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An Experimental Research on Stabilization of Black Cotton soil using Granite dust and Glass fiber

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ABSTRACT: ***Traditional stabilizers like cement, lime and others have been efficient and effective in soil stabilization but their rising cost has led to the research in granite dust and glass fiber to be used as an additional material in soil stabilization. The usage of black cotton soil in construction has continually been a difficult task for the engineers as the structure resting on it will fail without any cracks and damage. In this project an attempt has been made to stabilize the black cotton soil by using granite dust and glass fiber. An experimental study on geotechnical properties of soil had been carried out with the addition of 10%, 15%, 20%, 25% and 30% of granite dust and 1%, 2%, 3%, 4% and 5% of glass fiber to the soil. Results shown that the addition of 25% granite dust and 4% glass fiber in the black cotton soil significantly increases the Geotechnical property of soil.***

Keywords: Stabilization, Clay Soil, Black Cotton Soil, Granite dust, Glass fiber.

Abbreviations: GD, Granite Dust; GF, Glass Fibers; SPT, Standard Proctor Test; OMC, Optimum Moisture Content; MDD, Maximum Dry Density; UCC, Unconfined Compression.

1. INTRODUCTION

The process of improving the strength and durability of soil is known as soil stabilization. The main aim of stabilization is cost reduction and to efficiently use the locally available material. Stabilization is the process of blending and mixing materials with a soil to improve its properties. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation and improve the engineering properties of soil, thus making it more stable. Black cotton soil is weak soils, exhibiting high swell or shrinkage characteristics when exposed to changes in moisture content and hence have been found to be most troublesome from engineering considerations which leads to cracks formation, damage and collapse. In our project the stabilization of black cotton soil is done by adding granite dust and glass fibers as stabilizing agents.

OBJECTIVE

The objective of the project is,

- To determine the Unconfined Compressive strength of black cotton soil with granite dust and glass fibers as stabilizing agent.

- To study the changes in properties of black cotton soil while adding glass fiber and granite dust materials.
- To bring out the effect of granite dust and glass fiber on compaction characteristics and strength of soil.

2. MATERIALS

Black Cotton Soil. Black Cotton Soil is weak soil and it has high plasticity, excessive swelling and shrinkage and has low Strength. Black soils are highly argillaceous and are enormously rich in CaCo3. All the black soils are not expansive soils and all the expansive soils are not black in colour.

Granite Dust. The Granite Dust (GD) is a by-product produced in granite factories while cutting huge granite rocks to the desired shapes. The granite dust is in the form of granules which passes through 4.75mm IS Sieve. The specific Gravity of granite dust is 2.55.

Glass Fiber. The Glass Fibers (GF) used is synthetic fiber produced by chopping continuous Boron Free "E" glass fiber. The length of E glass fiber used is 6mm.

Properties of E-Glass fiber

Density = 2.55 g/cm2
Compressive Strength = 4000 Mpa
Modulus of Elasticity = 70000Mpa
Hardness = 5.5 Mohr Hardness
Bending strength = 45Mpa

3. METHODOLOGY

The Black cotton soil sample used for this study was collected and the preliminary tests were conducted to find the geotechnical properties. The Soil sample is mixed with Granite dust and Glass fiber in different proportions and the tests were carried out to find the optimum percentage of additives to soil.

PROPERTY TESTS

The Tests performed are:

- Sieve Analysis
- Specific Gravity
- Atterberg's limits
- Standard Proctor Compaction test
- Unconfined Compression test

A. Sieve Analysis

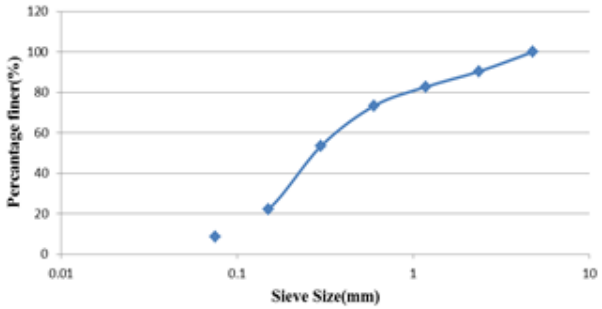

Fig. 1. Particle Size Distribution

Fig. 1 shows the particle size distribution of Black cotton soil sample. For the collected soil sample, the coefficient of uniformity and coefficient of curvature is found to be 4.62 and 1.05 respectively.

B. Specific Gravity

The Specific gravity of Soil sample is found as 2.48 by Pycnometer method.

C. Liquid Limit

Liquid limit is the minimum water content at which the soil completely changes to liquid state. The observation for Soil sample is noted and the graph is plotted between the water content and number of blows, the moisture content corresponding to 25 blows will give the liquid limit.

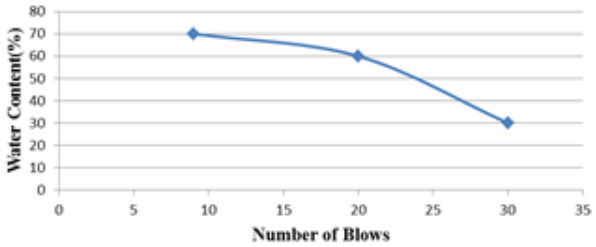

Fig. 2. Liquid Limit

From Fig. 2, the liquid limit of the clay soil is found to be 47.5 %.

D. Plastic Limit

Plastic limit is the minimum water content at which the soil will just begin to crumble when rolled into a thread approximately 3mm in diameter. The plastic limit for the Soil sample is found to be 7.55 %.

E. Compaction Properties

The Standard Proctor Test (SPT) was performed to determine the compaction properties of soil i.e., to find the optimum moisture content (OMC) and maximum dry density of soil (MDD). The test results are shown in Fig. 3.

