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IMPROVEMENT OF WEAK SUBGRADE SOIL STRENGTH USING WASTE TILES

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Abstract:

In many parts of India, the soil is found to be weak in sustaining heavy loads. This scenario becomes more prominent at areas covered by expansive and problematic soils like soft clays. The containment of pavement structures over these weak regions becomes more pensive, as the durability of the pavement structure depends on the strength and stability of the underlying soils. Thus in these cases, the underlying soil or the subgrade becomes ineffective and these ineffective soil need to be transformed into effective earth material for the effectual functioning of the pavements. Thus to strengthen the weak subgrade soil layer and to achieve sustainability, construction and demolition waste are used. In this study, the problematic and weak black cotton soil (BCS) is taken from Chittor region of Palakkad district of Kerala and the waste broken tile pieces are taken to conduct the study. The crushed Mangalore pattern tiles and the soil is tested in CBR test apparatus at different proportions and the results are evaluated. The California Bearing Ratio value increased with the increase in h/T ratio of 0.0 to 1.0 from 6.2% to 59.5% indicating an increase in its strength. Thus the utilization of the waste tile in pavement construction helps to reduce the pavement thickness as well as the need of very complicated and expansive stabilization methods.

Keywords: Weak Subgrade, Stabilization, CBR, Waste tiles, Pavements, Construction and Demolition waste

1. INTRODUCTION

The central India and the Deccan plateau of India consists of soil that are very weak in sustaining heavy loads. They are ideal for the cultivation and growth of Cottons. These soil are characterized by high compressibility, low shear strength and very high settlement. Thus these areas are of prime importance and interest to geotechnical engineers.

The stability and the strength of the pavement structures depend on the stability of the soil underlying it. Since the Black Cotton soil are very weak in sustaining these heavy loads, the need to transform these inactive soil material into an effective soil structure is highly important. Thus, an effective and economical method for strengthening these weak subgrade soils could be that using the waste material as a stabilizing agent. The construction industry in India is the highest economic sector after agriculture. Thus the amount of the waste produced by that industry varied from 0.25 to 5.14 million tons (Hanna and Sobha, 2016)[4]. Thus, to interlink the construction sector with the Indian economy, a suitable practices are required to handle the Construction and demolition waste in order to attain sustainability. Bindu C. S (2015)[3] carried out a study on the influence of the waste tile as a stabilizing material on the flexible pavement construction. The results showed an increase in CBR value indicating the increase in the subgrade strength. The study on the use of construction and demolition wastes like bricks, concrete tiles etc. for the mechanical stabilization of poor soil was conducted by Kumar (2015)[5]. The study concluded by indicating the use of CDW for increasing the pavement strength. [2]Ayothiraman et. al (2002) indicated that the lower CBR value (less than 10), lead to the deflection of the subgrade material under heavy traffic loadings. Thus, it is very crucial for the engineers to develop a minimum CBR value of 10 for all subgrade. This paper focuses on the application of Construction and Demolition waste for improving the strength and stability of subgrade soil.

2. OBJECTIVE

The main objective of the paper is to investigate the feasibility of using Construction and Demolition waste, Waste tile as a stabilizer in improving the strength of weak subgrade. The weak subgrade is chosen as Black Cotton soil collected from Chittor region of Palakkad district in Kerala and the waste tile is collected from the local tile factory.

3. MATERIAL CHARACTERISATION

1. Subgrade soil

The soil chosen for the study as subgrade are Black Cotton Soil, which are very weak in taking loads. They are expansive in nature viz. they swell on absorbing water and they shrink on drying. This rapid change of its volume make it a problematic soil as it causes deferential settlement of the structure overlying it. The BCS is collected from Chittor region in Palakkad district. The properties of the BCS were found as per IS and the results are tabulated in table 3.1. The particle size distribution curve of BCS is represented in Figure 3.1.

. Table 3.1 Properties of subgrade soil (Black cotton soil)

Property	Black Cotton Soil
Natural water content	60%
Specific gravity	2.2
Liquid limit	68%
Plastic limit	24%
Shrinkage limit	11%
Plasticity Index	445
Maximum dry density	1.77 g/cc
Optimum Water Content	16%
CBR value (unsoaked)	6.2 % at MDD and OMC
Coefficient of curvature	0.865
Coefficient of uniformity	6.15

2. Waste tiles

Waste tiles are collected from a local tile factory in Palakkad district. The waste Mangalore pattern tiles are collected from the factory and are crushed into smaller ones for testing. These burned tiles are used as roofing material and are often used as fire proof materials and to construct the walls of buildings. Table 3.2 shows the properties of the waste tiles.

