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Heave Control and Strengthening of Expansive Soil using Lime Mixed GGBS Column

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***Abstract*—Expansive soils causes alternate swelling and shrinkage with the change in water content. The experimental studies from heave test conducted with installing lime mixed GGBS columns in the clay bed formed in a laboratory test tank. This technique improves swelling problem as well as low shear strength of soil. Various lime-GGBS combinations are used with different spacing and patterns of column to get an optimum combination of lime GGBS proportion, spacing and pattern of the columns. Strength tests were also conducted with three combinations of GGBS and lime. Effect of one column on the surrounding soil mass was noticed by taking UCC samples from different locations from the column in a test tank. Also effect of curing on strength improvement was also studied. The result from the test shows that the method can be effectively used for reducing heaving problem hence to provide additional strength in an economical manner compared to other methods.**

***Keywords*—GGBS,Lime**

I. INTRODUCTION

Expansive soil is the adobe soil that we hear so much about. These are soils that have a relatively high percentage of clay minerals and are subject to changes in volume with changing moisture conditions. Expansive soils cause damage to buildings, roads and other structures. Soil stabilization can be achieved by two methods; mechanical stabilization and chemical stabilization. Mechanical stabilization can be attained by compaction, rolling, using geotextiles etc. Treatment with "lime" is one of the most traditional treatment method. Together with cement and GGBS, lime is referred to as a "calcium-based treatment". Most commonly used for treating the sub grade on highway construction projects.

The use of blast furnace slag in expansive soil stabilization is a new process in the geotechnical field. Ground-granulated blast-furnace slag (GGBS) is a by-product obtained from iron and steel-making industry. The use of GGBS to the expansive soil stabilization by determining the beneficial effect on the reduction of expansion and improvement of mechanical properties. The GGBS are commonly available in cement production plant. Soil replacement method are difficult in the case of clayey soil because uniform mixing with additives with clayey soil is very difficult. In this aspect we go for certain soil improvement method like column on soft ground.

II. SCOPE AND OBJECTIVE

To study the heave control of expansive soil using GGBS column .Obtain the optimum percentage of lime out of 2%,4%,6%,8%,16% for reducing the heave of expansive soil further from GGBS column.To study the effective spacing of two column for heave controlling(1D,2D,3D).To study the effect of number of columns(1,2,3,4 columns) on the heave reduction of expansive clay bed.Study the effect of lime stabilized GGBS column on the shear strength properties of expansive soil.To study the effect of curing period(3 ,7,14,28 days) on shear strength .The main objective of this research is to To study the heave control of expansive soil using GGBS column.To study the improvement in strength of expansive soil using column

III. MATERIALS USED

In present Study the materials used are soil, GGBS, lime

A. Soil

High expansive clayey soil was used for the study. Expansive nature of soil found out by conducting free swell index test.

Figure 1:lime

B. GGBS

GGBS was collected from m /s JSW cements Amballur, Thrissur. This is off-white colored material. Ground-granulated blast-furnace slag (GGBS or GGBFS) is a by-product obtained from iron and steel-making from a blast furnace in water or steam to produce a glassy product that is then dried and ground into a fine powder.

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Figure 2: GGBS

C. Lime

The lime used in this research is hydrated lime Ca $(OH)_2$

Figure 3: lime

IV. LABORATARY STUDIES

The soil samples prepared for heave test and U.C.C test were prepared.

Heave Test

Computed quantity of air-dried soil, passing through 4.75 mm sieve, is mixed thoroughly. Based on the natural water content in the soil, calculated quantity of water is added to reach 15% moisture content. A test tank of 40 cm diameter and 40 cm height is taken. Sand layer of 1 cm thick has been laid at the bottom of the test tank. An iron casing of size of 30 cm diameter and 50 cm height is coated with oil on both sides and pushed in to the test tank. The gap between tank and casing is filled with sand. The mixed and matured expansive soil is divided into three nearly equal amounts. Each part of the expansive soil is compacted in the space inside of the casing and is compacted to approximately 5 cm thick. The top of the compacted surface is scratched to develop bond between the layers and the total thickness of four layers would be 20 cm. After the soil has been compacted the casing is withdrawn slowly to minimize the disturbance to the clay sub grade.

