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Enhancing Index and Strength Properties of Black Cotton Soil Using Eco Friendly Material: GGBS

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***Abstract* - This research investigates the efficiency of utilizing Ground Granulated Blast Furnace Slag (GGBS) for soil stabilization, aiming to improve index and strength properties and address environmental sustainability through waste utilization. Various laboratory tests, including compaction, Atterberg limits, and unconfined compressive strength evaluations, were conducted on soil samples of Hingoli district amended with GGBS at different ratios. The results reveal significant enhancements in engineering properties, indicating the potential of GGBS in soil stabilization practices. The findings underscore the economic and environmental benefits of incorporating GGBS into soil stabilization techniques, offering a sustainable solution for both soil improvement and waste management in construction projects. This study contributes to the advancement of sustainable engineering practices by demonstrating the effectiveness of waste utilization in enhancing soil performance and mitigating environmental impacts.**

Keywords-: GGBS, Atterberg Limit, Hingoli, Unconfined Compressive Strengtht, Speicfic Gravity

1. Introduction

BC soil is characterized with high clay content, water holding capacity, expansiveness, plasticity index, swelling, shrinkage, fertility and due to which, it imposes low bearing capacity. The BC soil is found rich in calcium carbonate, potash, magnesium carbonate and lime with small traces of phosphoric content. Due to its peculiar characteristics, it is unsuitable for the construction purpose. Hence, the soil stabilization technique needs to be adopted to improve its engineering properties to use as a construction material.

The main objective of the project is to investigate the effects of GGBS stabilization on the geotechnical qualities of expansive soils and analyze the findings and give recommendations for best practices. To investigate the impacts of GGBS on soil permeability reduction. As the nature of black cotton soil is that it shrinks in the summer and swells in the rainy season. The structure of the building will move upward and below because of the soil is more flexible

during the wet season, the structure will penetrate deeper into the soil. Using GGBS, we want to improve the soil's bearing capacity and shear strength. In this paper we are going to see the increase in the plastic limit and decrease in the liquid limit by adding GGBS in the black cotton soil.

2. Materials -:

2.1 BC Soil-: Expansive soil, commonly known as black cotton soil due to its dark color and high clay content, poses significant challenges in construction and agriculture. Found in regions with dry climates, such as parts of India, Africa, and the United States, this type of soil is notorious for its ability to swell significantly when wet and shrink when dry. The expansive nature of black cotton soil can lead to serious structural problems in buildings, roads, and other infrastructure, as the soil's volume changes can cause foundations to crack and shift. In agriculture, it can hinder crop growth by impeding root development and water infiltration. Managing black cotton soil requires careful planning and engineering techniques such as moisture control, proper compaction, and the use of additives like lime or cement to stabilize its properties.

2.2 GGBS -: Blast furnace slag is an industrial by-product which is produced in large quantity from iron industries after extraction of iron from iron ores in a blast furnace and poses serious disposal problems and creating environmental hazards. In recent years there is an increase in trend to utilize the Blast furnace slag for geotechnical applications. Stabilization is found to be one of the effective methods to improve the engineering properties of soils. Blast furnace slag can be effectively utilized for civil engineering constructions which will minimize the disposal problems and reduce the environmental hazards. Ground-granulated blast-furnace (GGBS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

3. Objective-:

i. To study about the soil properties and physical feature.
ii. Safe disposal of Industrial waste product.
iii. To check for the suitability of GGBS combination as a stabilizing agent for black cotton soil found in Hingoli, Maharashtra.
iv. To obtain the most efficient proportion of GGBS and soil to be mixed for enhancing Index and Strength properties of BC soil.

4. Experimental Procedure-:

4.1 Atterberg's Limit -:

i. The value of liquid limit is used in classification of the soil and it gives an idea about plasticity of the soil.
ii. It is water content at the boundary between the plastic and semi-solid states of consistency of the soil.

4.2 Proctor Test-:

i. The Proctor is a laboratory test performed to determine the maximum dry density and optimum moisture content of a given soil.
ii. This method also covers determination of relationship between penetration resistance and water content of the compacted soil.

4.3 Unconfined Compressive Strength-:

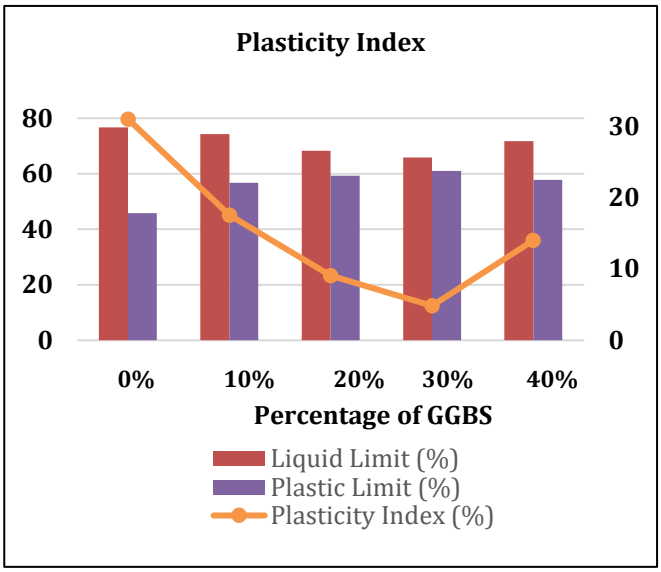
i. Evaluate the stability of structures against loads.
ii. Determine the unconfined compressive strength of clayey soils.

