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STABILIZATION OF EXPANSIVE SOILS USING CONSTRUCTION AND DEMOLITION WASTE

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Abstract - : *Black Cotton (BC) soil has an impact on its volume due to change in water content which is one of the primary reasons for destruction of structures in India as BC soil 20% of the land area. It is of great importance for engineers to study the effectiveness and usefulness of all stabilizers. significantly in volume with change in water content is the major cause of distortions to structures in India since it covers around 20 percent of land area. It is of great importance for engineers to study the effectiveness and usefulness of all stabilizers. The present work deals with the alteration of BC soil using Construction and Demolition (C & D) waste (concrete and plastering debris) which resulted in soil+10 percent C & D waste optimum mix obtained through standard proctor test. Further, the cohesion (c) and angle of internal friction (ϕ) were evaluated using Direct Shear test and the Safe Bearing Capacity (SBC) of soil was calculated using Terzaghi's equation for BC soil alone, BC+10 % C & D, BC + 12 % C & D and BC + 14 % C & D waste respectively. In the experimental studies carried out it can be seen that optimum addition of C & D waste can efficiently contribute in decreasing the swelling characteristics of black cotton soil by transmitting high bearing capacity and strength and can be contemplated as a substitute stabilizer which enhances the use of waste product obtained from construction industry.*

Keywords: Black cotton soil; Construction and Demolition waste; Safe Bearing Capacity.

1. INTRODUCTION

Black cotton soil have montmorillonite clay mineral that have a tendency to alter volume with application of moisture into it which in turn sustain various construction problems in site due to swelling and shrinkage characteristics of soil [18]. The existence of montmorillonite clay mineral in black cotton soil offers high degree of expansiveness which results in 12" deep cracks [16]. Expansive soils undergo swelling and shrinkage during cycle of wet and dry seasons induce substantial damage to structures founded on them [17]. The difficulties caused by expansive soils to the safety of civil engineering structures have received worldwide attention in view of high economic losses at national level of many countries [14]. Engineering structures when associated with expansive soil with moisture tend to swell or shrink effecting the structure to cause moments resulting in structural failure [10]. All these problems can be prevented by improvement techniques which are of great significance.

Traditional soil stabilizers like lime, fly-ash, cement, rice husk ash etc. are used other than mechanical compaction and soil reinforcement to strengthen the soil. Soil stabilization is the alteration of one or more soil properties to improve the physical characteristics of soil that will exist in place under the design conditions throughout the design life of project [3]. The present mechanical and chemical stabilization methods are generally carried out to improve the soil properties.

Researchers have in detail analysed various geotechnical properties of BC soil using various stabilizers. Ashango & Patra, 2014 observed higher compressive strength values at optimum mix on addition of two stabilizers; namely Portland slag cement and rice husk ash to black cotton soil. However, the study depicted that Optimum Moisture Content (OMC) reduced with increase in quantity of stabilizers. Yadu & R.K, 2013 performed experiments which showed that Granulated Blast furnace Slag (GBS) can be effectively used as a stabilizer which directly enhances the physical and strength properties of soil. With addition of GBS to expansive soil the OMC decreases and also the compressive strength of the soil was found to be higher. Cement dust imparts essential and long lasting benefits when used as a stabilizer for BC soil [16]. The construction in difficult ground conditions can be prevented by lime stabilization of clay which increases the unconfined compressive strength [12]. The addition of groundnut shell ash improves the compressive strength of clay soil [15]. On addition of natural inorganic stabilizer (RBI-81) strength properties were found to be influenced additive to black cotton soil [3]. Recently Kamei, et al., 2013 conducted a same experiment of stabilizing soft clay soil using gypsum plasterboard which is a major waste obtained from construction and demolition waste in Japan and observed a significant development in strength which in turn enhanced the durability.

