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Effect on Engineering Properties of Black Cotton Soil treated with Agricultural and Industrial waste

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Abstract

The aim of the study was to reduce the Swell Percentage and increase the Strength (Unconfined Compressive Strength and California Bearing Ratio) of the Black Cotton Soil (BCS) with the help of agricultural and industrial waste. Experiments were carried out in the given BCS sample by adding (a) Combination of Bagasse Ash and Ground Granulated Blast furnace Slag (GGBS) and (b) Wood Powder. Results indicate that both the additives help in improving the above stated properties.

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Keywords: Black Cotton Soil (BCS); Swell Percentage; Unconfined Compressive Strength; Bagasse Ash; Ground Granulated Blast furnace Slag (GGBS) and Wood Powder.

1. Introduction

BCS is a type of expansive inorganic clayey soil with medium to high compressibility which expands when comes in contact with water and shrinks when the water evaporates. It expands during the rainy season due to intake of water and shrinks during summer season. It possess low strength and undergo excessive volume changes, making their use in the constructions very difficult. Its stabilization is required to mainly improve the above stated properties. A lot of damages occur on structures founded on this type of soil. The damages normally appear as

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cracks in buildings, canal beds and linings, pavements, lifting of water supply pipeline and sewerage lines etc. The properties of the black cotton soils may be altered in many ways viz. Mechanical, thermal, chemical and other means. The main objective of the present investigation is to assess the usefulness of agricultural and industrial waste as a soil admixture so as to improve the engineering properties of soil to make it capable to be used as lower layer of road construction in a better way.

The study is focused on stabilizing black cotton soil with (a) Combination of bagasse ash and Ground Granulated Blast furnace Slag (GGBS) and (b) wood powder. To retrieve the Bagasse Ash, first sugarcane straws are sun dried for twenty days. After that, they are burnt and the ash is collected and finely crushed to obtain the final product-Sugarcane straw ash also known as Bagasse Ash. GGBS was collected from a local Ready mix concrete plant named Patel infrastructure who had bought it from Jindal Steels, Bellary. Wood Powder which is retrieved from hard wood (obtained from local furniture manufacturer) is composed of cellulose (50%), hemicelluloses, lignin, and extractives. High composition of cellulose makes it hydrophilic due to which the swell index of soil may reduce.

The black cotton soil was obtained from Dahej near Bharuch region, Gujarat state, India. The black cotton soil was air dried, pulverized and passed through 425 micron BIS sieve was used for the investigation. Table 1 summarizes the basic properties of the collected soil sample as per IS: 2720 [1] test methods.

Table 1. Summary of basic properties of the soil sample.

Properties	Value
Colour	Grayish black
Specific gravity G_s	2.74
Water content, w (%)	23.1
Fine sand fraction (%)	2.4
Silt size (%)	22.5
Clay size (%)	75.0
Liquid Limit, W_L (%)	63.795
Plastic Limit, W_P (%)	25.48
Plasticity index, I_p	38.315
Shrinkage Limit, W_s (%)	14.05
Free swell index (%)	33.33
Maximum dry density, ρ_{dmax} (kN/m^3)	17.34
Optimum moisture content OMC(%)	14.4
California Bearing Ratio (%)	2.05
Unconfined Compressive Strength, q_u (kN/m^2)	82.92
Soil type as per IS: 1498-1970 [2]	CL

2. Experimental Program

The main objective of the present study is to stabilize the given Black Cotton Soil sample by adding agricultural and industrial waste. These additives were used in different proportions as listed in table 2 to achieve this objective.

Table 2. Combinations of Additive With soil.

Sr. No.	Name of the Sample	Description
1	1	Pure Black Cotton Soil
2	2	Black Cotton Soil + 6%Bagasse Ash + 10%GGBS
3	3	Black Cotton Soil + 9%Bagasse Ash + 10%GGBS
4	4	Black Cotton Soil + 12%Bagasse Ash + 10%GGBS
5	5	Black Cotton Soil + 15%Bagasse Ash + 10%GGBS
6	6	Black Cotton Soil + 6%Bagasse Ash + 15%GGBS
7	7	Black Cotton Soil + 9%Bagasse Ash + 15%GGBS
8	8	Black Cotton Soil + 12%Bagasse Ash + 15%GGBS
9	9	Black Cotton Soil + 15%Bagasse Ash + 15%GGBS
10	10	Black Cotton Soil + 2.5 % Wood Powder
11	11	Black Cotton Soil + 5% Wood Powder
12	12	Black Cotton Soil + 7.5% Wood Powder
13	13	Black Cotton Soil + 10% Wood Powder

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