EFFECT OF GGBS ON GEOTECHNICAL PROPERTIES OF INTERMEDIATE COMPRESSIBLE CLAY

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ABSTRACT: ***In today's scenario soil stabilization is the good practiced process for increasing the stability of soil and to reduce the construction cost .The main properties required for the stabilization are strength, volume stability, durability and permeability.The present study aimed at the usage of lime and industrial waste material Ground Granulated Blast Furnace Slag (GGBS) an industrial waste for the purpose of eco-friendly and cost effective soil improvement method. It is also effective in checking the disposal problem of the industrial waste. It is used to improve the properties of clay soil which is easily available material when compare to other stabilization materials. It is low in cost and also the use of the by-product materials for stabilization has environmental and economic benefits. In stabilization the usage of lime and GGBS will attain more strength to the soil, when compared with the usage of lime alone.***
In this study the main soil properties improving are liquid limit, plastic limit, differential free swell, specific gravity, compaction and unconfined compressive strength (UCS). Liquid limit, plastic limit, differential free swell and compaction are tested by increasing the lime percentage added to the soil. Based on the test results of compaction it is known that optimum moisture content and maximum dry density of soil and according to IS code provisions it is know that soil is classified as an intermediate compressible clay soil. Based on this results the various percentages of GGBS is added to the soil and unconfined compressive strength test will be carried out. The testing is done by preparing the samples by blending blast furnace slag with intermediate compressible clay soil with increasing percentage. The results indicated that there is an improvement in geotechnical properties of soil by addition of blast furnace slag and volumetric changes by swelling and shrinkage are observed.

KEY WORDS: Clay Soil, GGBS, Lime, Atterberg' S Limits, Compaction, UCS

INTRODUCTION

Clay soils are characterised by low shear strength, high compressibility and low bearing capacity. These soil experience very large settlement when loaded. The scenario is further worsened by the rapid urbanisation which demands the construction of infrastructures over such weak soil. Stabilisation of soils using conventional chemical binders though popular, introduces harmful gases which pollute the environment. Studies have shown that production of lime and cement results in the huge emission of carbon dioxide that disturbs the ecological balance of nature [Higgins, 2007]. This encourages the use of environmental friendly stabilisers which can substitute these conventional binders todiminish the harmful threats associated with their production. Moreover, ground improvement of soils using lime and cement leads to stabilisation induced cracking due to the exothermic reactions and release of moisture, occurring upon mixing withbinder. Hence the usage of waste based binders or industrial by-products like Fly ash, GGBS can be a better option that serves the primary aim of improving the geotechnical characteristics of the weak soil along with preserving the cost effective strategies and environmental-friendly principles. Ground Granulated Blast furnace Slag (GGBS), a by-product of Iron industry is chemically rich in Calcium and Silica and has properties similar to that of Cement. When GGBS is added to the soil mixture, it reacts with silica in the soil to produce cementitious products resulting in improved strength. An ever increasing demand for steel has led to a peak increase in the GGBS production but the utilisation of the same is less resulting in its disposal to landfills. Efficient utilisation of these materials could, in fact, be a step towards sustainable development.GGBS is a latent hydraulic product and it requires an alkaline environment for the breakdown of Al and Si bonds thereby enhancing its activity in the stabilisation process. The reactions between binders involve Soil-Lime and Soil-Lime-GGBS. The formation of deleterious compounds like ettringites and thaumasites in the lime-stabilisation of sulphate-rich soils were widely researched upon. GGBS-lime mixtures produce strong forces through cementitious reactions which nullify the repulsive nature of ettringites thereby reducing the adverse swelling problems. A huge reduction in the swell using GGBS is also noted. The swell reduction is controlled by cation exchange reactions whereas strength improvement is mainly controlled by pozzolonic reactions.

MATERIALS USED

The soil used in the study is obtained from constructing site from 2m below Ground Level at Vijayawada. Ground Granulated Blast furnace slag used in the study is obtained from Karnataka. The results of the characterization of soil and GGBS are given in Table 1.