India is growing rapidly with the construction industry being benefitted the most due to better economic growth; and hence large amount of wastes are generated. The plastering slices, concrete debris and bricks are the major wastes posing serious disposal issues by reducing the area of landfill sites provided for disposal. Researchers are concentrating on other solution for the optimum use of wastes in ground improvement projects. To substitute the usage of these wastes as stabilizer, it is important to examine the durability of the soil stabilized with C & D waste. The investigation carried out, the C & D waste were ground into powder form and were mixed in varying percentages to BC soil. The objectives of the present research comprises of:

a) To improve the bearing capacity of black cotton soil on addition of stabilizer.

b) To study the variation of strength of soil at different water content.

c) To study the effect of C & D waste on shear strength of soil.

d) To ensure reduction in cost compared to other conventional materials.

2. MATERIALS AND METHOD

2.1. Location of the study

The BC soil sample was collected from Vidurashwatha, Gauribidanur Taluk, Karnataka, India. C & D waste was collected from site at Kengeri, Bangalore, Karnataka. The C & D waste comprised of block works, cement plastering, brick works and concrete works.

2.2 Testing methods

Laboratory testing on raw soil consisted of, grain size analysis (dry and wet sieve analysis), specific gravity direct shear test, standard proctor test and Atterburg limits. The engineering characteristics of the soil were decided concurring to Bureau of Indian Standard (BIS) [5-7, 9]. Standard compaction tests were done on samples prepared with addition of 2%, 4%, 6% till 14 % C & D waste respectively in interval of 2% [8]. Direct shear test was analysed at optimum stabilizer content (OSC), OSC+2% and OSC+4% respectively as per Indian standards [4].

2.3 Properties of Black cotton soil and Construction and Demolition waste

The characteristics of black cotton soil and C & D waste were analysed according to BIS standards. The specific gravity of soil 2.66 and the clay content was observed to be greater than 70 %. The plasticity index was observed to be higher i.e. 24.85%. The group index of raw soil was observed to be higher proving the low quality of soil and the soil was classified as per AASHTO soil classification system [2,13] and was observed in group A-7-5 showing that the soils falls below the specific standards which requires stabilization. The results of standard proctor test on raw soil and C & D waste has also been reported in Table 1. The specific gravity of C & D waste was observed to be 2.75 and wasobserved to be less plastic.

Table 1. Properties of Black cotton soil and Stabilizer.

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3. RESULTS AND DISCUSSIONS

3.1. Atterberg limits

The plastic limit and liquid limit of the Black Cotton soil were evaluated as per IS: 2720 (V) [7]. The plasticity index was observed to be decreasing with increase in percentage of C & D waste. Figure 1. specifies the decreasing of PI with increase in percentage of C & D. It could be surmised as PI diminishes with increment in C and D rate till around optimum percentage.

3.2. Compaction properties

MDD and OMC for mixtures were evaluated in accordance with IS: 2720 (VII) [8]. The MDD was observed to be increasing with increase in percentage of C & D waste. The requirement to increase in MDD could be due to the increment in specific gravity of stabilizer in correspondence to BC soil. The OMC was found to be decreasing with increment in quantity of stabilizer. The reduction in water content could be comprehended as the decreased clay and silt percentage in light of the supplement of C and D waste bringing about lesser surface area [18]. The change in OMC and MDD with varying percentages of C & D waste can be seen in Figure 2.

