RESEARCH ARTICLE OPEN ACCESS

# Effect of Non Traditional Additives on Soil Stablization

Shaik Hussain[1], S Priyanka Reddy[2], T Harsha Nandan[3]
[1]Assistant Professor, Gayatri Vidya Parishad Technical Campus, School of Engineering, Department of Civil Engineering, Visakhapatnam
[2]Department of Civil Engineering, Andhra University, Visakhapatnam
[3]Director at GMT Global Impex PTE LTD.

**Abstract**
Long-term performance of pavement structures is significantly impacted by the stability of the underlying soils. In situ sub grades often do not provide the support required to achieve acceptable performance under traffic loading and environmental demands. Though stabilization provides a platform in improving the soil properties greatly, the engineering properties derived from stabilization vary widely due to heterogeneity in soil composition, differences in micro and macro structure among soils, heterogeneity of geologic deposits, and due to differences in physical and chemical interactions between the soil and candidate stabilizers. These tribulations demand the consideration of site-specific treatment options which must be validated through testing of soil-stabilizer mixtures. This report addresses soil treatment stabilizers: Cement and Ground Granulated Blast Furnace Slag (GGBS) as an additive. The report compares engineering properties of unmodified and modified samples. The report presents a straightforward methodology to determine which proportion of stabilizers added to the soil sample is suitable. The mixture design process defines an acceptable amount of stabilizer for the soil in question based on consistency testing, strength testing.

**Keywords:** Stabilization, Non Traditional Additives, Ground Granulated Blast Furnace Slag

## I. INTRODUCTION

The soil that exists in its very natural form, at times might not reciprocate to the desired needs of a particular task. It is for this very purpose that it is essential that the soil is to be modified in accordance to our requirement. Soil stabilization is the alteration of one or more soil properties, by mechanical or chemical means, to create an improved soil material possessing the desired engineering properties. It helps in improving the engineering properties of soils used for pavement base courses, sub base courses, and subgrades by the use of additives which are mixed into the soil to effect the desired improvement. Stabilization can increase the shear strength of a soil and control the shrink-swell properties of a soil, thus improving the load-bearing capacity of a sub-grade to support pavements and foundations and can be used to treat a wide range of sub-grade materials from expansive clays to granular materials. [1]

The most common improvements achieved through stabilization include better soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength. In wet weather, stabilization may also be used to provide a working platform for construction operations.

a) Improved soil characteristics (R-Values, strengths, reduction in plasticity).
b) Allows use of existing on-site soils for structural values.
c) Cost savings up to 50% of traditional methods.
d) Potential reduction of imported base material and pavement sections.
e) Eliminates excavation of old materials and importing of new materials.
f) Significantly reduces construction traffic

Scholen indicated that limited laboratory testing revealed only minor changes in grain size distribution and Atterberg limits for 10 clays gathered from construction projects stabilized with one of the seven chemical stabilization additives, including electrolytes, enzymes, mineral pitch, clay filler, and an acrylic polymer. Thus no particular additive was recommended. Laboratory testing conducted by Scullion on a clay soil stabilized with two acid (ionic) stabilizers revealed no significant reduction in shrink and swell potential or strength improvement for either product.[2] [3]

The objective of present study is to test the additive on soil sample for when added to the soil in the proper quantities, improve some engineering characteristics of the soil such as strength, texture, workability, and plasticity. The traditional additives addressed in particular study include

i. Ground Granulated Blast Furnace Slag
ii. Cement

This study presents and analyses various lab test results of GGBS additive and cement with local soil sample in different proportions. The report describes and compares the basic reactions that occur between these stabilizers and soil that result in stabilization. The scope of present study is limited to studying some of the engineering properties like strength, moisture content, plasticity index and classification of soil on the soil sample in two conditions. They include

i. Unmodified soil sample
ii. Modified soil sample

Modified soil sample include

a. With 2% GGBS additive,
b. With 4% GGBS additive and
c. With 2% cement.

## II. METHOD AND METHODOLOGY

The dry density of each sample is plotted against the different water contents and the curve is plotted between them called as compaction curve. This curve is unique for a soil type, method of compaction and compactive effort. The peak point of compaction curve corresponds to Maximum Dry Density and Optimum Moisture Content.

The moulds of unmodified sample, samples with 2% additive, 4% additive, and 2% cement are prepared of required dimensions (150 mm diameter, 175 mm height). Loading machine with a capacity of at least 5000 kg and equipped with a movable head or base that travels at a uniform rate of 1.25 mm/min. Complete with load indicating device.

