

## Review Paper on Soil Stabilization by Terrazyme

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### ABSTRACT

During construction work soil stability is one of the major problems. Due to lack of strength possessed by soil, it fails to bear the loads imposed on it during or after the construction. The process involved in soil stabilization must be eco-friendly, cost effective and efficient. Terrazyme proves to be the best solution for this problem. It is natural, non-toxic, biodegradable liquid which significantly improves the strength of soil by reducing the voids. It increases the compaction of soil with minimal compactive efforts and its effect is permanent. This paper deals with all the information about terrazyme including its working mechanism and effects on different properties of soil. Advantages and disadvantages of using terrazyme are also mentioned in the paper.

Keyword: Terrazyme, Soil Stabilization, Enzyme, Biodegradable

### I. INTRODUCTION

Soil stabilization is the process of increasing the strength and durability of soil by altering the physical properties of the soil. It is necessary for the soil stabilization process to be cost efficient, eco-friendly and yield optimum results. For any construction project it is highly recommended to improve the strength of soil in order to increase the life of structure [1]. After soil stabilization Unconfined Compressive Strength (UCS), California Bearing Ratio (CBR) and Shear strength of in-situ soil are largely affected and can increase up to 4-6 times. There are many ways in which soil stabilization can be done like use of surfactants, biopolymers, synthetic polymers, copolymer based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fiber reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride etc. In this project the enzymatic stabilization is performed with the particular enzyme i.e. Terrazyme.

### II. SOIL STABILIZATION WITH ENZYME

An enzyme is an organic catalyst that speeds up a chemical reaction without becoming a part of the end product. Bio-enzyme is a natural, non-flammable, non-corrosive and non-toxic liquid fermented from vegetable extracts. Bio-enzyme is safe, convenient to use and effectively increases the compaction of soil thereby increasing the strength.

In present time, bio-enzymes are becoming the most effectual soil stabilizer due to its low cost, easy manufacturing, effective results and simple application techniques [2]. Although enzymes are initially expensive but as a very small amount is needed for the required results the overall project becomes economical [3]. There are many types of enzymes like renolith, Perma-Zyme, Terrazyme, Fujibeton etc. each of these enzyme have different properties and can be used specifically. In this paper we have discussed in detail about a particular enzyme- terrazyme].

### III. TERRAZYME

Terrazyme is non-toxic, non-corrosive, non-flammable natural material which is formulated from vegetable extracts. It is brown in color with smell of molasses and can be easily used without the need of masks or gloves [4]. It is easily mixed with water and for optimal results should be diluted with optimum moisture content of that soil. Terrazyme act on the soil to reduce the voids between soil particles therefore minimizing the absorbed water in the soil and maximizing compaction. It reacts with the organic matter (humid matter) in the soil to form cementitious material. This decreases the swelling capacity of the soil particles and reduces permeability by increasing the chemical bonding between the soil particles making a permanent structure. This structure can withstand the effect of weather, wear and tear, weathering etc. The treated soil becomes

water resistant and also resists deformation. The benefits of mechanical compaction do not degrade even after reapplication of water. These features are remarkably evident in fine-grained soils as the terrazyme mainly reacts with the clay particles. In road construction the use of terrazyme eliminates the need of granular base and granular sub base, therefore making it a popular practice all over the world.

#### IV. MECHANISM OF TERRAZYME

Soil (clay) particle is surrounded by a negatively charged layer making the particle prone to combine with positive charge in order to neutralize. It is found that the absorbed water layer

on soil contains sufficient positive metals like Na, K, Al, Mg etc becoming the reason of the bond between the negative clay particles and water molecules. Thus a significant water layer is created around the soil particles. In order to attain permanent compaction it is necessary to decrease or eliminate this water layer. This is exactly what terrazyme does [5]. Terrazyme reduces the electric charge in water molecule, thus creating enough pressure on the positive metal ions to release in free water. This breaks the electrostatic potential barrier thereby reducing the absorbed water layer. Thus the soil particles come closer and attain greater compaction with lower compactive effort.

