# Performance evaluation of Soil Using Bio-Enzyme on Black Cotton and Red Soil

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***Abstract*—Soil stabilization is a crucial step in construction projects, especially in regions with problematic soil conditions. Traditional stabilization methods often involve the use of chemical additives, which can pose environmental and health risks. Terrazyme, a bio-based soil stabilizer, offers a sustainable and eco-friendly alternative. This paper presents an overview of terrazyme soil stabilization, exploring its mechanism of action and its effectiveness in improving soil properties such as strength, compaction, and erosion resistance. Additionally, the paper discusses the application of terrazyme in various construction projects and its compatibility with different soil types and environmental conditions. Case studies demonstrating the successful use of terrazyme in real-world construction scenarios are also reviewed. Terrazyme soil stabilization presents a promising solution for sustainable construction practices, contributing to environmental preservation and long-term infrastructure stability.**

***Key Words*: Black Cotton Soil (BCS), Red Soil (RS), Terrazyme, Atterberg Limit, California Bearing Ratio (CBR), Unconfined Compression Test (UCC)**

## 1. INTRODUCTION

Engineers often face the problem of constructing facilities on or with soils, which do not possess sufficient strength to support the loads imposed upon them either during construction or during the service life of the structure. Vast areas of India consist of Black Cotton Soil (BCS) which has high clay content, low strength and minimal bearing capacity. The poor engineering performance of such soils has forced Engineers device cost effective and eco-friendly methods for improving the engineering properties of poor soils.

Red soil (RS) seems to be an essential soil resource with significant implications for agricultural sustainability and economic prosperity. Red soil can range in color from red through brownish, chocolate, yellow, grey, and even black Red soils have been typically formed by crystalline rocks. They are often poorly developing soils, lacking in nutrients, therefore hard to cultivate due to their limited water carrying capacity. The primary mother rocks include crystalline as well as metamorphic rocks including such acidic granites, gneisses, or even quartzites. As the conventional soil stabilizers like gravel, sand, etc. are depleting and becoming expensive day by day at a very rapid pace, it becomes necessary to look towards for alternative eco-friendly stabilizers as their substitute.

Recently many Bio enzymes have emerged as cost effective stabilizers for soil stabilization. Bio-enzymes catalyze the chemical reactions in the soil surface, which results in increasing the density of soil and thus less water retention. This results in getting the soil stabilized and preparing it for the construction of roads and building. Bio-enzyme treated soil forms a high density, firm, and water-resistant layer as a result of chemical soil stabilization which results in soil surface perfect for road surfacing, dust suppression, and constructing different types of hard surfaces and roads appropriate for construction and transport purposes.

The various tests such as Unconfined Compression Test (UCC), California Bearing Ratio (CBR), and Atterberg limit.

### 1.1 Objective of Study

The objectives of the present laboratory experimented study

- To study change in the properties by stabilizing with Terrazyme
- To optimize use of local materials in the design and construction of roads by improving their engineering properties.
- To optimize the quantity of Terrazyme to to be used as a stabilizing agent.
- To increase the durability, strength and stiffness of soil, improve workability and constructability of the soil and reduce plasticity index.

## 2. LITERATURE REVIEW

Lacuotore and Gonzalez (1995) conducted a comprehensive study of Terrazyme soil stabilizer product and its effectiveness on sub base and sub-grade soils. The reactions of the soil treated with enzyme was observed and recorded and compared to untreated control samples. The variations in properties during the early days but the soil showed improved performance progressively.

Bergmann (2000) concluded from his study on bio enzyme that imparting strength to the soil, bio enzyme requires some clay content. He stated that for successful stabilization of soil minimum 2% clay content is required and 10 to 15% of clay gave good results, compared to 28% of untreated soil CBR after 1, 2, 3, 14 weeks was found as 37, 62, 66 and 100 respectively.

Venika Saini et al (2015) the performance of Bio-Enzymatic soil has been scrutinized. From the results obtained by the tests conducted on the soil, the following observations were made. Bio Enzymes are organic, non-toxic and biodegradable in nature. The end products obtained by usage of Terrazyme are biodegradable in nature and their effect is perpetual. The initial cost for the application of Terrazyme maybe high as compared to other traditional proposals but the benefit of using Terrazyme such as the zero-maintenance cost and long durability makes this approach economically cost-effective.

