Comparative Study of Soil Stabilization by Using Polypropylene Fiber and Non-Woven Geotextile for Black Cotton Soil

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***Abstract*—The Black cotton soil is a cohesive soil which is generally considered as a weak soil due to high swelling and shrinkage characteristics, In this soil we cannot construct structure because of foundation failure or sinking of settlement can occur So, the soil stabilization is essential to improve its strength, durability and load-bearing capacity. The soil stabilization of black cotton soil is also necessary because it occupies 15-20% of India. The Polypropylene Fiber is going be added in various Percentage until we find the optimum percentage and Non-woven Geotextile is placed as reinforcement layer at the center of soil sample.**

The improvement in Load Bearing Capacity, Shear Strength and Axial compressive strength is identified by California Bearing ratio (CBR) Test and Unconfined compressive strength (UCS) Test of Black cotton soil with Non-woven Geotextile vs Polypropylene Fiber (in various percentage) material.

***Index Terms*—Black cotton soil, Polypropylene Fibers, Compaction characteristics, Unconfined compressive strength, California bearing ratio.**

I. INTRODUCTION

- Soil is the most unpredictable material in field of civil engineering; however, some soils are weak in nature such as black cotton soil. Black cotton soil is widely found in many parts of India and for construction of structure on such soil we have to improve the characteristics of the soil to some extent
- Polypropylene Fiber is a reinforcing material which is used for soil stabilization in civil engineering, and when mixed with soil, the polypropylene Fiber has the acts as reinforcement and improve the bond between the soil particles and helps to increases the shear strength, axial compressive strength, and lad bearing capacity etc.
- Nonwoven geotextile is a geosynthetic material made from synthetic Fibers. It is used in civil engineering for various purposes. One of the main purposes is soil reinforcement. When it is placed between the layers, the geotextile helps distribute load evenly and also helps to improve the stability of soil. It can prevent the intermixing of different soil layer and improves the strength of weak soil
- Through this comparative analysis, the study aims to determine the most effective reinforcement method for improving the engineering properties of black cotton soil.
- Enhancing its suitability for construction purposes. This project studies the improvement in load Bearing Capacity, shear strength and axial compressive strength of black cotton soil by use of Polypropylene Fiber vs Non-woven Geotextile.

II. OBJECTIVES

- To Compare the load-bearing Of Black Cotton Soil by using polypropylene Fiber and non-woven geotextile.
- To Compare the Axial compressive strength Of Black Cotton Soil by using polypropylene Fiber and non-woven geotextile.
- To Compare the Axial compressive strength Of Black Cotton Soil by using polypropylene Fiber and non-woven geotextile.

III. MATERIAL COLLECTION-

1. Black cotton soil –

1. Black cotton soil is a fine-grained clayey soil commonly found in many parts of India.
2. It has high plasticity and high water-holding capacity.
3. The soil swells when it absorbs water and shrinks when it dries.
4. Due to shrinkage, it develops cracks during dry seasons.

2.Polypropylene Fiber –

1. Polypropylene Fiber is a synthetic Fiber made from polymer material.
2. It is lightweight and has high tensile strength.
3. It has good resistance to chemicals and corrosion.
4. The Fiber does not absorb water.

3.Non-woven geotextile –

1. Non-woven geotextile is a permeable synthetic fabric used in civil engineering works.
2. It is usually made from polypropylene or polyester Fibers.
3. It has good filtration and drainage properties.
4. It allows water to pass through but prevents soil particles from moving

IV. TESTING

A. Optimum moisture content (OMC)

- Take about 5 Kg. of de-aired soil passing through sieve 20 mm in tray.
- Add about 4% water (approximately 120 ml) to the soil and mix thoroughly with trowel.
- Note the dimension of proctor mould, collar and base plate.
- Take the empty weight of the mould (without collar and base plate).
- Apply a thin film of grease on inside of the mould.
- Fix the mould to the base plate with the help of wing nuts, place collar on the mould.
- To determine the Proctor density till the soil in mould in three equal layers and give 25 blows to each layer using standard hammer. Scrap the top surface of compacted layer before placing the next layer of a soil.
- Remove the collar trim the soil with a straight edge, disconnect the mould from base plate and weigh it.
- Extrude the compaction soil from the mould. Collect sample from middle of the mould for water content determination
- Repeat same steps after taking fresh sample of same soil with addition of 3 to 4 % more and repeat the same process.
- Calculate bulk density of compacted soil for each test. The test is carried out as per I.S. 2720 (Part-VIII)
- Determine the maximum dry density and optimum moisture content corresponding to the standard proctor compaction by plotting graph water content v/s. dry density.

B. California bearing ratio (CBR)

- Take 3kg of oven dried black cotton soil sample which passes through the sieve 20mm
- . Add 21% water to the dry weight of soil as per OMC content.
- Oil the apparatus such as mould, collar, base plate.
- Assemble the mould, base plate, collar and tight them with screw.
- Compact the soil in 3 Layers and give 56 blows to each layer of soil rammer to avoid rammer sticking to the soil
- Remove the soil sample from the mould with help of hammer

- Then carry out the test on soil sample with the CBR test machine and the readings are displayed on electronic device connected to the CBR machine.
- Repeat the same process for 0.50%, 0.75%, 1%, 1.25% Polypropylene Fiber with black cotton soil and Layer of Non-woven Geotextile to black cotton soil

The test is carried out as per I.S. 2720 (Part-31)

- Plot the Graph with help of Load vs Penetration, to find the Maximum load bearing capacity of Black cotton soil.