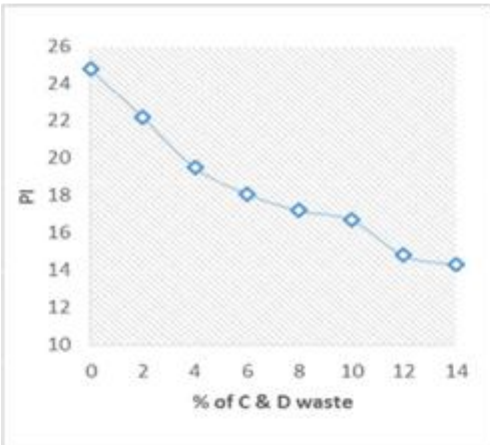

Figure 1. Plasticity index versus different percentage of stabilizer

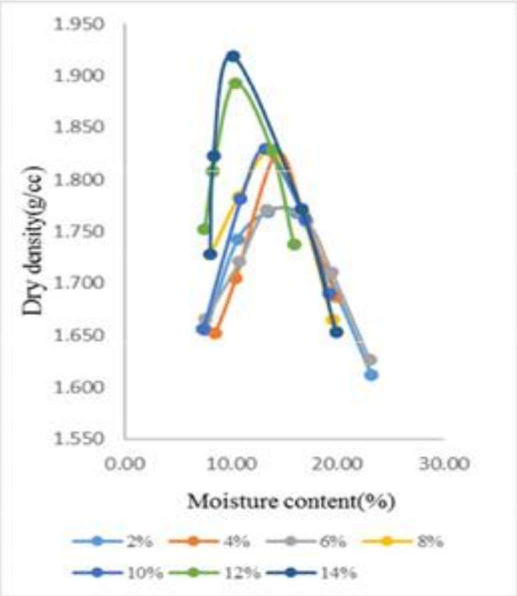

Figure 2. Variation of OMC and MDD with different percentage of C & D waste.

3.3. Cohesion and frictional properties (c and ϕ)

The compaction characteristics curve determined from 10 % C & D waste blended soil was observed to be optimum. Further, Direct shear test as per IS standard [4] was tested for BC soil, optimum, optimum+2, optimum+4 percentage of blended soils. The cohesiveness of the soil decreased and angle of internal friction increased with increase in percentage of C & D as shown in Figure 3. The rough and angular surface of individual C & D particles could be considered as the explanation behind for increment in angular friction. In any case, additionally on particle shape and size of individual particles mean the above reached determination.

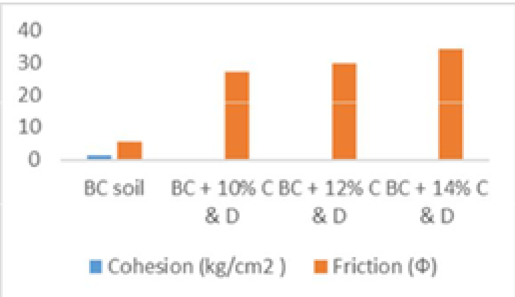

Figure 3. Variation in cohesion and angle of internal friction with change in blend %.

3.4. Safe Bearing Capacity

On the basis of 'c' and 'ϕ' results observed, the Soil Bearing Capacity of expansive soil alone, 10 %, 12 % and 14 % blended soil respectively were solved using Terzaghi's bearing capacity equation as given in equation-1. Table 2. show Terzaghi's Bearing capacity factors for various values of angle of internal friction. Calculations were done by presumptions like Circular footing with two different diameters and three different depths. The valued given in Table 3. show that the SBC of the soil drastically improved on addition of 10 % C & D in comparison to BC soil alone i.e. from 1411 to 2148 kN/m3. In any case not much changes in bearing capacity was found on furthermore addition of C & D waste to the black cotton soil. Consequently, 10 percent C & D waste could be considered as the optimum mix percentage required to enhance the soil properties.

$$Q^F = 1.3cN_c + \Upsilon DN_q + 0.3\Upsilon BN_\Upsilon$$

Where c= cohesion in kg/cm2, Nc, Nq, Nϒ are known as bearing capacity parameters, ϒ= dry density kN/m3, D= depth of footing (m), B= diameter of footing (m).

4. CONCLUSIONS

The future utilization of C & D wastes in stabilizing the Black cotton soil has been examined here. The soil has increased GI value in A-7-5 subgroup as per AASHTO soil classification systems [13] which proves a low quality of soil and considers stabilization. The strength and physical parameters have been calculated for raw and blended soils. The experimental studies demonstrate that the addition of C & D waste essentially influences the properties of soil. The plasticity index of the soil decreased with increase in quantity of stabilizer. The MDD increased and OMC decreased with increase in the amount of stabilizer. Ba of the strength test 10 percent of C & D waste is taken to be optimum and the Soil Bearing Capacity of the soil significantly improved on addition of 10 percent stabilizer i.e. from 1411 to 2148 kN/m3.

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