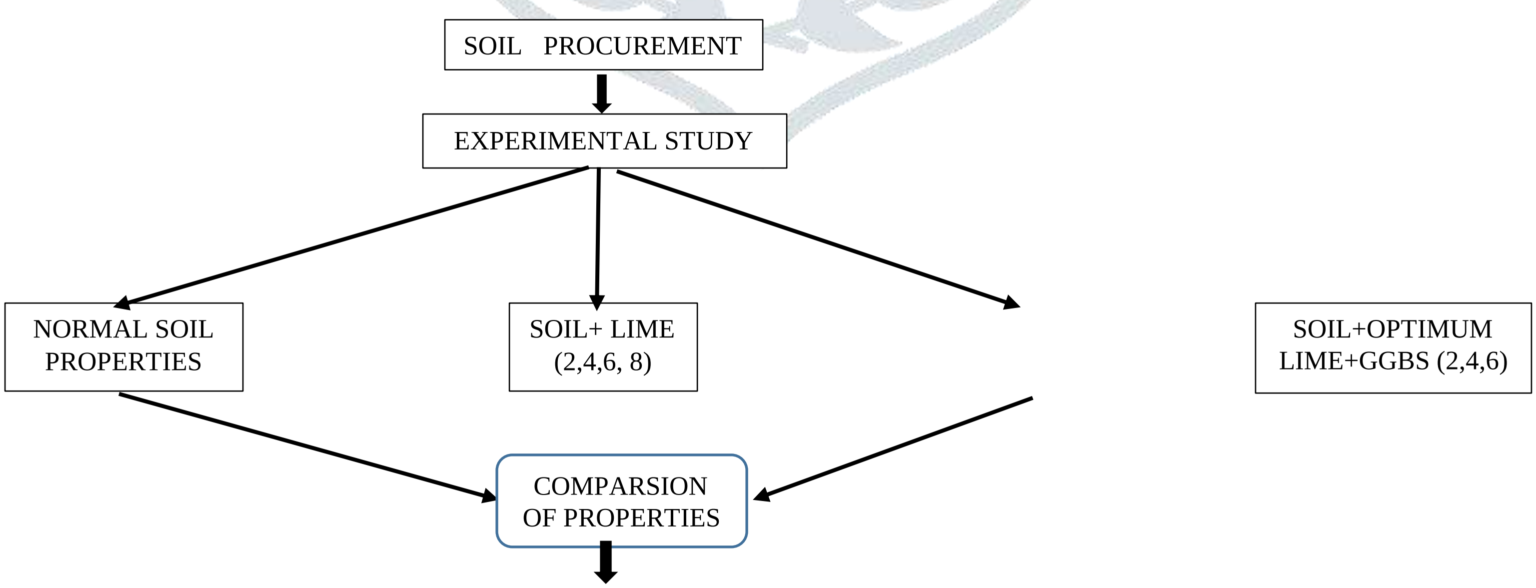
Table 1 Properties of soil

Properties	Soil
Natural Moisture Content,%	33

Specific Gravity		2.2
Grain size distribution	%sand	32
	%silt	30
	%clay	38
Liquid limit,%		50
Plastic limit,%		40
Plasticity index,%		10
Soil Classification		CI
CBR (Soaked)%		0.85
Unconfined Compressive Strength (N/cm^2)		13.56
Optimum Moisture Content %		15.0
Maximum Dry Density(kN/m^3)		16.05
Free Swell Index %		58

METHODOLGY

The soil collected from the site is pulverised and then sieved to conduct various tests. The binder, LIME &GGBS is added in varying percentages; 2, 4, 6, 8(LIME) and 2, 4, 6(GGBS).Atterberg limits, Standard Proctor Tests and unconfined compressive strength tests were conducted to arrive at the optimum GGBS content. Optimum lime content is fixed by conducting UCS test. Different combinations of GGBS and Lime are mixed with soil and UCS is conducted and optimum binder mixture is fixed.