Table 3.2 Properties of waste tiles

Property	Waste tiles	MoRT& H Specification
Specific gravity	2.6	2.5-3.0
Crushing value	35	Max 45
Impact value	24	10-30
Abrasion value	34	Max 40
Flakiness index	18%	15-25
Elongation index	13%	<15
CBR value	59.5 %	-

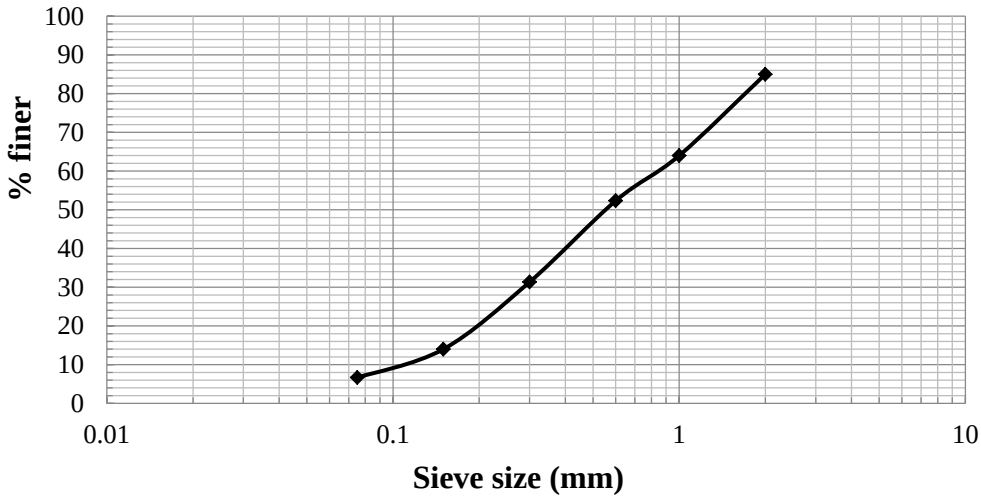

Figure 3.1 Particle Size distribution curve of BCS

4. EXPERIMENTAL INVESTIGATIONS

The CBR test (IS 2720 Part XVI, 1987) has been performed on soils with different clay tile waste contents. The tests were performed on different thickness combinations of the subbase and subgrade layers together. The total thickness of both layers together in the CBR test be denoted by T. The total thickness T in CBR test is 127.5mm. The thickness of the subbase (CDW) is denoted by h. The different combinations of heights of subbase

and sub grade are shown in table 4.1. The CBR test are performed by compacting the soil in 5 layers with 56 blows as per the standard requirements. For type II, III and IV, the CDW layer is compacted for the required volume and then the soil layer is compacted. After compaction, the mould is reversed. Then the testing is continued. Figure 4.1 shows the variation of CBR value with various h/T ratios.

Table 4.1 Combinations of subbase and subgrade layers

Subgrade (BCS)	Sub base (CDW)	h/T ratio	Type
100%	0 %	0	I
75%	25%	0.25	II
50%	50%	0.5	III
25%	75%	0.75	IV
0%	100%	1	V

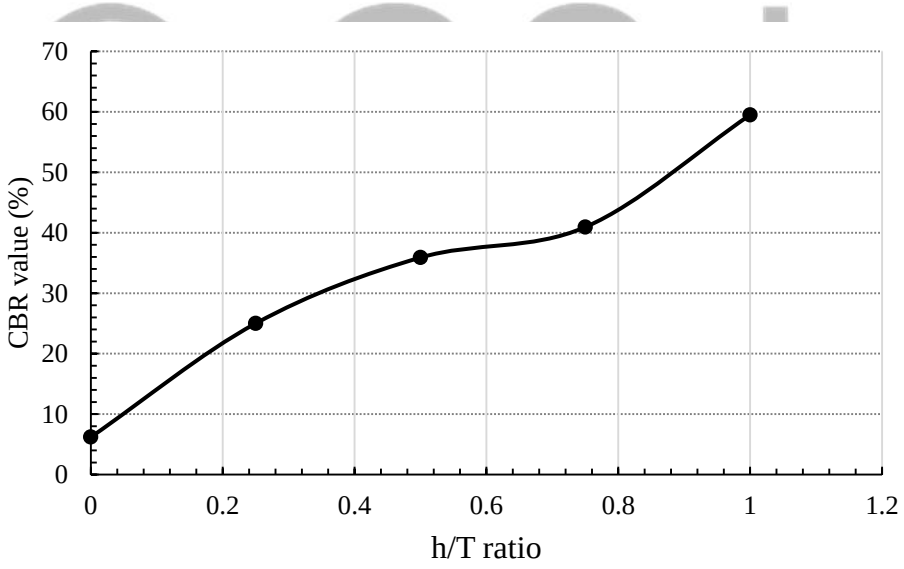

Figure 4.1 Variation of CBR value with h/T ratio

5. CONCLUSIONS

The CBR tests have been performed on the soil layer with different proportions of Construction and Demolition waste (CDW- Waste tiles). Figure 4.1 shows the variation of the CBR value with the h/T ratio. It is observed that the CBR value increases with the gradual progress of h/T ratio from 0.0 to 1.0. This increase in the CBR value is due to the shifting of the pressure bulb of CBR plunger within the weak subgrade to fully into the sub base layer at h/T ratio of 1.0.

Thus the present study shown an encouraging results. Thus, the waste tiles, which are Construction and Demolition waste could be used for strengthening the weak subgrade soil, hence attaining sustainability. The subgrade with very low CBR value, otherwise could have required stabilization or reinforcing for the effective functioning of the soil structure. Thus, the use of waste tiles will eliminate the need of very expensive stabilization methods and hence be cost saving by decreasing the pavement thickness.

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