

Soil sample with 2% crumb rubber		
Soil sample	**Penetration (mm)**	**CBR value (%)**
A2	**2.5**	**2.99**
	5	**4.96**



5. CONCLUSION

The California Bearing Ratio (CBR) values you provided for two different samples can be analyzed to draw conclusions about their relative strengths and suitability for various applications. The CBR test is commonly used to evaluate the mechanical strength of subgrade, subbase, and base materials for road and pavement construction.

Comparing the CBR values between the two samples, it appears that Sample A2 with the addition of 2% Crumb rubber shows slightly higher CBR values at both penetration depths compared to Sample A1.

Soil sample	Liquid limit
Surface soil	22.22
Soil at 1 feet	26.31
Soil at 2 feet	25.26
soil with 2% CR	33.33
soil with 4% CR	30.95
soil with 6% CR	35.29

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