C. Uniform confined Strength (UCS)

- Take 3kg of oven dried black cotton soil sample which passes through the sieve 20mm
- Add 21% water to the dry weight of soil as per OMC content
- Oil the apparatus such as mould, collar, base plate.
- Assemble the mould, base plate, collar and tight them with screw
- Compact the soil in 3 Layers and give 56 blows to each layer of soil with help of Digital soil compactor and also oil the rammer to avoid rammer sticking to the soil
- Also oil the standard UCS mould from smooth removal of oil sample
- Then place the soil sample on the Hydraulic Lifter machine and place/fit the standard mould of UCS on top of machine and then extract various sample from the hydraulic lifter
- Then carry out the test on soil sample with the UCS test machine and the readings are displayed on electronic device connected to the UCS machine.
- Repeat the same process for 0.50%, 0.75%, 1%, 1.25% Polypropylene Fiber with black cotton soil and Layer of Non-woven Geotextile to black cotton soil.
- The test is carried out as per I.S. 2720 (Part 10)
- Note down the reading of each sample and then find the average of same type of sample

V. PREPARATION AND TESTING-

- For Unreinforced soil

Material	Quantity
1)Black cotton soil	3kg
2) Water	630ml

- For 0.50% Polypropylene Fiber

Material	Quantity
1)Black cotton soil	3kg
2) water	630ml
3) Polypropylene Fiber	15ml

- For 0.75% Polypropylene Fiber

Material	Quantity
1)Black cotton soil	3kg
2) water	630ml
3) Polypropylene Fiber	22.5ml

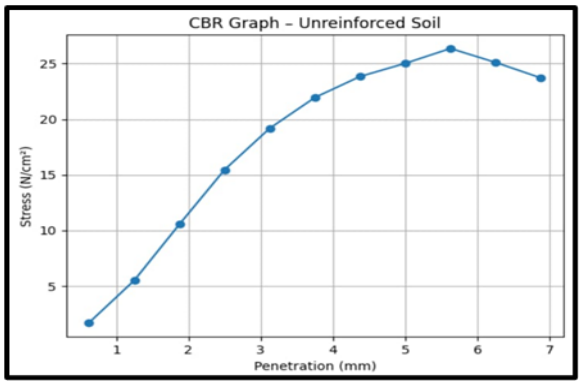
- For 1% Polypropylene Fiber

Material	Quantity
1)Black cotton soil	3kg
2) water	630ml
3) Polypropylene Fiber	30ml

- For 1.25% Polypropylene Fiber

Material	Quantity
1)Black cotton soil	3kg
2) water	630ml
3) Polypropylene Fiber	37.5ml

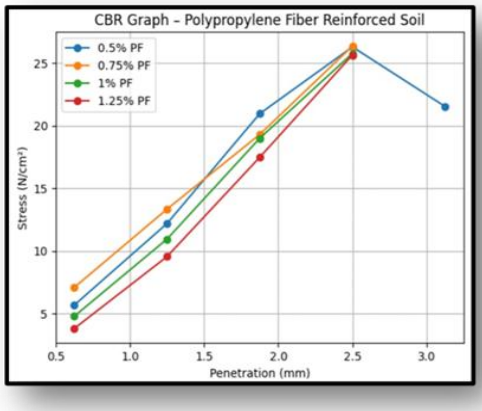
VI. RESULT



a. Unreinforced soil

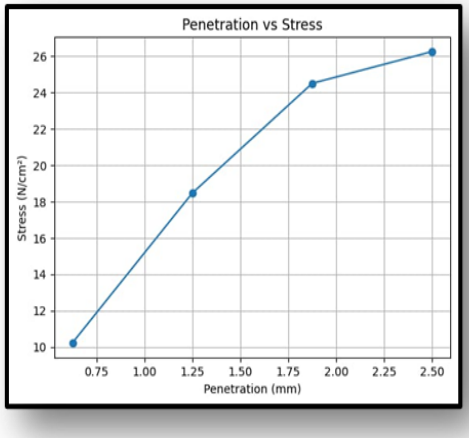
Penetration	Stress (N/cm²)
2.5 mm	15.45
5.625 mm	25.47 (Highest)

b. Polypropylene Fiber



PF %	Highest Stress (N/cm²)	Penetration
0.5% PF	26.29 N/cm²	2.5 mm
0.75% PF	26.36 N/cm²	2.5 mm
1% PF	25.77 N/cm²	2.5 mm
1.25% PF	25.65 N/cm²	2.5 mm

b. Non-Woven Geotextile



Penetration (mm)	Stress (N/cm²)
0.625	10.22
1.25	18.47
1.875	24.51
2.5	26.26

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