CONCLUSIONS

RESULTS AND DISCUSSIONS

Consistency Characteristics

The plasticity characteristics of the soils are determined by the diffused double layer surrounding the clay particles. A remarkable decrease in the consistency limits is observed on addition of GGBS to the virgin soil. Liquid limit, shows a reduction in the value (Figure.1). A significant decrease in the liquid limit is observed till 6 percent of both LIME and GGBS is added. The addition of the binder to the soil breaks apart the diffused double layer leading to flocculation of particles. This results in the reduced plastic behaviour of the soil shown by a decline in the plasticity index.

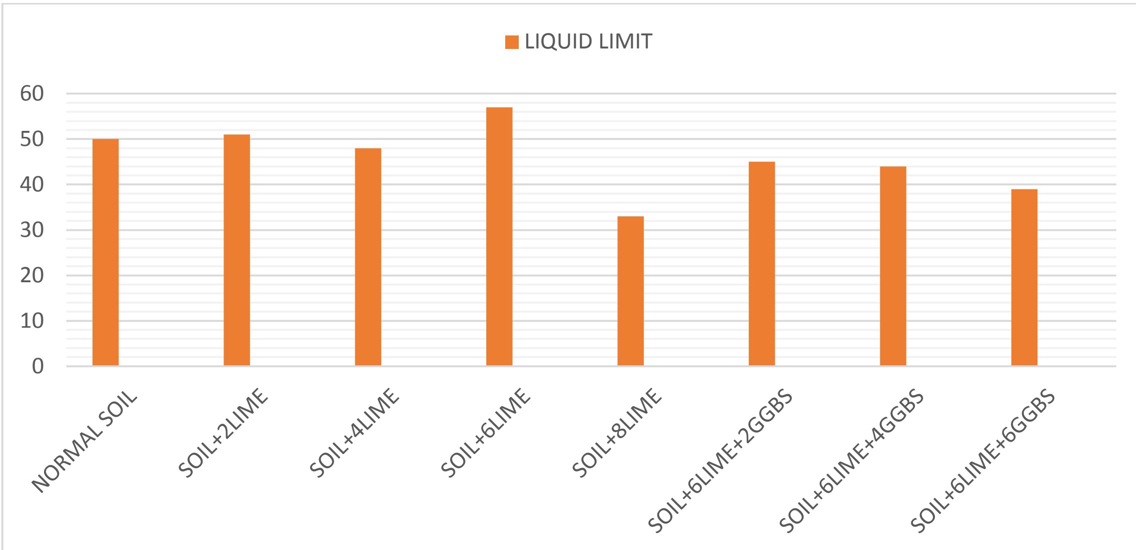


Fig. 1 Showing Variation In Liquid Limit Values

Compaction characteristics

Standard proctor test is conducted on the soil with different percentages of lime and GGBS. The optimum moisture content required for maximum density under a particular comp active effort is obtained from the proctor curve. Optimum moisture content shows a declining trend in its value whereas values of maximum dry density have increased. The decline in the optimum moisture content is due to flocculation of particles which demands smaller percentages of water for full compaction. An increase in the maximum dry density is due to the better binding of the soil particles upon improved gradation of soil-binder mix. Compaction values shows a sharp peak on addition of 6 percent lime and 6 percent GGBS (Figure2). More addition of silt size GGBS particles has led to poor bonding which further decreases the density of the soil.