An open mild steel tube of 3.8 cm diameter and 30 cm height are pushed into the clay bed. The tube is turned for two revolutions to shear the sample off at the bottom. Then the tube is removed from the clay bed. The void created by the mild steel tube is filled with the column material in 3 layers. Each layer compacted with tamping rod.

A mild steel plate of 3 cm diameter is placed on the top of the clay bed.For measuring the vertical displacement of bed a dial gauge is placed on the top of the steel plate. Set dial gauge reading to zero or note the initial reading. Then water is added through the sand drain around the clay bed. When the water is available to the expansive clay bed, it starts absorbing the water results in increase in volume. Since the sides and bottom of the clay bed are fixed boundaries the increase in volume results in increase in height of the clay bed which can be measured in the dial gauge. Since the process of absorbing water by the expansive soil bed is a time consuming, hence the dial gauge reading are to be recorded with respect to time till the swelling rate was decreased. The test was repeated with different column material, number of columns and different spacing of two columns.

IV. RESULTS AND DISCUSSION

Heave test- results

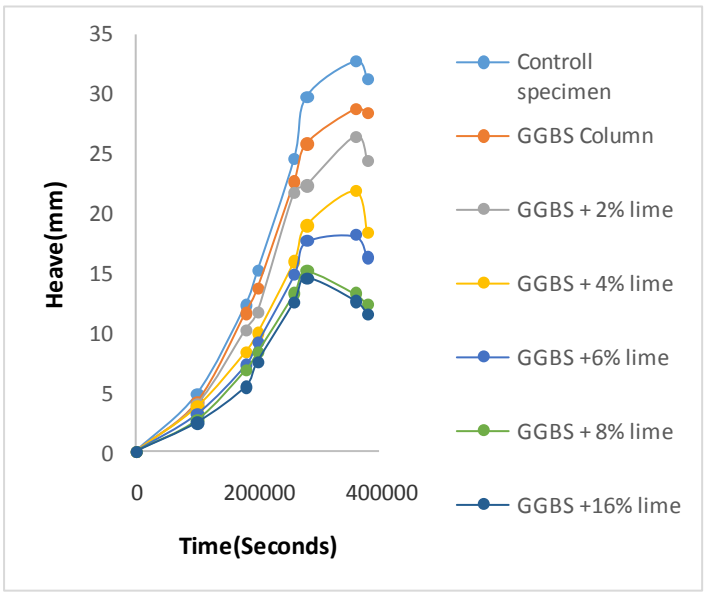

Figure 4: Variation of heave with different combinations of GGBS and lime

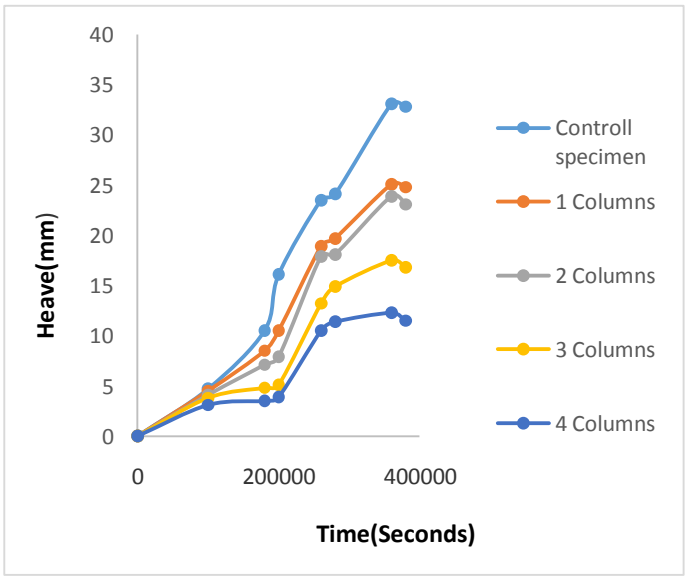

Figure 5: Variation of heave with change in number of columns

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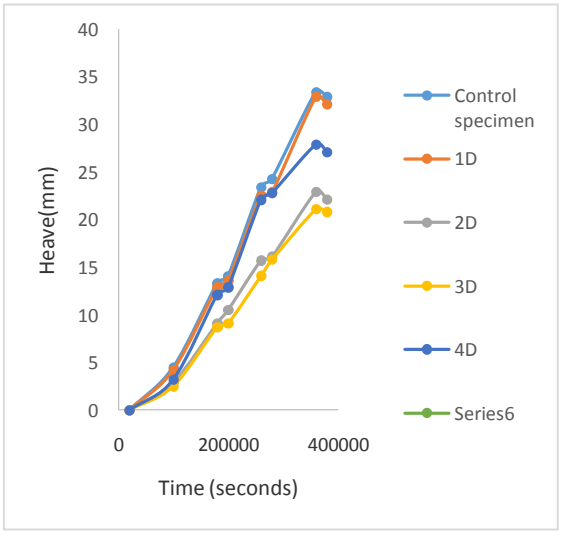

Figure 6: Variation of heave with variation in spacing between two columns.

Strength test-results

Variation in strength of samples by different combinations of ggbs and lime

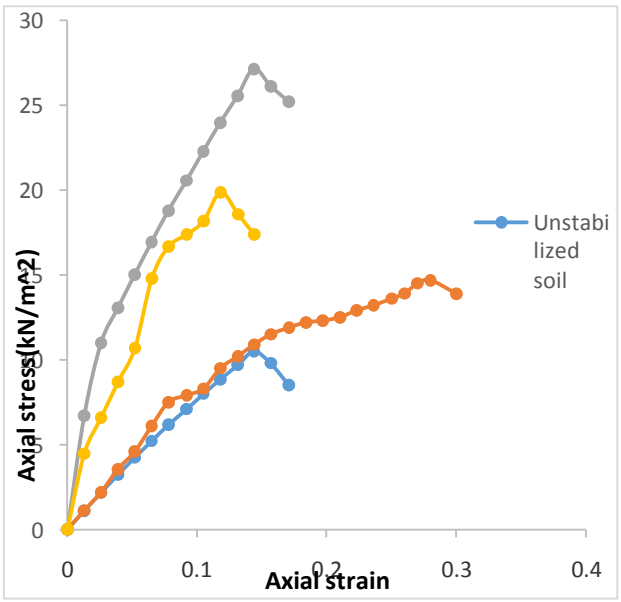

Fig 7: Var iation in strength of samples collected from 1D after three days curing

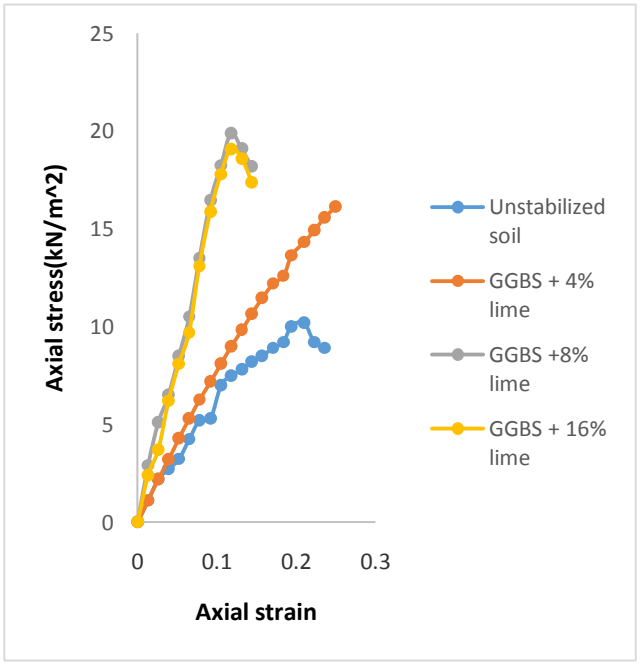

Fig 8: Variation in strength of samples collected from 2D after three days curing

