EFFECT OF CBR OF BLACK COTTON SOILS REINFORCED WITH POLYESTER FIBER

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ABSTRACT
Expansive soils undergo large volume changes due to change in moisture content so as to affect the structures resting upon it. Large tracts of expansive soils are reported in India and many parts of the world especially in the arid and semi-arid regions of the tropical and temperate zones. Construction of building and many civil engineering structures on weak or soft soil is very risky and dangerous on geo-technical grounds because this type of soil is take place settlements, poor bearing capacity, weak strength parameters and high compressibility of soil. Improvement of load bearing capacity of the soil may be undertaken by a variety of ground improvement techniques like soil stabilization, vibro flotation and fiber reinforced earth technique of soil etc. Fiber reinforced earth technique is a very effective ground improvement technique because of its cost effectiveness, easy adaptability and reproducibility and workability etc.

In the present project work, it is experimentally carried out to investigate the effect of soil with the inclusion of randomly distributed polyester fibers in to the soil. The California Bearing Ratio (CBR) Test is a method of evaluating the strength of soil subgrade/sub-base and base course material for flexible pavement. The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. The effectiveness of inclusion of randomly distributed fibers in soils for improving the California bearing ratio values is investigated through an experimental investigation. The California Bearing Ratio (CBR) Tests were conducted on expansive soils reinforced with randomly distributed discrete polyester fibers at different aspect ratios of various percentages i.e., 0.5% to 4%, under both soaked and unsoaked conditions. The paper describes the load penetration response obtained from CBR tests performed on black cotton soils. The CBR values of black cotton soil increase significantly due to inclusion of randomly distributed fibers under soaked and unsoaked conditions. The increase in CBR is as high as 106.3% with the inclusion of 4% fiber of 1/b ratio 1.0.

KEY WORDS: Black cotton soil, polyester fiber, compaction, CBR, soaked, unsoaked

INTRODUCTION
In India, soils vary from one place to the other, and the engineering properties are equally varied. Soils can be formed by physical and chemical weathering of rocks. Physical weathering may be one of two types. First, is the disintegration caused by wetting (or) drying or by freezing and thawing in the cracks of rock. Second is erosion – caused by the action of glaciers, water or wind. The minerals of rock is composed are converted into a very different collection of minerals known as clay minerals. Well known members of this group are Kalonite, Montmorillonite and Illite, but less well known clay minerals of considerable importance in volcanic areas are hallo site and allophone. Clay sand stone particle are generally crystalline in shape as well as are of colloidal size i.e., they are less than 0.002mm. These minerals provide soil the property of cohesion and plasticity, which are the distinctive characteristics of clay.

Soil is a non-homogeneous, porous, earthen material in which their engineering properties can be influenced by water- content and density changes. Soils supply plants with mineral nutrients. A fertile soil will give a continuing supply of dissolve mineral nutrients in amounts and relative proportions appropriate for optimal plant growth.

The development of the soil depends on the elements that assure the soil formation. The organic influence on soil properties is great near the surface, but the authority of geotechnical properties on soil is strong at the deeper depths of soil.

To develop the soil structure, soil includes of untreated matter, water, gases and the time combine to form aggregate. After formation of aggregate, the soil is developed further describes in provisions of texture, porosity, consistency etc. the major influencing factor in stabilizing the soil fertility of the soil.

A soil collection consists of varied compilation of solids with the voids in between them. The voids contain water and gas.

The necessity for stage systems computation arises, to found the active stress profile at a site and does not know the total density of soil only the water content. The soil formed directly as of the chemical weathering of rocks is called residual soils. The residue in position of straight above and in contact with its parent rock.

The top most layer of the pavement section built is known as subgrade. It is the result of earthwork operations, and it may consist of undisturbed existing soil or material excavated and can be placed as a fill material anywhere. The subgrade acts as a base for the roads and is normally of depth 30 to 50 cm. the structural design
of the road in terms of the thickness of overlaying pavement layers is dependent relative to the bearing capacity of that subgrade. Sub grade quality has a striking impact together the initial cost of the road and the subsequent maintenance costs.