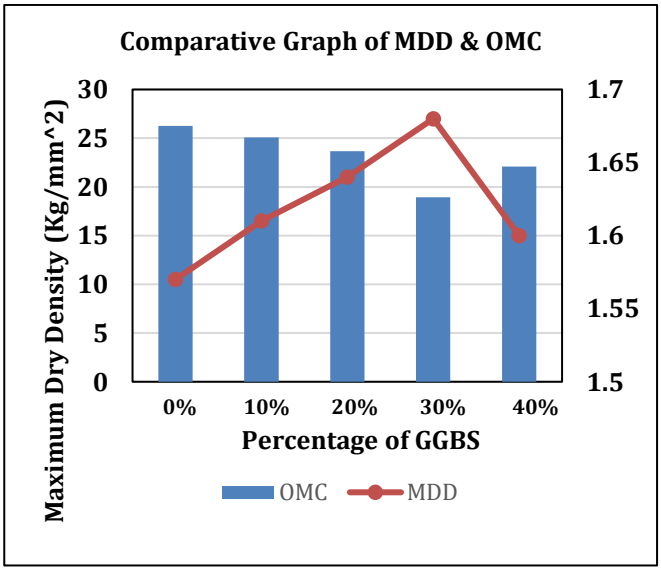
5. Result & Discussion-:

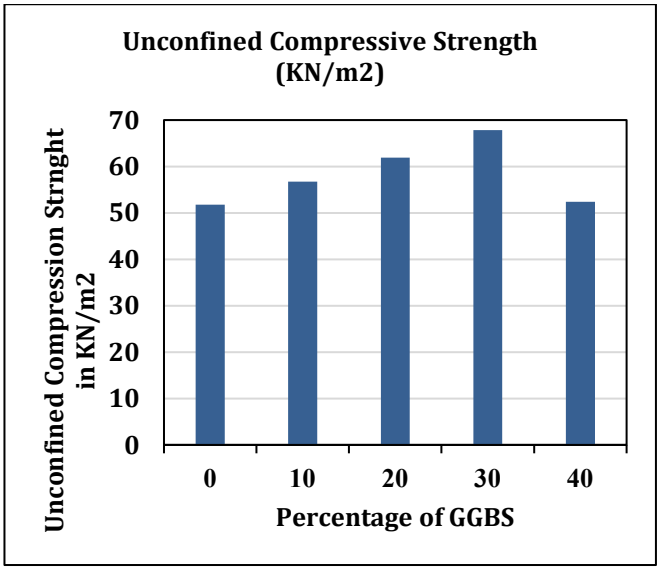
5.1 Result-:

For study we have collected BC Soil from Hingoli, Maharashtra. When the BC Soil is tested for the Atterberg Limit, Proctor Test Unconfined Compressive Strength it shows the following results. The stabilization of BC Soil using Ground Granulated Blast Furnace Slag (GGBS) as a binder was carried out through several tests, including Proctor test, Atterberg's limit, Unconfined Compressive Strength.

Sr. No.	Test Particular	Test Result					Test Method
		Basic	10%	20%	30%	40%	
1.	Liquid Limit	76.75	74.29	68.33	65.61	71.74	IS:2720-5(1985)
2.	Plastic Limit	45.75	56.74	59.27	61.08	57.74	
3.	MDD	1.57	1.61	1.64	1.68	1.6	IS:2720-7(1980)
	OMC	26.25	25.09	23.68	18.94	22.08	
4.	UCS	51.8	56.7	61.9	67.8	52.4	IS:2720-10(1991)







5.2 Discussions-:

i. Finally, this study concluded that for the proportion of (BC soil + 30% GGBS) The following results were obtained:

ii. The liquid limit was decreased by 34.09% and The plastic limit was increased by 34%.

iii. The Plasticity Index of Black Cotton Soil was decreased by 84.41%.

iv. The MDD was increased by 7% and the OMC of Black Cotton Soil was decreased by 27%.

v. The Unconfined Compressive Strength of Black Cotton soil was increased by 31%.

Conclusion-:

In this study, the stabilization of Black Cotton Soil using GGBS. The following key findings were observed:

1. The primary benefits of using these additives for soil stabilization are

a. Cost Savings: because GGBS is typically cheap.

b. Availability: because GGBS sources are easily available across the country from nearby steel plants.

2. Waste management one of the industrial wastes can be done economically.

3. Use of, GGBS as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor black cotton soil.

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