## 3. MATERIALS

In this the soil sample is collected from DURG, CHHATTISGRARH. Terrazyme is obtained from Avijeet Agencies Chennai.


Fig -1: Terrazyme

## 4. TERRAZYME PROPERTIES

Table -1: Properties of Terrazyme

| IDENTITY | TERRAZYME |
|---|---|
| Hazardous components | None |
| Boiling Point | 212F |
| Melting Point | Liquid |
| Specific gravity | 1.05 |
| Evaporation rate | Same as water |
| Solubility in water | Complete |
| Appearance/Color | Brown |
| Odor | Non- Obnoxious |
| Explosive hazard | None |

## 5. RESULT OBTAINED

CBR Test Result

1. California bearing ratio (CBR) test was done for both unsoaked and soaked conditions.
2. The test was performed by taking different dosages of TerraZyme i.e. taken ($2m^3$ per 200ml, 1.5 $m^3$ per 200ml, $1m^3$ per 200ml and $.5m^3$ per 200ml)
3. Table 2and 3 shows the effect of TerraZyme on the CBR value of soil sample (Unsoaked).
4. Chart 1 and 2 shows the results of Unsoaked CBR respectively.

Table -2: Black Soil

| Terrazyme Dosage | Soaked | Unsoaked |
|---|---|---|
| Untreated Soil | 8.26 | 2.68 |
| 200ml/$2m^3$ | 8.78 | 3.07 |
| 200ml/$1.5m^3$ | 12.04 | 4.02 |
| 200ml/$1m^3$ | 8.52 | 3.47 |
| 200ml/$.5m^3$ | 8.50 | 3.39 |

Table -3: Red Soil

| Terrazyme Dosage | Soaked | Unsoaked |
|---|---|---|
| Untreated Soil | 3.92 | 2.54 |
| 200ml/$2m^3$ | 5.78 | 3.42 |
| 200ml/$1.5m^3$ | 7.53 | 4.56 |
| 200ml/$1m^3$ | 6.10 | 3.68 |

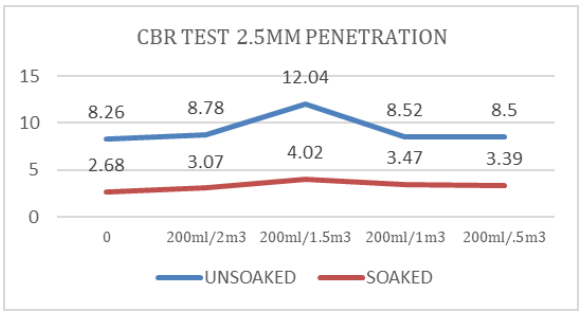


Chart -1: Black Soil

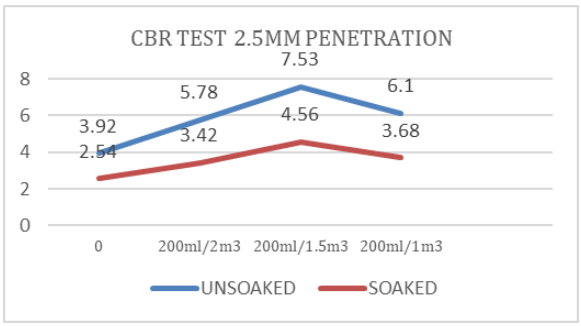


Chart -2: Red Soil

UCS Test Result

1. The materials used for the tests include the Black cotton soil, Red Soil and TerraZyme (Bio-Enzyme).
2. The Black cotton soil obtained from the field was tested in the laboratory for Unconfined Compressive Strength.
3. The Unconfined Compressive Strength was evaluated by stabilization with variable dosages of enzyme taken $2m^3$ per 200ml, 1.5 $m^3$ per 200ml, $1m^3$ per 200ml and $.5m^3$ per 200ml). The test results have been given in table 4 and 5.