INDIAN STANDARD SOIL CLASSIFICATION SYSTEM

IS:1498-4970 describes the Indian Standard on Classification and Identification of Soils for general engineering purposes (first revision). Significant provisions of this system are given below. Soils shall be broadly divided into three divisions:

- Coarse grained Soils
- Fine grained Soils
- Highly Organic Soils

Engineering properties

The major engineering properties of the soil are permeability, compressibility and shear strength. Permeability of soil indicates facility of water flow through soil. It is required for the estimation of leakage release through earth mass. Compressibility is related to the deformation produced in soils when they are subjected to compressive load. Compression description is required for the calculation of settlements of structure originated on soils. Shear strength of soils is its ability to check shear stress. The shear determines the stability of slope, bearing capacity of soils and earth gravity on retaining structures.

All the black soils are not expansive soils and all the expansive soils are not black in colour. The behaviour of the expansive soils is very uncertain when it is subjected to moisture changes. These changes pose considerable challenge for the civil engineers during construction activities specially while constructing foundations. The strength of soil changes when water occupies large space in the voids of soil.

CHARACTERISTICS OF BLACK COTTON SOILS

- They are very fertile.
- They are black in colour.
- They are high in organic matter.
- They often from in grasslands and wetlands.
- Organic matter contains plant nutrients and it also improves the physical properties of the soil, enhancing it for plant growth.
- It is also known as rigour soil.

SCOPE OF THE PRESENT WORK

The work emphases on the application of randomly discrete fibers reinforced clayey soils. The main objectives of the work are:

- To study the index properties to classify the unreinforced soil.
- To study the OMC and MDD and also individually soaked and unsoaked CBR conditions of unreinforced soil.
- To study the influence of OMC and MDD of the soil samples reinforced at varying percentages of fiber.
- To study the influence of CBR of the samples reinforced for individually soaked and unsoaked conditions of various percentages of fiber.

II. LITERATURE REVIEW

Mali and Singh, 2014 analyses the strength conduct of cohesive soils strengthened with coir fibers, polypropylene fibers and scrap tire rubber fibers as described after investigational exploration, that comprises of triaxial, direct shear and unconfined compression tests. The results from the triaxial rests shows that the stress- strain behaviour of the soil is improved by the coir fiber inclusion of the coir fiber in silty soil and the deviator stress failure is increased up to 3.5 times over the unreinforced soil.

Direct shear test results shows that when the polypropylene fibers are included into the soil, the strength improves up to 0.4% addition of fiber and beyond which it decreases.

From the UCC test results it is concluded that the inclusion of the polypropylene fiber into soil increases UCS of the soil. The optimum fiber content is found in the range of 0.2-0.3% of fiber addition.

Singh and Mittal, 2014 did UCC tests and CBR tests without and with coir fiber. The proportion of coir fiber by dry weight of soil is engaged as 0.25%, 0.50%, 0.75% and 1% and corresponding to each coir fiber content unsoaked and soaked CBR and UCS tests are lead in the laboratory. Experiment results of CBR of the soil with the coir fiber inclusion indicates that both unsoaked and soaked CBR value of soil increases with the increase in fiber content.

Maliakal and Thiyyakkandi, 2013 discusses the shear strength of clay reinforced with randomly distributed coir fibers based on a series of consolidated untrained triaxial compression tests. Test results show that major principal stress at failure for clay-coir fiber matrix increases with increase in fiber content (Wt) and fiber aspect ratio (A). In general, the work classifies that the presence of discrete coir fibers in random manner suggestively improves the shear strength of clay.

Ramesh, et al., 2013 describes the compaction and strength behaviour of black cotton soil (BC soil) reinforced with coir fibers. BC soil reinforced with coir fiber displays only minimal growth in the strength of soil, preventing its use for ground
improvement. In order to additional increase the strength of the soil-coir fiber blend; optimum proportion of 4% of lime is more. It is originate that strength properties of optimum grouping of BC soil-lime samples reinforced with coir fibers is substantially better than unprocessed BC soil or BC soil alone with coir fiber. Lime behaviour in BC soil improves strength then it reports brittleness in soil specimen. BC soil treated with 4% lime and reinforced with coir fiber expresses ductility behaviour earlier and after failure. An optimum fiber content of 1% (by weight) with aspect ratio of 20 for fiber was suggested for reinforcement of BC soil.

