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## Stabilization of Soil Using Acidic Bio-Enzyme (Terrazyme)

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**ABSTRACT:** The present study provides an effective technique of ground improvement using bio-enzyme. Bio Enzymes are basically organic solutions. They are produced by the chemical changes of fruit extracts, vegetable, sugar and water caused due to fermentation. In this study, a bio-enzyme named Terrazyme is used for improving the Unconfined Compressive Strength (UCS) and California bearing ratio (CBR) value in soil and they are further been compared with the virgin soil's CBR and UCS value. Terrazyme is natural, non-toxic and liquid enzyme. Sugarcane extracts are been fermented for Terrazyme production. It can be used as a soil stabilizer. It can also improve the rate of stabilization of soil in various constructions. The Terrazyme is acidic in nature. The engineering properties of the soil show improvement upon the application of this bio-enzyme. Its amount of dose and type of soil available defines the extent of improvement in the soil sample. The dosage of Terrazyme is taken as 200ml/1.5m<sup>3</sup>, 200ml/1m<sup>3</sup> and 200ml/0.5m<sup>3</sup> in the soil sample at the Optimum Moisture Content and results are been analysed. A significant increase is found in UCS and CBR value of the soil sample as the dosage of Terrazyme has been increased.

The effects of Terrazyme has given very positive results, is very effective and economically efficient. Also, this enzyme is environment-friendly.

**KEYWORDS:** Bio-enzyme, Stabilization, Terrazyme, Unconfined Compressive Strength, California Bearing Ratio.

### I. INTRODUCTION

#### 1.1 General

Treating the soil in order to improve gardening applications acted as a foundation for the idea of using the enzyme in the application of soil stabilization. A higher adaptation to the process produced a material that was suitable for the stabilization of poor ground for road traffic, construction etc. The enzymes increase the wetting and bonding capacity of the soil particles when added to a soil.

An enzyme, as per its definition is an organic catalyst that speeds up a chemical reaction without becoming a part of the end product as the otherwise would happen at the much slower rate. A very small amount of bio-enzyme is required for soil stabilization as neither have they become the part of end product nor they're consumed by the reaction. If conditions are contributory to the reaction then only this organic molecule catalyses a chemical reaction. For an enzyme to be workable in a soil, it needs to have movability so as to reach the site of action. This movability of the enzyme molecules is attained with the help of the pore fluid that is already present in the soil. This pore fluid also provides the specific soil science and time are needed by the enzyme to diffusion into the reaction site. Until and unless there are no more reactions to catalyse, an enzyme will be operational in the soil.

The enzyme is customized in such a manner that it advances a chemical reaction within or between other molecules. However, there's no effect on enzymes because of these reactions. The host for other molecules, Bio enzyme, greatly enhances the rate of normal chemical and physical reactions. The soil materials become more easily wet and more densely compacted with the effect of bio-enzyme. It creates a more permanent structure by improving the chemical bonding between soil particles that are more resistant to weathering, water penetration and wear and tear. Enzyme's role mainly emphasizes strength, performance and higher resistance towards deformation. Its application requires

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dilution in water before it can be applied to the soil. The use of Terrazyme enhances the load bearing capacity of the soil. They have the ability to change the connective substance and texture of the soil so that after compaction the soil loses its ability to reabsorb water. Also, the mechanical benefits of compaction are not lost even after water is reapplied to the newly compacted soil. Hence, the load-bearing capacity of the soil is enhanced by the application of the enzyme. Also, these changes in the soil are perpetual. So it plays the crucial role in the compaction and stabilization of soil. The Terrazyme is a biodegradable product.

## 1.2 The objective of the study

1. To characterize the effect of Terrazyme on the soil.
2. To study the effect of varying dosages of Terrazyme on strength and other characteristics of identified soils.
3. To find out optimum Terrazyme dosage required for selected soils.
4. To compare the results obtained from the enzyme with virgin soil.

## 1.3 Scope of Study

In this study, one Bio-Enzyme was considered which was acidic in nature. Three dosages of enzyme were prepared as follows: 200ml/1.5m<sup>3</sup>, 200ml/1m<sup>3</sup> and 200ml/0.5m<sup>3</sup>. Another sample of virgin soil is also been taken. The dry densities and optimum moisture content of these soils are determined. For the improvement of the soil properties, each soil is treated with different dosages of Bio-enzyme and the properties were evaluated after subjecting the samples to 0, 7, 14, 21, 28 days curing in desiccators.