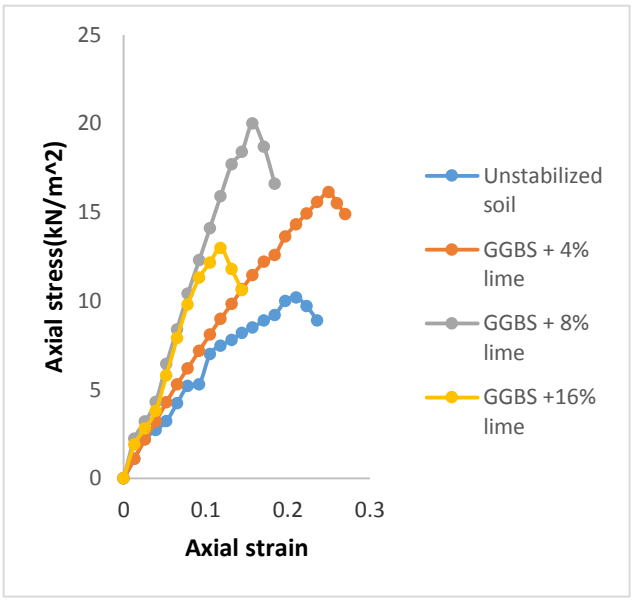

Fig 9: Variation in strength of samples collected from 3D after three days curing

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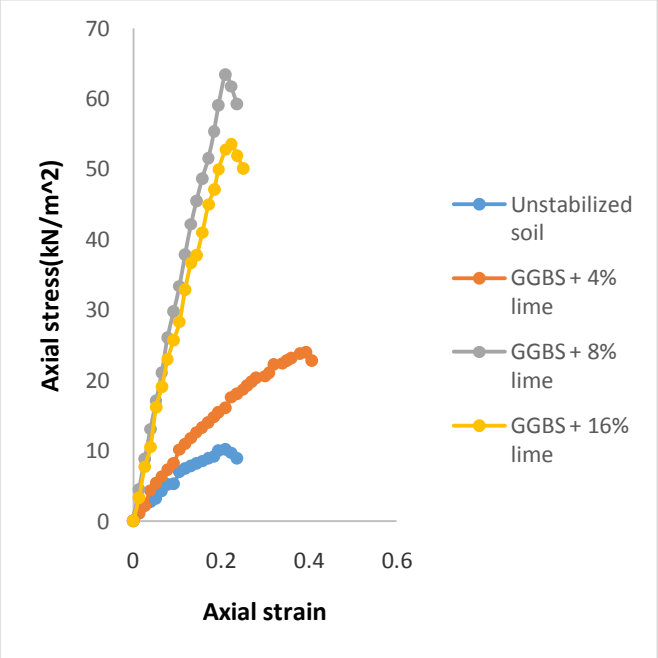

Fig 10: Variation in strength of samples collected from 1D after seven days curing

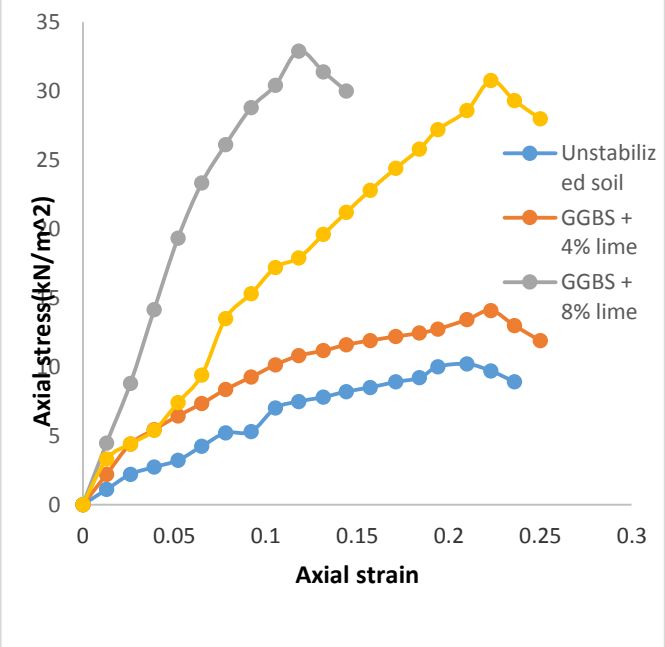

Fig12: Variation in strength of samples collected from 3D after seven days curing

