EXPANSIVE SOIL STABILIZED WITH GROUND GRANULATED BLAST FURNACE SLAG

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Abstract:

Due to the spectacular expansion of road infrastructure, soil stabilization has become a key challenge in construction activity in developing nations like India. Stabilization is a method of altering or modifying one or more soil qualities to enhance soil's engineering features and performance and the processing of existing resources to provide low-cost design and construction.

Low plasticity and shear strength are common characteristics of expansive soils. These soils provide major geotechnical and structural engineering issues worldwide, with yearly expenses related to expansive behavior estimated to be billions of dollars. Expansive soils have a significant volume change in response to changes in water content, indicating that they are volumetrically unstable owing to seasonal moisture variations. When they are wet, their strength drops, and their compressibility increases dramatically. By varying the content of ground granulated blast furnace slag, a waste by-product released during iron and steel metals processing, the cohesive natured clayey soil was chosen and checked for compaction properties and other general soil characteristics keeping the above problem in mind.

According to the findings of this investigation, the rise in ggbs concentration causes a considerable decrease in the clay's compressibility properties. Finally, ggbs-stabilized composite soil proved to be a valuable construction material for complicated civil engineering structures such as dirt mounds, earthen dams, and runways. The use of ggbs for soil stabilization is cost-effective and environmentally friendly, as it recycles industrial waste.

Keywords – Soil Stabilization, Expansive Soil, Ground Granulated Blast Furnace Slag (GGBS), Strength Properties.

I. INTRODUCTION

Any sort of land-based structure is only as strong as its basis. As a result, soil is an essential factor in the success of a construction project. Soil is either a component of the foundation or one of the primary building elements. As a result, knowing the engineering qualities of soil is critical for achieving strength and long-term economic viability. Lately, soil stabilization has become a popular technique due to the rising worldwide demand for raw resources, fuel, and infrastructure.

Soil stabilization enhances soil compatibility for specific construction use. When the strength or other attributes of the in-situ soil do not match the desired or needed levels for expected traffic, soil stabilizers can be used to treat the upper several inches of soil or aggregate surfaces of low-volume roads. Chemical, mechanical, thermal, and electrical approaches can modify or stabilize the soil. The modification benefits are often short-term and include things like improved workability (expediting construction and saving time and money). Stabilization usually leads to a longer-term increase in strength.

Expansive soils cause significant damage to engineering structures because they have a solid tendency to alter the volume. Due to the enormous swelling pressure imposed by these soils, lightweight structures are badly harmed. Large-scale discomfort caused by the expanding shrinking nature of expansive soil may be avoided by either blocking soil movement and lowering the swelling pressure of soil or making the structure sufficiently resistant to soil movement harm. Although mechanical compaction, dewatering, and earth reinforcement have increased soil strength, other approaches, such as admixture stabilization, are more favorable. Lime, cement, fly ash, blast furnace slag, and other admixtures are available. Because of its abundant availability and environmental problems associated with its manufacturing, the current stabilization is growing important these days.

Scope and Importance of the Study:

The experiment's goal is to pick an approximate type of soil to create a high degree of compaction and expose the compaction capabilities of clay. Clayey soils are difficult to compact at first, but as the moisture content of the soil increases, compaction becomes much more accessible. The study's findings can be used to generate ideas for using clay soil in various soil stabilizing applications.

The study covers ground granulated blast furnace slag (GGBS) for clay soil stabilization, which is thoroughly blended in various amounts such as 5%, 10%, 15%, 20%, and 25%. The efficacy of the stabilizer will be tested using CBR, Unconfined Compression, and Proctor Tests on the combination.

Soils encountered daily in construction areas have a variety of features and have a significant impact on the construction process. To meet the specifications, soils not suitable for construction need to be treated. The construction's kind, cost, and duration should all be taken into account when selecting an acceptable soil treatment approach. GGBS is a stabilizer becoming a more common method of treating problematic soils.