## II. LITERATURE REVIEW

- Sandeep Panchal et al (2017): In this study different type of geotechnical tests were performed on the soil sample under study with and without enzyme. Consistency limits, dry density and CBR values of a local soil sample by mixing different dosages of Terrazyme with different curing periods showed great improvement. The duration of treating bio-enzyme on the local soil played an important role in the improvement of strength. The CBR value with the third dosage having two week curing period showed great outcome and percentage increase as compared to local soil sample without Terrazyme is 131.49%.
- Venika Saini et al (2015): In this work, 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.
- Joydeep Sen et al (2015): In order to use this technology for low volume roads, the properties of soil modified with the bio-enzyme have been studied. Based on results from the testing done on soil treated with bio-enzyme, field trials were carried out using bio-enzyme on some of the roads in India. Also, it was found that in the dearth of granular subgrades, bio-enzyme treated soil surfaces can be used to realize the pavement design requirement, provided with a thin bituminous surfacing. It was also found that after adaptation of the IRC method for soil CBR, the thickness of bio-enzyme stabilized soil reduces around 25 to 40 per cent.
- Puneet Agarwal et al (2017): A significant increase in Unconfined Compressive Strength (U.C.S), up to 200% was observed after a soil sample was treated with bio-enzyme namely Terrazyme. The treating duration played a pivotal role in the outcome and soil treated for 7 days with the bio-enzyme gave higher strength.

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- PriyankaShaka et al (2016): Based on IS classification, red soil is classified as Clayey sand and the black cotton soil as highly compressible clay. Laboratory testing showed that decrease in liquid limit and plasticity index was observed with the increase in dosages of Terrazyme. Also, the Terrazyme dosage of 200ml/0.75m<sup>3</sup> of dry soil garnered the best result. Further increase in the dosage does not alter the plasticity characteristics of soils substantially. CBR Value of the soil sample was increased by 2.75%. 3.345%. 3.47% and 3.56% by application of the bio-enzyme with a dosage of 200ml/0.75m<sup>3</sup>. With further increase in the dosage of the enzyme, no substantial increase was recorded.

## III. EXPERIMENTAL SETUP

### 3.1 General

The sample was locally available from a construction site in sector 63, Noida. It was extracted from a site under construction. Hence the sample was taken from the depth of 2metre. Around 50kg sample was taken to the laboratory. The sample contained 0% gravels.

### 3.2 Bio-Enzymes

TerraZyme was the preferred Bio-Enzyme in the project. Terrazyme is acidic in nature and was imported from the USA under the client surveillance lab situated in Chennai.

### 3.3 Physical and Chemical properties of Enzymes

The properties of enzymes are shown in Table 3.1

**Table 3.1:**Physical and chemical properties of enzymes.

Item	TERRAZYME
Water	>50%
Alcohols, C12–C16, ethoxylated	<30%
Fermented vegetable extract	<20%
Specific gravity	1.0
pH (neat)	2.8 to 3.5
Boiling point	>100%

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### 3.4 Dosages of Bio-enzymes in soil

The dosages are shown in Table 3.2

**Table 3.2:** Dosages of Enzymes in soil (TERRAZYME)

S No.	Dosage	ml/ kg	ml/5kg
1	200ml/1.5m <sup>3</sup>	0.06 ml/kg	0.3 ml/5kg
2	200ml/1m <sup>3</sup>	0.1 ml/kg	0.5 ml/5kg
3	200ml/0.5m <sup>3</sup>	0.2 ml/kg	1 ml/5kg

### 3.5 Test to be conducted on all the soil samples

The test to be conducted on virgin, terrazyme treated soil are as shown below

Test to be conducted on soil samples

- Atterberg's Limit
- California Bearing Ratio Test
- Unconfined Compressive Strength

Apart from the above tests, the virgin soil also tested for the following

- Grain Size Distribution
- Moisture Content
- Specific Gravity (by Density Bottle)

### 3.6 General Characteristics of soil

**Table 3.3:** General Characteristics of soil

1) S. No	Properties	Values
1	Grain Size Distribution	Gravel 0% Sand 41% Silt and Clay 59%
2	Specific Gravity	2.65
3	Atterberg's Limit Liquid Limit Plastic Limit Liquidity Index	21.81 15.17 5.64
4	Standard Proctor Result Maximum Dry Density(gm/cc) Optimum Moisture Content (%)	1.94 10.61
5	California Bearing Ratio (%)	10.9
6	Unconfined Compressive Strength Result(KN/m <sup>2</sup> )	12