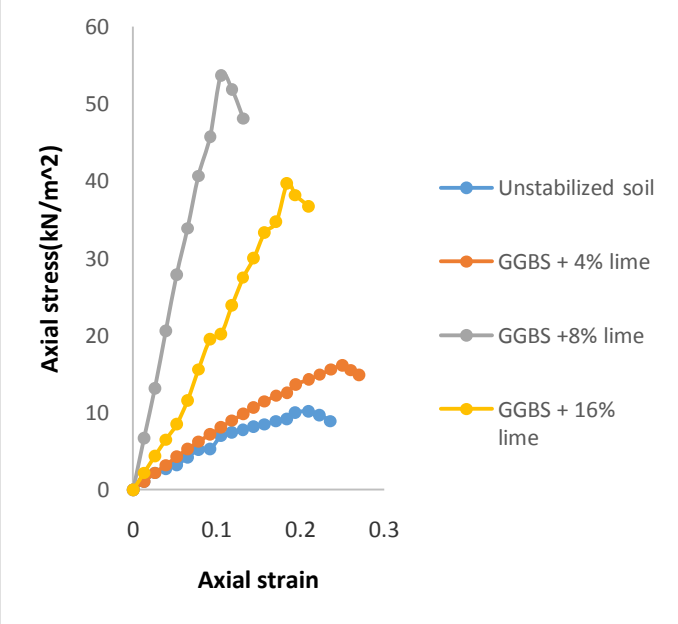

Fig 11: Variation in strength of samples collected from 2D after seven days curing

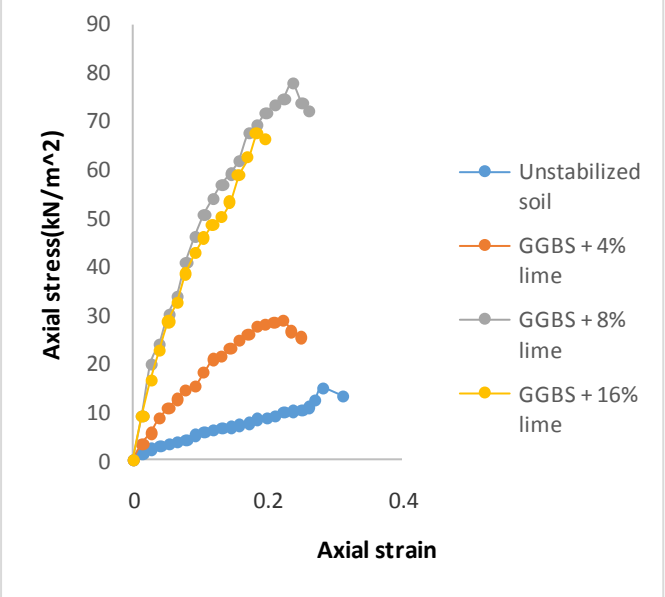

Fig 13: Variation in strength of samples collected from 1D after fourteen days curing