Readings on the dial gauge in accordance to load is noted down for every 0.5mm penetration of piston. Readings as such are noted for 0.5mm, 1mm, 1.5mm, 2mm, 2.5mm, 3mm, 5mm, 7.5mm, and 10mm. These readings constitute the UNSOAKED condition. If the sample is Modified, as soon as the mould is prepared it is wrapped in a plastic wrapper or put in a desiccators for 3 days and then left to atmosphere for another 3 days and then tested. The other samples are put in water for 4 days and then taken out and tested. These readings constitute SOAKED conditions. [4] [5]

The values of the failure loads for an unmodified sample, samples with 2% GGBS additive, 4% GGBS additive, 2% Cement are compared.

## III. FIGURES AND TABLES

Table 3.1 Plasticity Index for all the samples

| Sample | Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|---|
| 1) Unmodified sample | 29 | 13.71 | 15.29 |
| 2) 2% GGBS | 33.6 | 13.31 | 20.29 |
| 3) 4% GGBS | 32 | 11.73 | 20.27 |
| 4) 2% Cement | 36.25 | 13.83 | 22.42 |

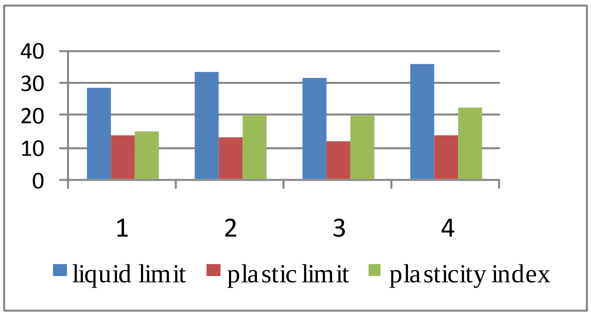


Fig 3.1 Liquid Limit, Plastic Limit and Plasticity Index of samples

Table 3.1 and Fig 3.1 depict the range of Liquid Limit, Plastic Limit and Plasticity Index for the Unmodified sample and the samples Modified by Ground Granulated Blast Furnace Slag and Cement. A graph between Water Content and Number of Blows is plotted and Water content for 25 blows is determined in order to find the Liquid Limit.

Table 3.3 Optimum Moisture Content vs Maximum Dry Density

| Samples | Optimum Moisture Content | Maximum Dry Density |
|---|---|---|
| Unmodified sample | 10.5 | 2.04 |
| With 2% GGBS | 8.7 | 2.06 |
| With 4% GGBS | 11.3 | 2.01 |
| With 2% cement | 8.5 | 2.08 |

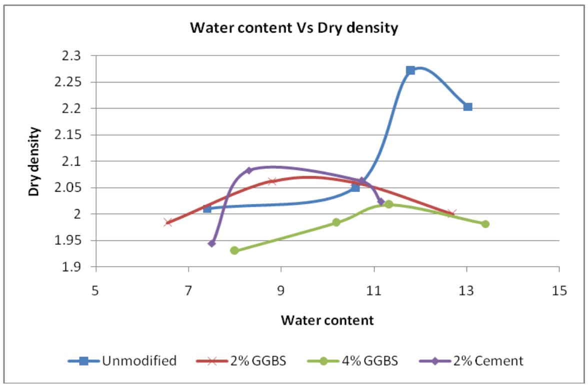


Fig 3.2 Water Content vs Dry Density

Table 3.3 and Fig 3.2 indicate the Optimum moisture content vs Maximum dry density and graph between Water Content vs Dry Density respectively for the various sample of Unmodiied and Modified conditions through Standard Proctor test.

Table 3.4 California Bearing Ratio values of Samples for Unsoaked Condition

| Penetration of plunger in mm | Load dial readings | | | |
|---|---|---|---|---|
| | Unmodified sample | 2% GGBS | 4% GGBS | 2% Cement |
| 0 | 0 | 0 | 0 | 0 |
| 0.5 | 1.5 | 67 | 38 | 45 |
| 1 | 3 | 104 | 68 | 83 |
| 1.5 | 4.5 | 136 | 95 | 113 |
| 2 | 5 | 171 | 123 | 137 |
| 2.5 | 5.5 | 205 | 154 | 158 |
| 3 | 6.5 | 235 | 185 | 177 |
| 5 | 9 | 335 | 285 | 250 |
| 7.5 | 12.5 | 390 | 380 | 337 |
| 10 | 15.5 | 480 | 458 | 415 |

