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Subgrade Stabilization of Soil treated with Sand & Cement

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Abstract: The ground improvement technique is a special method aimed at increasing bearing capacity, reduce compressibility, decrease permeability, modify dynamic response, and reduce the risk of liquefaction potential of subsoil and increase the stability of soil in slopes. On many occasions, it is noted that the local soil is by nature, unable to bear the proposed structure. Hence the use of ground improvement techniques may be necessitated. Use of soil stabilization is one such technique. The present study involves stabilizing black cotton soil using admixtures such as cement and sand. These admixtures enhance the strength of subgrade soil.in this work mainly the appropriate dosage is found out which enhances engineering properties of the soil. When the parent soil is treated with these two admixtures changes in various soil properties such as Liquid limit, Plastic Limit, Maximum Dry Density, Optimum Moisture Content, and California Bearing Ratio were studied. The result shows that the use of sand and cement stabilised soil increases the California Bearing Ratio values (CBR) i.e. the strength of soil to a great extent.

Key Words: Black cotton soil, Liquefaction, California Bearing Ratio, Sand and Cement.

1. INTRODUCTION

In India deposition of Black cotton soil is very good and prosperous for farmers. All the basic amenities of life i.e. food, clothes and house have been fulfilled by the soil, without soil it is just next to impossible to think about life on the earth. But on the other side in Civil Engineering aspects Black cotton soil is very troublesome and problematic and hazardous due to its characteristics. Because of its high swelling and shrinkage characteristics, the black cotton soil has been a challenge to the Engineers. The black cotton soil is very hard when dry but loses its strength completely when in wet condition. Soil deposits in nature exist in an extremely erratic manner producing there by an infinite variety of possible combination which will affect the strength of the soil and the procedure to make it purposeful [1].

These Expansive soils possess high strength in summer and decreases rapidly in winter. Swelling and shrinkage of expansive soil cause deferential settlement resulting in severe damage to the foundation, buildings, roads, retaining structures and canal linings. To prevent the structure from such damages, stabilization of soil is required with the stabilizing materials like fly ash, lime, sand, bitumen, cement, rice husk ash etc. The engineering properties of Black cotton soil (B.C. soil) can significantly be improved with these stabilizing agents [2].

The technique of stabilizing the soil with sand and cement is being carried from long time. Mixing Portland cement, sand and pulverized black cotton soil with the optimum moisture content and compacting the mix to attain required density. The material obtained by mixing soil, cement and sand is known as cement sand soil. Cement in the range of 2 to 5 per cent brings remarkable improvement in the engineering characteristics of B.C. soil. Similarly increasing proportion of sand as stabilizer also improves the properties of soil.

2. OBJECTIVES OF STUDY

With limited finances available, the biggest challenge in developing countries like India is to provide a complete network of road system, particularly in providing connectivity to remote villages. The cost of road construction using conventional construction materials and methods has been increasing by leaps and bounds year after year. Therefore there is a need to resort to one of the suitable low-cost road construction methods by effectively utilizing locally available materials and adopting soil stabilization techniques. Thus the object of soil stabilized road construction is:

1. Improvement of Index and Engineering properties of Black Cotton Soil on addition of sand and cement.
2. Effect of sand and cement on CBR value of the soil.
3. Effect of sand and cement on Compressive strength of soil.

The fundamental purposes behind picking these materials are

1. They are practical as they are the waste items
2. They don't have critical use in any gainful work
3. They have transfer issue
4. They are locally accessible.

3. MATERIALS AND METHODOLOGY

3.1 Materials

In the present study, the following materials are used

1. Black Cotton Soil.
2. Sand and
3. Cement

3.1.1 Black Cotton Soil

Black cotton soil sample were collected from Kurki in davanagere district of Karnataka state, India .It is located in 14.3739N and 75.9739E which is 13km towards south davanagere.

3.1.2 Sand

Sand used for the work is clean and coarse sand passing through 425 micron sieve, it is oven dried for 24 hours to eliminate sand's moisture before the conduction of tests and the specific gravity of 2.6.