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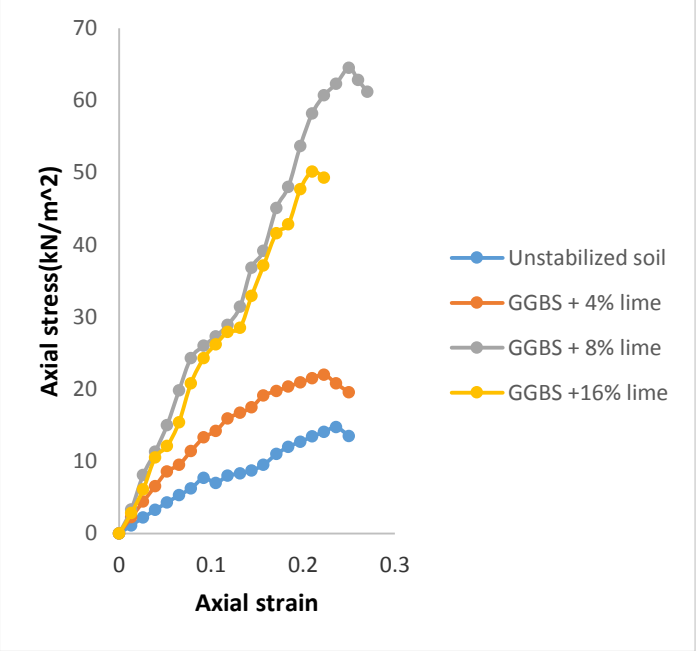

Fig 14:Variation in strength of samples collected from 2D after fourteen days curing

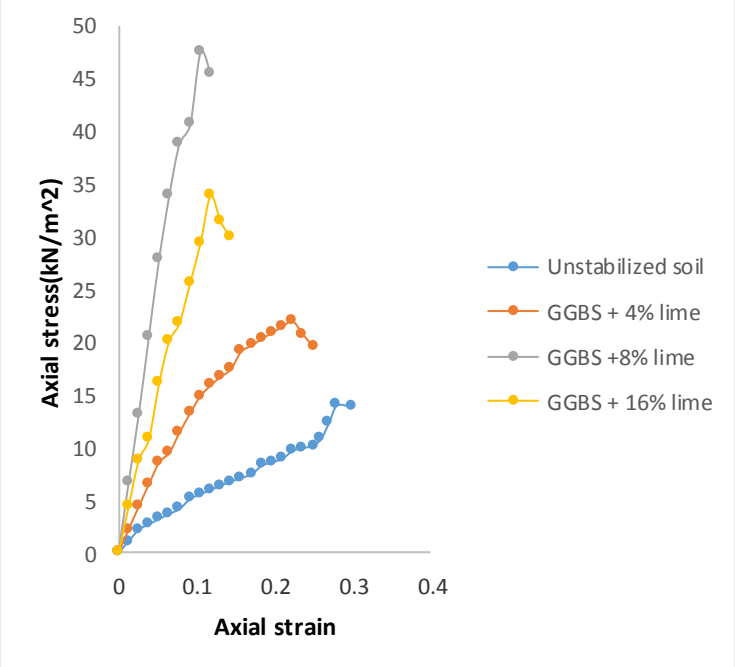

Fig 15: Variation in strength of samples collected from 3D after fourteen days curing

V.CONCLUSION

An experimental program was conducted for solving the main problems associated with expansive soils. Heave test and strength test was conducted in unstabilized soil and soil with GGBS column and lime mixed GGBS column.The heave test results are

- It was observed that by introducing GGBS columns in expansive clay bed, only 18% heave reduction can be attained. Maximum heave of 33 mm reduces to 28 mm by this method. By adding different amount of lime in the GGBS column, further reduction in heave was attained. By analyzing the heave pattern of different combinations, an optimum combination of GGBS with 8% lime content was selected for further tests.
- By using the optimum combination, number of columns are varied. By providing a single column, only 24% in the heave value was obtained. Heave reduces to nearly 30% by providing two columns in the clay bed. From the results, it was clear that as the number of columns increases, heave value continuously reduces and attains a value of 7.1mm using four columns in the clay bed.
- The effective spacing between two columns for getting maximum reduction in the heave value was selected by changing the spacing between two columns. 36 % reduction in the heave value was observed when the columns are placed at a distance of 3D. When the spacing between the columns decreased, the effective zone of GGBS columns reduced and thereby heave reduction was less.

The strength test results are

- From the three combinations of GGBS and lime, an optimum combination of GGBS with 8% lime content was selected for maximum strength improvement. Only 50% improvement in strength was obtained for GGBS with 4% lime content. For the combination of GGBS with 8% and 16% lime content, nearly 80% improvement in strength was obtained. Hence 8% lime content with GGBS was sufficient for the improvement.

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