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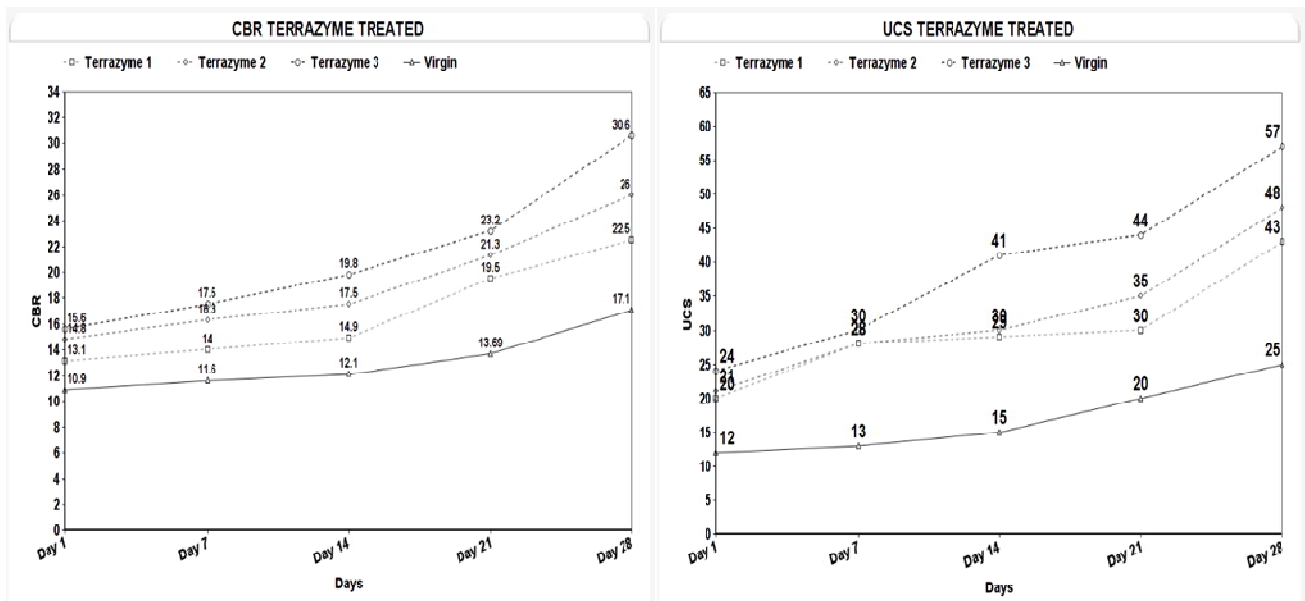
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## IV. RESULTS AND DISCUSSIONS

After adding varying dosages of Terrazyme, the result obtained on soil sample are given below:



Dosage: (Terrazyme 1 = 200ml/1.5m<sup>3</sup>) (Terrazyme 2 = 200ml/ 1m<sup>3</sup>) (Terrazyme 3 = 200ml/0.5m<sup>3</sup>)

### I. Conclusion

S. No	Test Sample	CBR @Day28	CBR of Virgin Soil @Day 0	The rate of Change (%)
1	Virgin	17.1	10.9	56.88
2	Terrazyme 1	22.5	10.9	106.42
3	Terrazyme 2	26.0	10.9	138.53
4	Terrazyme 3	31.1	10.9	185.32

S. No	Test Sample	CBR @Day28	CBR of Virgin Soil @Day 28	The rate of Change (%)
1	Virgin	17.1	17.1	0
2	Terrazyme 1	22.5	17.1	31.57
3	Terrazyme 2	26.0	17.1	52.04
4	Terrazyme 3	31.1	17.1	81.87

S. No	Test Sample	UCS @Day28	UCS of Virgin Soil @Day 0	The rate of Change (%)
1	Virgin	25	12	108.33
2	Terrazyme 1	43	12	258.33
3	Terrazyme 2	48	12	300.00
4	Terrazyme 3	57	12	375.00

S. No	Test Sample	UCS @Day 28	UCS of Virgin Soil @Day 28	The rate of Change (%)
1	Virgin	25	25	0
2	Terrazyme 1	43	25	72.00
3	Terrazyme 2	48	25	92.00
4	Terrazyme 3	57	25	128.00

Dosage: (Terrazyme 1 = 200ml/1.5m<sup>3</sup>) (Terrazyme 2 = 200ml/ 1m<sup>3</sup>) (Terrazyme 3 = 200ml/0.5m<sup>3</sup>)

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In the above study conducted, various geotechnical tests were performed on the soil samples with and without Terrazyme. After mixing of the enzyme, local soil sample showed proper improvement in consistency limits, CBR values and UCS values of the soil sample, each mixed with different dosages of enzymes with different curing periods.

- Increase in the dosage of Terrazyme decreased liquid limit and plastic index from 0.06 ml/kg
- Terrazyme dosage of 0.2 ml/kg increased UCS of the virgin soil by 375 %. (compared to Day 0 of Virgin Soil)
- Terrazyme dosage of 0.2 ml/kg increased CBR of the virgin soil by 185.32 %. (compared to Day 0 of Virgin Soil)
- Optimally increasing the dosage of Terrazyme increased the value of CBR and UCS up to the tested dose of 0.2 ml/kg

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