Table -4: Black Soil

| Terrazyme Dosage | UCS(KN/$M^2$) |
|---|---|
| Untreated Soil | 147.45 |
| 200ml/$2m^3$ | 149.84 |
| 200ml/1.5$m^3$ | 194.08 |
| 200ml/$1m^3$ | 267.35 |
| 200ml/.5$m^3$ | 232.84 |

Table -5: Red Soil

| Terrazyme Dosage | UCS(KN/$M^2$) |
|---|---|
| Untreated Soil | 168.75 |
| 200ml/$2m^3$ | 230.43 |
| 200ml/1.5$m^3$ | 294.59 |
| 200ml/$1m^3$ | 270.55 |

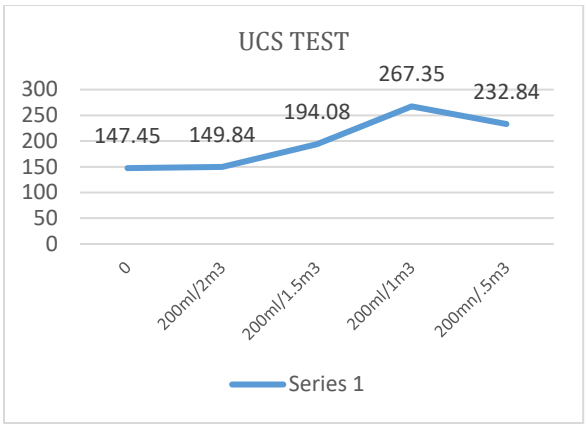


Chart -3: Black Soil

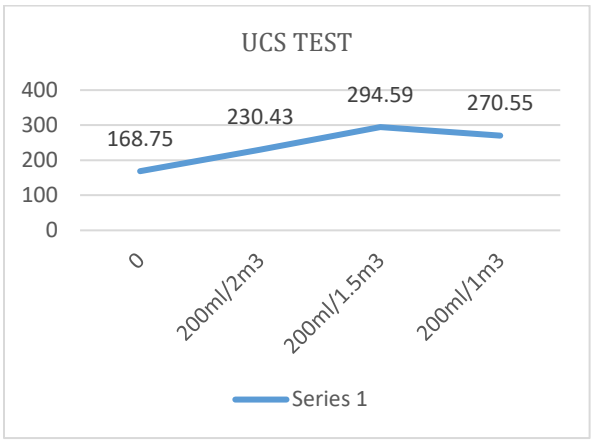


Chart -4: Red Soil

Atterberg Limit Test

1. These tests are performed to determine liquid limit, plastic limit and the plasticity of cohesive soil in order to characterize its condition by water content.
2. The effect of Bioenzyme at different dosage on index properties (LL., P.L. and P.I.) of Black Cotton soil from Durg, from Chhattisgarh respectively and red soil from Durg have been presented in table no. 6 and 7.
3. The enzyme treated soil sample's consistency limits were tested immediately after the mixing.

Table -6: Red Soil

| Terrazyme Dosage | Liquid Limit | Plastic Limit | Plasticity Index" |
|---|---|---|---|
| Untreated Soil | 39.84 | 17.35 | 22.49 |
| 200ml/$2m^3$ | 39.21 | 17.26 | 21.95 |
| 200ml/1.5$m^3$ | 38.04 | 16.54 | 21.5 |
| 200ml/$1m^3$ | 37.65 | 16.42 | 21.23 |

Table -7: Black Soil

| Terrazyme Dosage | Liquid Limit | | Plastic Limit | | Plasticity Index" | |
|---|---|---|---|---|---|---|
| Curing Period | 0D | 7D | 0D | 7D | 0D | 7D |
| Untreated Soil | 56 | 56 | 23.9 | 23.9 | 32.1 | 32.1 |
| 200ml/2m$^3$ | 56 | 55 | 23.9 | 22.57 | 32.1 | 32.7 |
| 200ml/2m$^3$ | 56 | 54.6 | 23.9 | 21.90 | 32.1 | 31.96 |
| 200ml/2m$^3$ | 56 | 52.54 | 23.9 | 20.58 | 32.1 | 31.96 |
| 200ml/2m$^3$ | 56 | 52.40 | 23.9 | 20.54 | 32.1 | 31.86 |