3.1.3 Cement

The Portland pozzolonic cement (PPC) used for the study was purchased from the market with the specific gravity of

3.2 Methodology

In this work, the black cotton soil is stabilized with sand and cement. The amount of sand for stabilization is taken in the proportion of 10%, 20%, 30%, 40% by dry weight of soil and the amount of cement was taken as 2% by dry weight of soil. Using these proportions, mix samples were prepared as given below and a set of laboratory tests were performed to determine the index and engineering properties of both natural soil and mixed proportion samples.

Mix Proportion Samples of soil, Sand and cement used for Stabilization were as follows:

1. Natural soil.
2. Soil +10% Sand +2% Cement.
3. Soil +20% Sand +2% Cement.
4. Soil +30% Sand +2% Cement.
5. Soil +40% Sand +2% Cement.

4. RESULTS & DISCUSSION

The objective of the present study is to investigate the strength characteristics of Black cotton soil by adding sand and cement. This has been done to make the black cotton soil suitable for the construction of structure and safeguard the structures form the hazards of expansive soil. The test results conducted on soil samples were as follows:

4.1 Grain Size Analysis

Sieve analysis test was conducted on parent soil and when compared to AASHTO Classification Chart, it was observed that it lies under the range of A-2 group, A-2-7 subgroup. And by Unified soil classification system (USCS) and IS Classification system the soil is classified as CH (Silt with High Plasticity).

4.2 Specific Gravity

As per IS Standards specific gravity value for BC soil should in the range of 2.3 to 2.65 and obtained value for our parent soil was within the range that is 2.41.

4.3 Atterberg Limit Test

As per AASHTO soil classification system the Liquid Limit value for the black cotton soil is in the range LL>40% But the value obtained for parent soil was found to be LL=52% which is within the permissible limit.

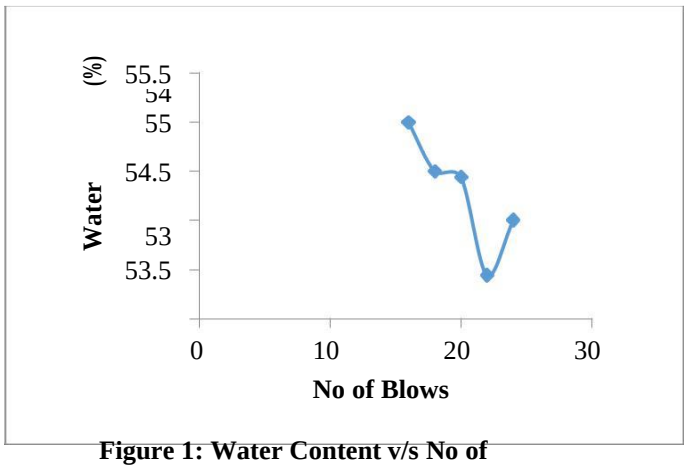

Figure 1: Water Content v/s No of Blows Determination of Plastic Limit:

- **Plastic Index** = Liquid Limit – Plastic Limit

PI =23%

As per AASHTO soil classification system the Plasticity Index value for the black cotton soil is in the range PI>10% but the obtained value for parent soil is PL=28.51% which is greater than required range.

4.4 Modified proctor test

Standard proctor test have been conducted to determine the optimum moisture content and maximum dry density of parent soil, stabilized with sand and cement Graph 5.2 to 5.6 shows the values of MDD and OMC for soil under investigation and stabilized with various dosages of stabilizer.

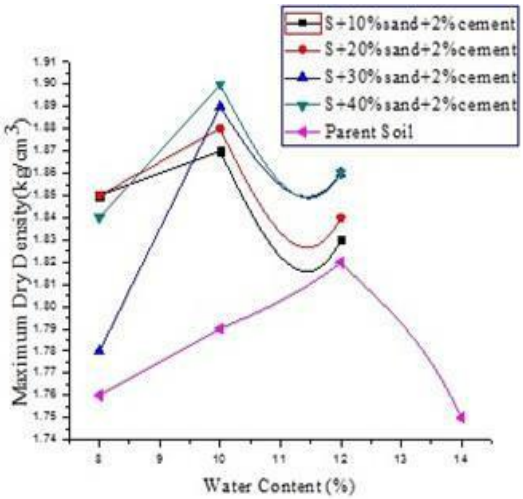

Figure 2: Proctor Compaction of soil + stabilized soil

4.5 California Bearing Ratio (CBR) Test

The CBR values are usually calculated for penetrations of 2.5 and 5 mm. Corresponding to the penetration value at which the CBR values is desired, corrected load value shall be taken from the load penetration curve and the CBR calculated as follows:

California Bearing Ratio = (Test Load/ Standard Load)*100

Generally, the CBR value at 2.5 mm penetration will be greater than that at 5 mm penetration and in such a case; the former shall be taken as the CBR value for design purposes. If the CBR value corresponding to a penetration of 5 mm exceeds that for 2.5 mm, the test shall be repeated. If identical results follow, the CBR corresponding to 5 mm penetration shall be taken for design. be taken for design.

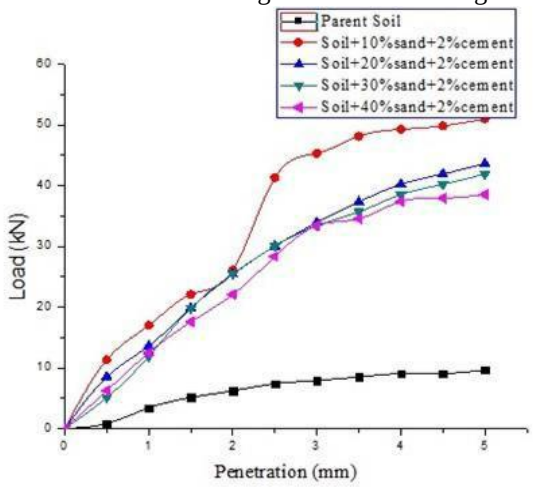

Figure 3: CBR of soil + stabilized soil

4.6 Determination of pavement thickness

Thickness of the pavement can be determined on the basis of CBR values and traffic classification based on commercial vehicles per day as shown below. CBR value for 20% sand and 2% cement=3.19

Number of commercial vehicles per day at study area 150-450 (Traffic classification=D)
Hence depth of thickness of pavement is=48cm

4.7 Unconfined Compressive Strength

The result of unconfined compression test has been shown in table 1. For natural soil, the value of compressive strength has been observed as 14.95 kg/cm^2,with addition of stabilizing agents like cement and sand for increasing percentages like 10,20,30,40% the corresponding values of UCC were 16.92,18.22,18.57,19.53 kg/cm^2 respectively.

Table 1: Obtained UCS Values

Type	UCS in Kg/cm^2
Natural BC Soil	14.95
Soil +10% sand + 2% Cement	16.92
Soil +20% sand + 2% Cement	18.22
Soil +30% sand + 2% Cement	18.57
Soil +40% sand + 2% cement	19.53

5. CONCLUSIONS

This study demonstrates the influence of sand and cement with various percentages (10, 20, 30, and 40%) on geotechnical properties of Black Cotton soil of Kurki in Davangere. Based on experimental test results, major conclusions have been drawn with regards to the effect of suitable 20% Sand and 2% cement on proctor density, unconfined compressive strength and CBR value of Black Cotton soil:

As per IRC classification the minimum thickness for sub base course, base course and surface course is in a range of 150-200mm, 225-250mm and 25mm respectively. The following trends are observed from the results of the experimental investigation:

- For 20% sand and 2% cement the obtained thickness of pavement from CBR design chart is 480mm which is approximately equal to the minimum thickness of 475mm
- With increase in sand percentage thickness will be reduced and cost increase, hence by using 20% sand and 2% cement cost can be reduced and also minimum thickness required for the pavement will be satisfied.

This study shows that treatment of soil with sand and cement provides substantial and durable benefits when used as stabilizing agent for Black cotton. There is significant change in the Density, Bearing value and compressive strength of Black Cotton soil which proves sand and cement is a worthy stabilizer for Black Cotton soil.

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