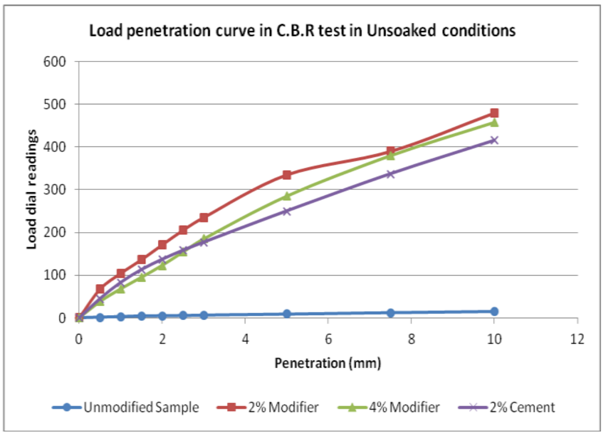


Fig 3.3 Load penetration curve in CBR test in Unsoaked condition

Table 3.5 California Bearing Ratio values of Samples for Soaked Condition

| Penetration of plunger in mm | Load dial readings | | | |
|---|---|---|---|---|
| | Unmodified sample | 2% GGBS | 4% GGBS | 2% Cement |
| 0 | 0 | 0 | 0 | 0 |
| 0.5 | 2 | 42 | 45 | 21 |
| 1 | 2.5 | 75 | 93 | 46 |
| 1.5 | 3 | 97 | 119 | 65 |
| 2 | 3.5 | 110 | 135 | 77 |
| 2.5 | 3.75 | 120 | 142 | 86 |
| 3 | 4 | 126 | 143 | 92 |
| 5 | 5.2 | 148 | | 104 |
| 7.5 | 6 | 172 | | 115 |
| 10 | 7 | 195 | | 133 |

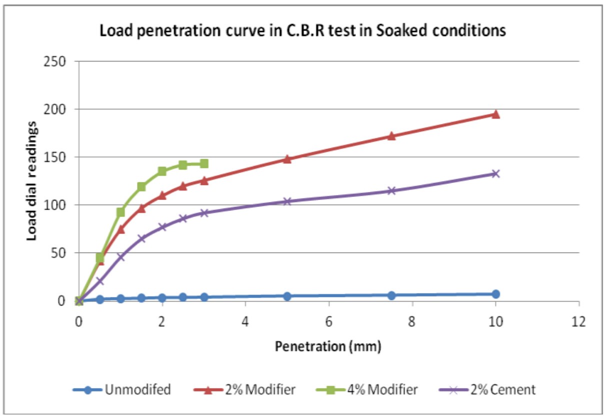


Fig 3.4 Load penetration curve in CBR test in Soaked condition

Tables 3.4 and 3.5 give the readings of Load penetration values of California Bearing Ratio of samples in both Soaked and Unsoaked conditions. Figures 3.3 and 3.4 show the graphical representation of Load penetration curve in CBR test.

Table 3.6 Failure load for the samples at Unconfined Compression

| Sample | Failure load (kN) |
|---|---|
| Unmodified sample | 42 |
| With 2% GGBS | 118 |
| With 4% GGBS | 87 |
| With 2% Cement | 67 |

## IV. CONCLUSIONS AND DISCUSSIONS

For the four different constituents of soil samples (unmodified, 2% additive modified, 4% additive modified, 2% cement modified), the consistency limits for each of the sample has been found. There has not been a significant change in the plastic limit, whereas the liquid limit has been increased by 15.86% when 2% additive is added, increased by 10.34% for 4% modifier and an increase by 25% for an addition of 2% cement.
Thus the plasticity index has been slightly improved when the soil sample is modified, with an increment of maximum 46 % upon the addition of cement in 2% by weight.

This test has been done on all the four combinations of sand additive and sand cement. It has been determined that, for 2% addition of cement, the optimum moisture content has decreased by 19.04%, whereas for 4% additive addition it has been increased by 7.6%.

This test conducted on all the combinations of soil additive and soil cement, is prerequisite in determining the strength of the subgrade. As soon as the modified samples are prepared, they are desiccated for 3 days and left to atmosphere for another 3 days.

After the testing has been done, the sample where 2% additive is added has shown drastic improvement in the CBR values compared to the rest.

After soaking the sample for 2 days, and testing them again, the same 2% added sample predominated the CBR values, whereas the sample where 4% of additive is added has failed after penetration of the piston to the depth of 3mm.

Hence one can unequivocally depict that 2% addition of the additive supplied it more useful than 4% of addition or addition of cement.

It generally is used to determine the strength bearing capacity for the axial loading. The failure load for each of the combinations has been taken and studied. It has been observed that 2% addition of the additive has proved to be more prominent than 4% or 2% cement. The UCS dial gauge readings show that the 2% addition of modifier has increased the UCS by 180%.

## REFERNCES

[1] Arora, "*Soil Mechanics and Foundation engineering*", $7^{th}$ edition, Standard Publishers and Distributors.

[2] Scholen, D. E. (1992). *"Nonstandard stabilizers," Report FHWA-FLP-92-01 1, Federal Highway Administration, Washington, DC.*

[3] Scholen*, D. E. Nonstandard Stabilizers. Report FHWA-FLP-92-011. FHWA, July 1992.*

[4] ASTM: D1883-07 "*Standard Test for CBR (California Bearing Ratio) of Laboratory-Compacted Soils*"

[5] IS:2720( Part 8)-1983 "*Methods of Testing for Soils: Part 8 Determination of Water content-Dry density relation using Heavy Compaction(second revision)*"