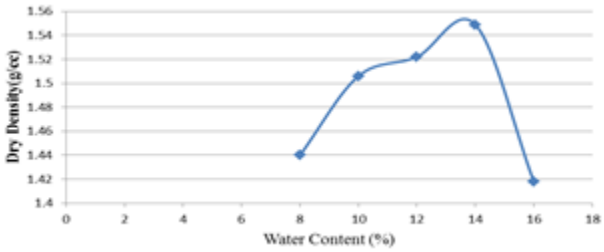

Fig. 3. Compaction curve

From Fig. 3, the Optimum Moisture content and Maximum Dry density of the soil is found to be 14 % and 1.549 g/cm^3.

F. Unconfined Compressive Strength

Fig. 4 shows the Unconfined Compressive (UCC) strength of Soil sample and it is found to be 1.13 kg/cm^2.

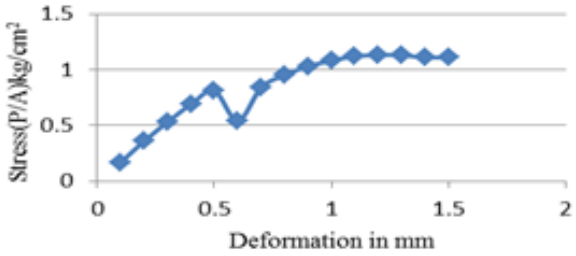

Fig. 3. Unconfined Compressive Strength

PROPORTIONS AND THEIR TEST RESULTS

The Soil Sample is added with various percentages of Granite dust and Glass fiber and Standard proctor Compaction test and Unconfined Compression test is performed to determine the optimum proportion.

A. SPT of soil with various percentage of Granite Dust

The Soil sample is added with various percentage of GD by weight of soil and the SPT was carried out to determine the MDD of Soil Sample with GD.

Si.no	**Sample description**	**OMC (%)**	**MDD (g/cm^3)**
1	Soil	14	1.549
2	Soil + 10% GD	16	1.77
3	Soil + 15% GD	18	1.74
4	Soil + 20% GD	20	1.95
5	Soil + 25% GD	22	2.06
6	Soil + 30% GD	20	1.86

Table. 1. Consolidated SPT results of soil with GD

Table 1 shows the OMC and MDD of the Soil sample with various percentage of GD and the MDD is found to be 2.06 g/cm^3 upon 25% addition of GD by weight of soil.

B. UCC Strength of soil with various percentage of GD

The Soil sample is added with various percentage of GD by weight of soil and the UCC test was carried out to determine the UCC Strength of Soil sample with GD.

Table 2 shows the UCC Strength of the soil with various percentage of GD and the maximum UCC Strength is found to be 1.63 kg/cm^2 upon 25% addition of GD by weight of soil.

Si.no	**Sample description**	**UCC Strength (Kg/cm^2)**
1	Soil	1.13
2	Soil + 10% GD	0.96
3	Soil + 15% GD	1.24
4	Soil + 20% GD	1.39
5	Soil + 25% GD	1.63
6	Soil + 30% GD	1.12

Table. 2. Consolidated UCC test results of soil with GD

C. SPT of soil with 25% GD and various percentage of GF

The Soil sample is added with 25% of GD and various percentage of GF by weight of soil and the SPT was carried out to determine the MDD of Soil sample with 25% GD and GF.

Table 3 shows the OMC and MDD of the Soil sample with 25% GD and various percentage of GF and the MDD is found to be 2.30 g/cm3 upon 25% addition of GD and 4% addition of GF by weight of soil.

Si.no	Sample description	OMC (%)	MDD (g/cm^3)
1	Soil	14	1.549
2	Soil + 25% GD + 1% GF	14	2.17
3	Soil + 25% GD + 2% GF	16	2.01
4	Soil + 25% GD + 3% GF	18	1.99
5	Soil + 25% GD + 4% GF	20	2.30
6	Soil + 25% GD + 5% GF	22	2.18

Table. 3. Consolidated SPT results of soil with 25% GD and GF

D. UCC Strength of soil with 25% GD and various percentage of GF

The Soil sample is added with 25% of GD and various percentage of GF by weight of soil and the UCC test was carried out to determine the UCC Strength of Soil sample with 25% GD and GF.

Table IV shows the UCC Strength of the Soil sample with 25% GD and various percentage of GF and the maximum UCC Strength is found to be 1.72 kg/cm^2 upon 25% addition of GD and 4% addition of GF by weight of soil.

Si.no	Sample description	UCC Strength (Kg/cm2)
1	Soil	1.13
2	Soil + 25% GD + 1% GF	1.05
3	Soil + 25% GD + 2% GF	1.34
4	Soil + 25% GD + 3% GF	1.48
5	Soil + 25% GD + 4% GF	1.72
6	Soil + 25% GD + 5% GF	1.35

Table. 4. Consolidated UCC test results of soil with 25% GD and GF

4. CONCLUSIONS

From the experimental research, the following conclusions are drawn:

- Soil stabilization by using Granite dust and Glass fiber material successfully improves the strength of existing black cotton soil.
- Granite dust and Glass fiber has effectively stabilized the black cotton soil and has led to tremendous increase in unconfined compressive strength of the soil.
- The maximum compressive strength of soil with addition of granite dust and glass fiber is found to be 1.72 kg/cm2 at the addition of 25% of granite dust and 4% of glass fiber.
- The optimum moisture content of stabilized black cotton soil with granite dust and glass fiber is 20%.

Hence, the granite dust and glass fiber is found to influence the index and engineering properties of black cotton soil.

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