III MATERIALS AND METHODOLOGY

MATERIALS:
In the present study, the following materials are used
1. Black cotton soils and
2. Synthetic fibers(Polyester)

Expansive soils:
Type of soil used in this investigation is of high clay content, Black cotton soil. The soil is brought from the surroundings of Krishnapuram village, Kadapa dist. The soil was air dried pulverised and passing through IS:425 micron sieve was taken for the study of properties. Different Engineering properties of soil initially can be find by conducting corresponding the experiments according to IS code specifications.

Polyester fiber:
The fiber utilized in the investigation is a polyester material and it is mesh fabric material. Polyester material is a synthetic resin and is made from chemicals. Properties of the fiber used in the study are given in table.

Table. Properties of Fiber

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>5-220cm</td>
</tr>
<tr>
<td>Weight</td>
<td>420gsm</td>
</tr>
<tr>
<td>Density</td>
<td>22kg/cm³</td>
</tr>
<tr>
<td>Thickness</td>
<td>3-20mm</td>
</tr>
</tbody>
</table>

METHODOLOGY:
In this work, different engineering and index properties of the soil were studied and then the synthetic fiber is contributed in the soil as per the aspect ratio (L/B) i.e., 0.25, 0.5, 1 from 0.5% to 4% by doubling the initial percentage of aspect ratio of fiber to the soil.

V RESULTS
The aim of the investigation is to analyse the effect of polyester fiber on black cotton soils. In this study the effect of the polyester fiber is studied on moisture content and on CBR values among different aspect ratios with different percentages of fiber in the soil.

PROPERTIES OF BLACK COTTON SOILS
The properties of black cotton soil that is used in the investigation are obtained as follows.

Table 6.1 properties of black cotton soil

<table>
<thead>
<tr>
<th>Property of soil</th>
<th>Obtained value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>2.3</td>
</tr>
<tr>
<td>Liquid limit</td>
<td>44.4%</td>
</tr>
<tr>
<td>Plastic limit</td>
<td>36.15%</td>
</tr>
<tr>
<td>Plasticity index</td>
<td>15.9</td>
</tr>
<tr>
<td>Standard proctor test</td>
<td></td>
</tr>
<tr>
<td>Optimum moisture content (OMC)</td>
<td>27.06%</td>
</tr>
<tr>
<td>Maximum dry density (MDD)</td>
<td>1.46g/cc</td>
</tr>
<tr>
<td>Unsoaked CBR</td>
<td></td>
</tr>
<tr>
<td>At 2.5 mm penetration</td>
<td>2.0</td>
</tr>
<tr>
<td>At 5.0 mm penetration</td>
<td>1.97</td>
</tr>
<tr>
<td>Soaked CBR</td>
<td></td>
</tr>
<tr>
<td>At 2.5 mm penetration</td>
<td>1.90</td>
</tr>
<tr>
<td>At 5.0 mm penetration</td>
<td>1.87</td>
</tr>
</tbody>
</table>

Effect of fiber content on OMC:
In the present work, OMC and MDD of unreinforced and reinforced soil are studied. The
values of OMC and MDD are obtained as shown in table 6.2. The soil is reinforced with polyester fiber of three aspect ratios 0.25, 0.5 and 1.0 at different percentages of 0%, 0.5%, 1%, 2% and 4%. From the test results, it is observed that the inclusion of fibers into soil increases its properties. OMC of reinforced soil increases than the unreinforced soil. This change occurs due to the increase in the fiber content. As the length and fiber content increases OMC increases. OMC of soil with inclusion at 0.5% and 1% of fiber slightly increases as compared with the other two percentages of fiber 2% and 4% inclusion in to the soil.