Objectives of the Study:

The following are the primary goals of our current research:

- The addition of GGBS improves the soil's bearing capacity.
- The strength of the soil varies depending on the amount of water present.
- The effect of GGBS on the soil's CBR value.
- The effect of GGBS on the soil's compressive strength.

II.LITERATURE REVIEW

The need to improve soil engineering qualities has been recognized since the beginning of construction. Many ancient Chinese, Roman, and Inca buildings and roads that remain today used various soil stabilizing techniques. Lime was first utilized as a building material 5,000 years ago when lime and clay were combined and compressed to make bricks used to build the Shensi pyramids in Tibet. The Romans utilized lime to improve the condition of their roads about 2,000 years ago. The Romans also manufactured "pozzolana," a combination of lime and volcanic ash that has the same principles as today's cement. In 1756, John Smeaton used a combination of blue lime and pozzolanic clay to build the Eddy stone lighthouse, unaware that he had found the underlying principle of cement manufacturing. In 1824, Joseph Aspdin was able to patent the method, which he dubbed "Portland cement."

The current period of soil stabilization began in the United States during the 1960s and 1970s when engineers were obliged to investigate alternatives to soil replacement due to a lack of aggregates and petroleum resources. Lime stabilization has been tested in the United States since 1930, but it was not until ten years later that it proved successful. Cement stabilization has been used for almost 65 years, employing procedures and materials that have been tested and verified. Since the 1960s, non-traditional stabilizing products have been under development, with several research articles and projects published on the issue. Despite the abundance of information accessible, the adoption of these stabilizing products will have to be demonstrated over time.

Blast furnace slag has a lengthy history of being used as an industrial by-product in the United States, dating back over 100 years. BFS is made up of non-metallic components that are extracted from iron ore during blast furnace processing. It is mainly made up of calcium silicates and alumina-silicates, and other bases. BFS has unique physical and chemical qualities that make it ideal for various applications in construction and civil engineering projects.

India produces ten million tonnes of blast furnace slag per year as a by-product of the iron and steel industry. The silicates and alumina silicates of lime and other bases make up blast furnace slag. It is a latent hydraulic product that can be activated with everything from lime to alkalies to Portland cement.

METHODOLOGY

Expansive Soil

This study's clay was a typical BC soil acquired from Odalarevu near Amalapuam in the East Godavari District. The soil utilized in the study was dried, crushed, and sieved using a 4.75mm sieve. Table 1 shows the qualities of black cotton soil that were tested based on applicable I.S. code rules.

Table 1 Physical properties of Clayey Soil

Laboratory Experimentation	Value
Specific gravity	2.46
Compaction Parameters	
Maximum Dry Density(g/cc)	1.66
O.M.C. (%)	20
Atterberg's limits	
Liquid limit (%)	27.1
Plastic limit (%)	16.4
Plasticity index(%)	10.7
IS classification	CL
Differential Free Swell (%)	105
CBR- Unsoaked	4.2
Soaked	3.49

Ground Granulated Blast Furnace Slag(GGBS)

The stabilizer, ground granulated blast furnace slag (GGBS), was supplied from the Vizag Steel Plant in Visakhapatnam for this experimental investigation.

Physical Properties of GGBS

Property/Parameter	***Value***
Colour	*Grey*
Size (mm)	*0.003*
pH Value	*8.4*
Atterberg's Limit ***a) Liquid Limit (%)***	*26* *Non -*
Specific Gravity	*2.81*
Compaction Characteristics a)Max. Dry Density (g/cc) *b)Optimum Moisture Content [OMC] (%)*	*1.38*

MIXING RATIOS

The percentages of slag used in this study are 0 percent, 5 percent, 10 percent, 15 percent, 20 percent, and 25 percent, and they are as follows:

A) 0% GGBS + 100% SOIL

B) 5% GGBS + 95 % SOIL

C) 10% GGBS + 90% SOIL

D) 15% GGBS + 85% SOIL

E) 20% GGBS + 80% SOIL

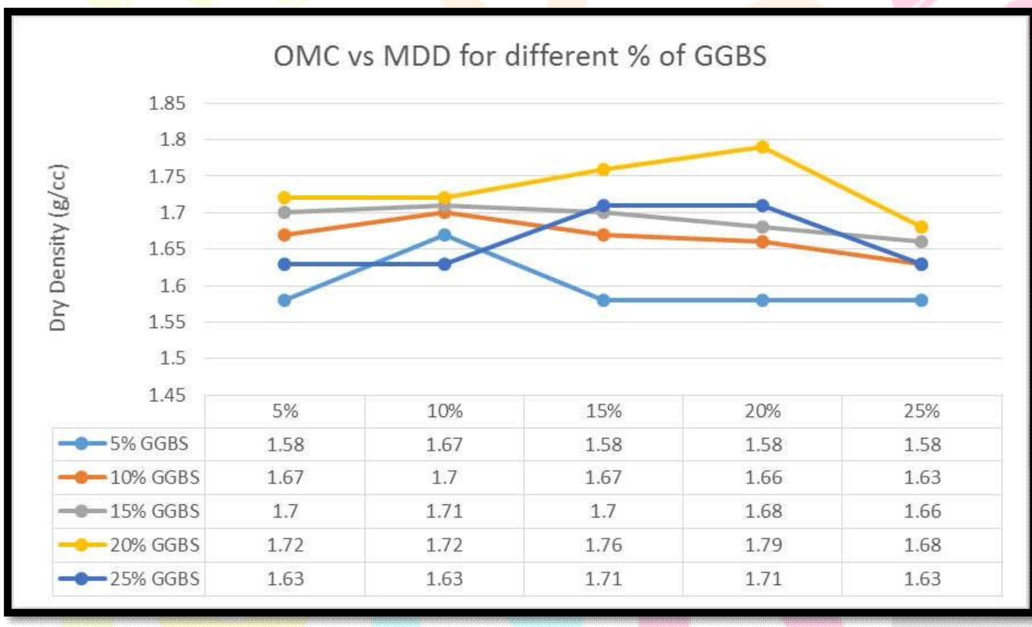
F) 25% GGBS + 75% SOIL

G) 25% GGBS + 75% SOIL

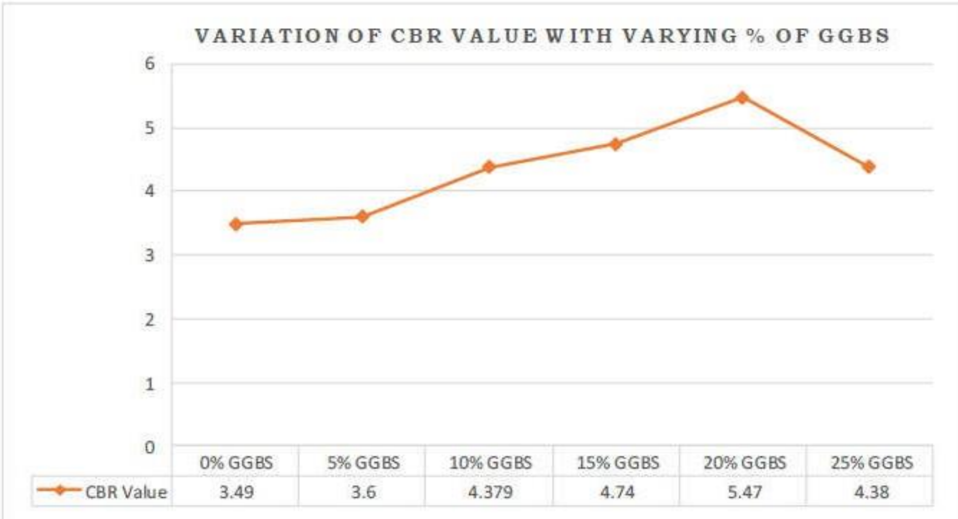
RESULTS AND DISCUSSIONS

Properties of Expansive soil with GGBS:

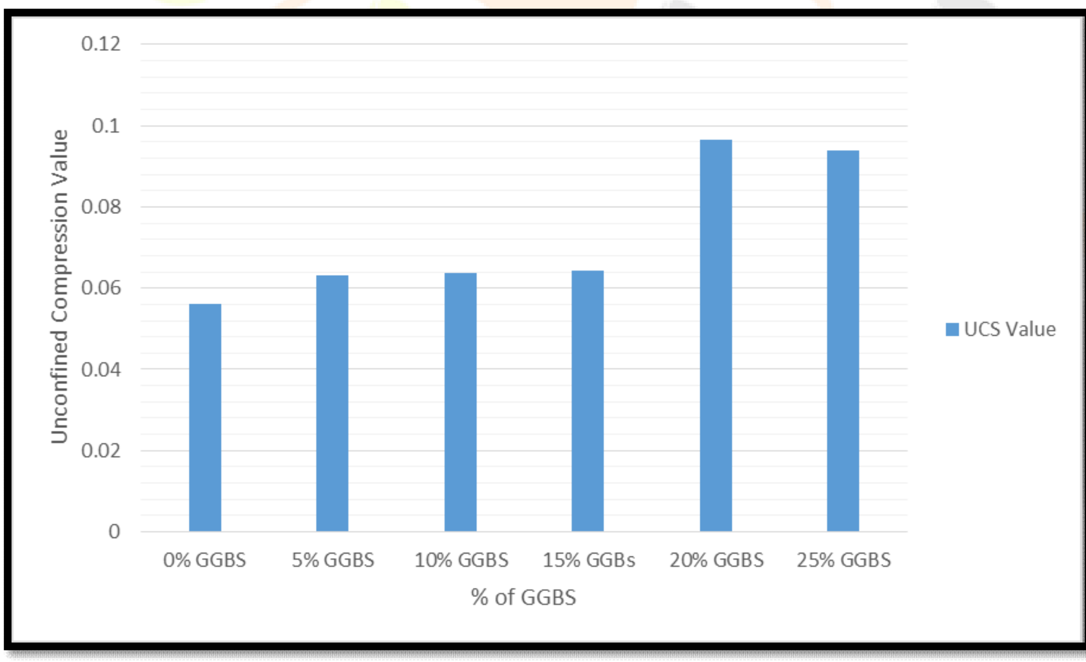
ES+GGBS(%)	OMC(%)	MDD(g/cc)	CBR(%)		UCC(MPa)
			UNSOAKED	SOAKED	
100+0	20	1.66	5.21	3.49	0.0562
95+5	19	1.72	6.01	3.6	0.0631
90+10	18.6	1.722	5.92	4.379	0.0637
85+15	20	1.76	6.23	4.74	0.0643
80+20	20	1.79	7.14	5.47	0.0965
75+25	20	1.79	5.88	4.38	0.0938



Variation of OMC vs. MDD for different % of GGBS



Variation of CBR for different % of GGBS



Variation of UCS Value with varying % of GGBS

CONCLUSIONS

- As the water content grows, the dry density increases as well, up to 10% moisture content, and then steadily falls as the water content increases.
- The greater specific gravity of fine GGBS compared to expansive soil and the quick creation of cemented products by hydration, which increases soil density, account for the rise in maximum dry unit weight as the proportion of GGBS increases.
- It was also noticed that the optimal moisture content dropped when the GGBS level increased.
- The lowest dry density was around 1.58 g/cc for a 95 percent soil and 5% GGBS mixture, while the most excellent dry density was around 1.79 g/cc for an 80 percent soil and 20% GGBS mixture.
- It can also be seen that the soil's CBR Value grew progressively until it reached 20% GGBS concentration, then fell as the GGBS percentage climbed further.
- When the results of the UCS test of the soil sample are compared, it is discovered that the unconfined compressive strength values have increased by 41.7 percent from 0.0562 MPa to 0.0965 MPa.
- Overall, reinforced soil may be a practical ground improvement approach, particularly in engineering projects involving expansive soils.

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