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Improvement in Properties of Black Cotton Soil with an Addition of Natural Fibre (Coir) Derived From Coconut Covering

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Abstract
Improvement of soil in foundation is a major challenge in civil engineering. Structures built on black cotton soil may be damaged due to high swelling and shrinkage characteristics of this soil with variation of water content. Black cotton soil is an expansive soil which loses its strength in presence of water. On the other hand, it has behavior of shrinkage when loss of moisture is there. About 20 % of land area in India is covered by black cotton soil. Because of its swelling & shrinkage properties, it is also called expansive soil. The present paper is an attempt to study the effectiveness of coconut fiber (coir) to control swelling properties of black cotton soil along with an impact on its strength characteristics and dry density. The test results show that in presence of 2% coir fibre, the shrinkage limit is increases by 7.52% to 12.62%. Increase in compressive strength was observed from1.09 to1.32 kg per sq-cm.

Keywords: black cotton soil; coir fibres: swelling behavior: Shrinkage

I. Introduction

Fast growth of Urbanization in India has led to increased construction activates in infrastructure sector. Construction of embankment for roads and highways passing through areas having black cotton soil need special attention to provide stable foundation below embankment.

Black cotton soil is clay of high plasticity. It has low bearing capacity and highly compressible nature. The expansive soil exerts upward swelling pressure in the structure. The pressure depends upon the degree of expansion and results in to uplift and cracking of structure. The present paper investigates the possibility of using coconut fibre for reinforcing black cotton soil to control expansion properties. Because of its high lignin content, it has infield service life of 4 to 10 year and good tensile strength in wet condition. Coir retains much of its tensile strength when wet. The degradation of coir depends on the medium of embedment, the climatic conditions and is found to retain 80% of its tensile strength after 6 months. Our paper is oriented to study comparative changes in properties of black cotton soil (considered as test soil) with an addition of coconut fiber so as to use this fiber as soil reinforcement, especially for black cotton soil.

Following studies are proposed to be carried out.
1. Change in swelling and shrinkage characteristics of black Cotton soil with an addition of coir (coconut fiber).

2. Change in compressive strength of black cotton soil due to addition of coir.
3. Change in OMC and MDD of black cotton soil due to addition of coir.

The studies are important from view point of using this natural fiber for improvement in properties of black cotton soil which shrinks with decrease in moisture content .During shrinkage, fiber will impart more inter surface resistance in between reinforcing fiber and soil, resulting in higher bearing capacity. On the other hand, addition of fiber will control swelling characteristics of soil during increase in moisture content.

II. Materials

2.1. Materials: Black cotton soil was collected from outer skirts of Gwalior city on Bhind road. Samples were collected from layer below 2.00m depth by excavating pits of 1.50 m x 1.50 m size.
The collected soil was passed through 600 micron sieve after drying and pulverization, in the laboratory. Coconut covers were collected from major temples of Gwalior city and used to get coir fibre of length varying from 50 to 180 mm. These fibres were cut randomly by scissor, in pieces of 50 to 70mm lengths.

III. Experimental Programme

Samples of black cotton soil were prepared with and without coir fibre. Quantity of coir was 2% by weight of soil sample.
Following tests were conducted for assessment of properties of plane soil and soil blended with coir fibre.

S No. Name of Laboratory test carried out

1. Specific gravity
2. Liquid limit
3. Plastic limit
4. Optimum moisture content
5. Maximum dry density
6. Unconfined compressive strength test at OMC.
7. Test for swelling of soil.

Above tests were carried out as per procedures described in various IS Codes. Specific gravity of soil was determined by density bottle method. Tests for atterberg limits were carried out .Liquid limit plastic limit shrinkage limits were determined for samples of plane soil. Soil mixed with2% coir fibre was tested for shrinkage limit. Water content of soil sample was determined by oven drying method.

Unconfined compression test was conducted both on plane soil sample and sample blended with 2% coir fibre.

Comparative results of plane soil & soil sample blended with coir fibre reinforcement are as per following.

S.N.	Laboratory test	Value for plane soil sample	value for soil blended with coir
1.	Specific gravity	2.63%	2.58
2.	Water content	8.50%	13.00%
3.	Liquid Limit	54.20%	-
4.	Plastic Limit	29.10%	-
5.	Shrinkage limit	8.20%	12.20%
6.	Optimum moisture content	20.10	27.20%
7.	Maximum dry density	1.56 g/cc	1.51g/cc
8.	Free swelling index	47%	32%
9.	Unconfined compressive strength test, at OMC.	1.09 Kg/cm^2	1.32 kg/cm^2

IV. Conclusion

Tests conducted on black cotton soil blended with 2% coir fibre sample, lead to following conclusion

1. Blending of coir fibre results in to increase in shrinkage limit from 8.20% to 12.20%. It controls the swelling behavior of black cotton soil.
2. Increase in optimum moisture content was observed from 20.20% to 27.20% due to blending of coir.
3. Appreciable increase in unconfined compressive strength was observed. It increased from 1.09 kg/cm^2 to 1.32 $Kg/cm^{2.}$

Above results indicate that the properties of black cotton soil are improved by blending of coir fibre with soil mass. Its swelling behavior is decreased and the un- confined compressive strength increases.

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