Table: OMC and MDD values of different aspect ratios

<table>
<thead>
<tr>
<th>% of fiber</th>
<th>16 = 0.25</th>
<th>16 = 0.5</th>
<th>16 = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMC</td>
<td>MDD</td>
<td>OMC</td>
<td>MDD</td>
</tr>
<tr>
<td>0.5%</td>
<td>27.06</td>
<td>1.426</td>
<td>27.23</td>
</tr>
<tr>
<td>1.0%</td>
<td>27.26</td>
<td>1.425</td>
<td>27.75</td>
</tr>
<tr>
<td>2.0%</td>
<td>27.88</td>
<td>1.421</td>
<td>28.44</td>
</tr>
<tr>
<td>4.0%</td>
<td>28.60</td>
<td>1.419</td>
<td>29.60</td>
</tr>
</tbody>
</table>

Effect of fiber on MDD:

In the present study, MDD of the reinforced soil decreases than the unreinforced soil. MDD of the reinforced soil decreases with the increase in the fiber content of different aspect ratios at different percentages of 0%, 0.5%, 1%, 2% and 4%. It is obtained as 1.426 MDD for unreinforced soil and later by the inclusion of the discrete fibers it decreases to 1.411.

Effect of fiber on CBR

<table>
<thead>
<tr>
<th>% of fiber</th>
<th>16 = 0.25</th>
<th>16 = 0.5</th>
<th>16 = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>25.4</td>
<td>37</td>
<td>25. 37</td>
</tr>
<tr>
<td>0.5%</td>
<td>27.4</td>
<td>39</td>
<td>37.8</td>
</tr>
<tr>
<td>1.0%</td>
<td>31.8</td>
<td>50.8</td>
<td>40.0</td>
</tr>
<tr>
<td>2.0%</td>
<td>33.6</td>
<td>48.8</td>
<td>43.4</td>
</tr>
<tr>
<td>4.0%</td>
<td>34.8</td>
<td>49.6</td>
<td>44.8</td>
</tr>
</tbody>
</table>

Figure. Comparison of fiber with OMC

Figure. Unsoaked CBR values at aspect ratio 0.25

Figure. Unsoaked CBR values at aspect ratio 0.5

Figure. Unsoaked CBR values at aspect ratio 1
VI. CONCLUSIONS

The tests are carried out to examine the effect of the polyester fiber on black cotton soils. Various conclusions are made from the tests conducted on black cotton soils using fiber of different aspect ratios i.e., 0.25, 0.5 and 1 at different percentages i.e., 0.5%, 1%, 2% and 4%. The percentages of the fiber are taken by doubling the initial percentage of fiber and this is due to the light weight and slight difference in the weight of the continuing percentages. The following are the conclusions made from the present study.

- From the series of standard proctor tests conducted, we found that the OMC of the reinforce soil increases with the gain of the fiber content.
- MDD of the reinforced soil decreases as compared to OMC with the fiber content increase.
- OMC of the reinforced soil increments with the rise of length of the fiber and MDD decrease.
- Unsoaked CBR of the unreinforced soil is low and it provides an opportunity to be improved for the further purposes.
- CBR of the reinforced soil for the aspect ratio 0.25, 0.5 and 1 increases to 37.4%, 76.37%, 106.30% as compared to the unreinforced soil.
- The percentage of unsoaked CBR value increases with the increase in the fiber content and also with increase of length of the fiber.
- Soaked CBR of the reinforced soil for the aspect ratios 0.25, 0.5 and 1.0 increase to 37.74%, 58.47% and 98.30% as compared to the unreinforced soil.
- Unsoaked CBR of the reinforced soil is higher as compared to the soaked CBR of the reinforced soil.
- The increase in the CBR value is due to the reason that the inclusion of randomly distributed fiber into the soil improves its load and deformation behaviour.
- CBR value of the reinforced soil was observed to be greater than that of the unreinforced soil by the increase in the fiber content.

REFERENCES

coir fiber”, International journal of research in engineering and technology, 3(5), pp.707-711