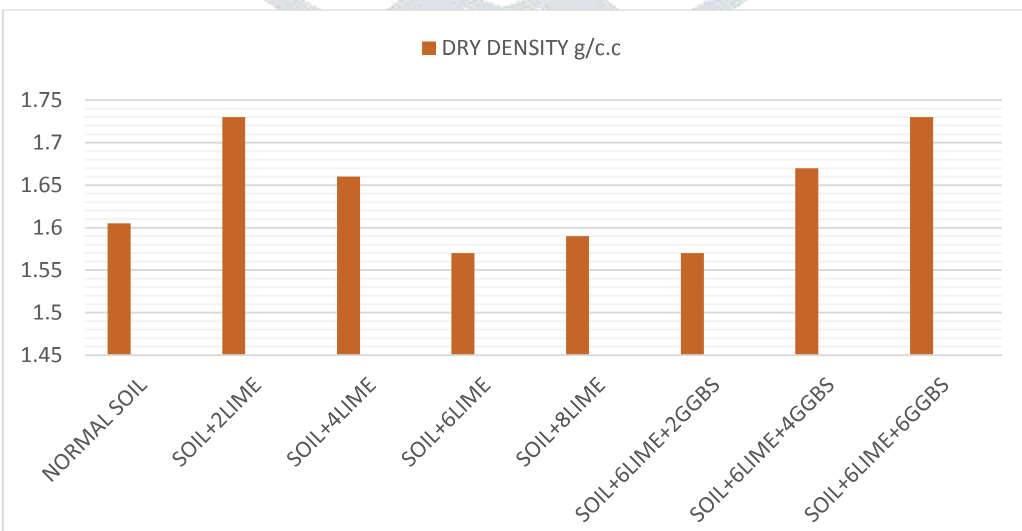


Fig. 2 Showing Variation In Dry Density Values

Unconfined Compressive Strength Test

The strength of clayey soil indicated by unconfined compressive strength increases with the addition of GGBS up to 6 percent and then shows a significant reduction in the value. The low value of optimum binder content is related to the small percentage of clay-fraction present in the soil. The long-term pozzolonic reaction takes sufficient time to occur and hence various curing periods were adopted. The results of unconfined compressive strength on the addition of varying percentages of binder along with curing period. The strength has improved significantly after 7 days of curing period on an addition of 6 percentage of both LIME&GGBS compared to the virgin soil. The alkaline condition necessary to break the Si and Al bonds in the GGBS is generated on the addition of required amount of lime obtained from the above test.

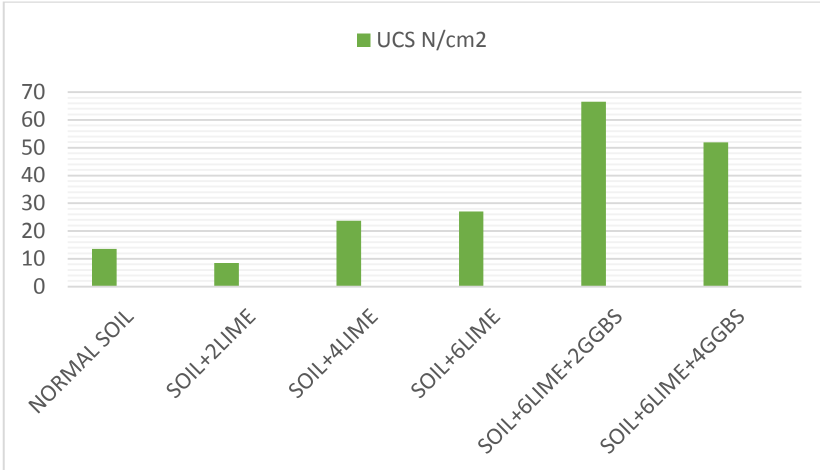


Fig.3 Showing Variation In Stress Values

CONCLUSIONS

By experimental data it can be concluded that the selected soil is classified as clay with Intermediate compressibility (CI).
It is observed that differential free swell value for the clay soil sample adding 6% lime is 91.30%.
The OMC & MDD values for the soil sample by adding 6% lime obtained as OMC = 30% & MDD = 1.25g/cc.
It is concluded that the differential free swell index property can be reduced up to 36% by adding 6% Lime and 6% GGBS.
From the experimental data it can be observed that the CBR value of normal soil is 0.852.
The liquid limit value for the stabilized soil is reduced by adding 6% lime and 6% GGBS to clay up to 36.67%.
The addition of 6% LIME and 6% GGBS to the clay is improving its Unconfined Compressive Strength value up to 13.56 N/cm^2 to 79.69 N/cm^2.
By addition of 6% Lime and 6% GGBS the improvement in MDD values and but no further improvement in OMC.

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