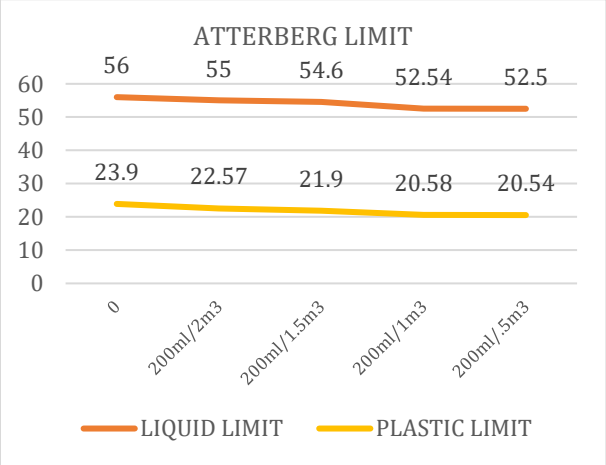


Chart -5: Black Soil

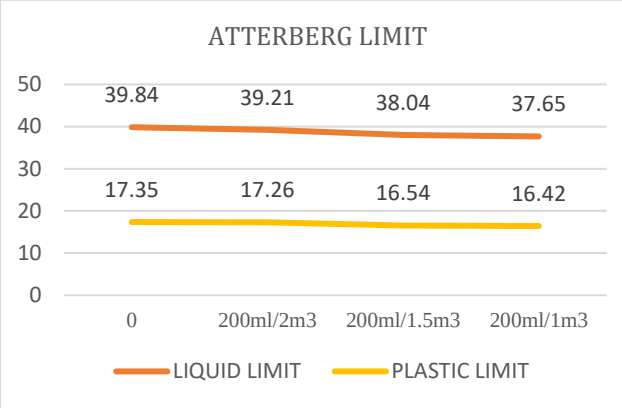


Chart -6: Red Soil

## 3. CONCLUSIONS

The suitability of TerraZyme for the modification of Geotechnical properties of expansive and non-expansive soils is concluded by studying the effect of TerraZyme on the index and engineering properties of black cotton soil and red earth. According to the data and results acquired from the experimental work on soil stability investigation with different doses of Terrazyme proportion (.5m3/200ml, 1.0m3 /per 200ml, 1.5m3/ per 200ml and 2.0m3/per 200ml) the following conclusion can be drawn.

1. The material to be used is eco-friendly and saves a lot of resources. Thus, the product so formed after the application of Terrazyme is biodegradable in nature and the affect is permanent.
2. Stabilization of the soil using Terrazyme resulted in significant increase in the Unconfined Compressive Strength of the Black Cotton Soil upto 80%.adn Red soil upto 75%
3. The optimum dosage of Terrazyme for improvement of UCS of Black Cotton soil is 200ml/per 1m$^3$ of soil. And Red Soil is 200ml/per 1.5m$^3$.
4. The addition of the TerraZyme to the soil reduces the clay content and thus increases in the percentage of coarser particles, reduces the Liquid limit and plastic limit of unmodified soil. The Plastic limit of soil goes on decrease from 23.9 % to 20.54%, Liquid limit of soil goes on decreasing from 56% to 52.5% and Plasticity index of soil decreases from 32.1% to 31.96% when TerraZyme is increased from 0 to 0.4 ml irrespective of the percentage of addition of TerraZyme Bioenzyme (TerraZyme) stabilization has shown good improvements in engineering properties of both black cotton soil and red soil.
5. Average of CBR value of Black cotton soil without terrazym is 8.26 for soaked condition and 2.68for unsoaked and CBR value of BC Soil with optimal dosage of terrazyme (200ml/1.5m$^{3)}$ is 12.04 for soaked condition and 4.02 for unoaked condition
6. Average of CBR value Red soil without terrazyme is 2.54 for soaked condition and 3.92 unsoaked and cbr value of red soil with optimal dosage of terrazyme.(200ml/1.5m$^{3)}$ is 4.56 for soaked condition and 7.53 for unsoaked condition

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