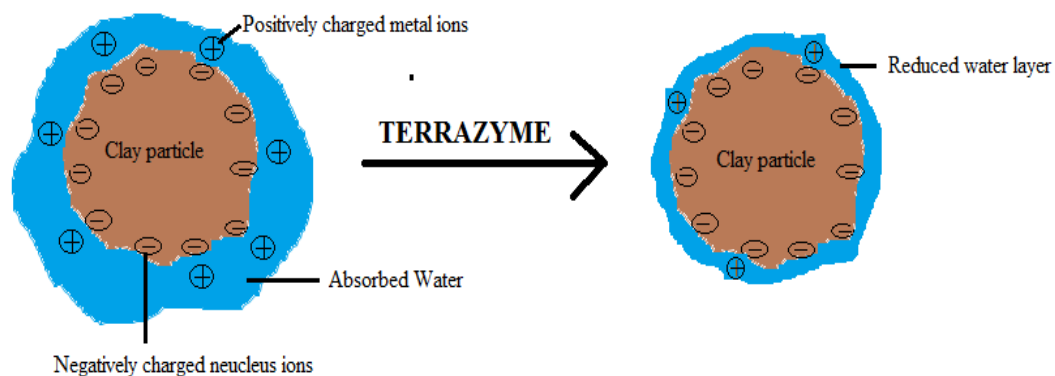


Figure No. 1. Mechanism of terrazyme

#### V. EFFECT OF TERRAZYME

Effect of Terrazyme is different for different types of soils and varying dosages. Some general changes on several properties of soil after the addition of diluted Terrazyme are listed below.

##### ➤ CBR

CBR is California Bearing Ratio, defined as the ratio of force per unit area required to penetrate a soil mass with standard circular piston to that requires for the corresponding penetration of standard material. This test is usually needed to determine the sub-grade strength of the soil in pavements.

With the addition of terrazyme a significant increase in the values of both soaked and unsoaked CBR samples is seen. This is because of the increased compaction which creates a stronger bond between the soil particles, helping them to resist penetration more appreciably. Also with the increase in curing period of samples with terrazyme it is seen that the CBR value increases, indicating more strength provided by the soil with time [6].

##### ➤ UCS

It stands for unconfined compressive strength. UCS is the maximum axial compressive stress a right. It stands for unconfined compressive strength. UCS is

the maximum axial compressive stress a right cylindrical sample of soil or any other material can withstand under unconfined (confining stress is zero) conditions. UCS test basically gives the strength of the soil so to determine the effect of terrazyme it is necessary to know the changes on UCS. After performing various tests on different types of soils it is seen that with the addition of terrazyme there is an increase in the unconfined compressive strength of soil to a great extent. In some cases UCS has increased as much as 200% making the enzyme an ideal solution for soil stabilization [7].

##### ➤ Consistency limits

The water content at which the soil changes its state is known as consistency limits. The water content at which the soil changes its state from liquid to plastic is known as liquid limit, and when it changes its state from plastic to semisolid it is known as plastic limit.

It is seen that with the addition of terrazyme both the liquid and plastic limits decreases signifying the denseness of the soil. As the soil particles come closer after enzyme action, the soil changes its state at lower water content [8].

### ➤ **Compaction**

The densification of soil with the help of mechanical force is known as compaction. For compaction Standard Proctor Test is performed in laboratories. In this test optimal moisture content at maximum dry density for the given soil is determined.

It is seen that after the addition of terrazyme the OMC decreases and maximum dry density increases for the given soil. It indicates that the voids between the soil particles have decreases and the soil has achieved greater compaction at minimal compactive effort [9].

### ➤ **Permeability**

Permeability is the property of soil to allow easy flow of water through the interconnected voids of soil.

It is seen that the permeability of terrazyme treated soil decreases noticeably. It is due to the decrease in the voids after enzyme action thereby not letting the water to flow easily through soil.

### ➤ **Density**

Density of soil is defined as the amount of mass per unit volume of soil. As the main objective of terrazyme is to reduce the voids, it is obvious that density of soil will increase after enzyme action. As the density increases, compaction increases thereby increasing the strength of soil.

## **VI. ADVANTAGES**

- **Eco Friendly-** terrazyme is natural and organic material. As it is non-toxic, it does not cause any harm to humans, animals or vegetation. Terrazyme is also biodegradable, thus it easily decomposes with the soil. There is no need for safety precautions to be taken while the application of terrazyme.
- **Cost effective-** Even though it is expensive product, it is economical due to its optimum results and permanent application. There is no need to treat the soil again after terrazyme action, thus making the project highly cost efficient. Also very little amount of terrazyme is required to achieve required results. Moreover, as the base and subgrade layers in case of pavement are eliminated, total cost of the project reduces considerably.
- **Easy handling-** as mentioned above it is non-toxic in nature and does not cause any harm to human, thus it can be easily used without the need of gloves and masks.
- **Durability-** as the effect of terrazyme is permanent; it stabilizes the soil for longer period. It is also seen that with time the effect of terrazyme in increasing the strength of soil escalates. It makes the soil water proof and the

strength of soil does not decrease even after saturation of soil.

- **Low maintenance cost-** as terrazyme is weather resistant it provides longer durability of soil and thus reduces the need of frequent maintenance.

## **VII. DISADVANTAGES**

- **Availability of terrazyme-** Terrazyme is not easily available in India and has to be ordered from the specified agency. As the transportation of terrazyme takes time, it can delay the project if not ordered in advance.
- **Correct application-** As a very small amount of enzyme is needed for application, it is important to pour the diluted terrazyme evenly throughout the soil to get best results.
- **Type of soil-** Since terrazyme reacts only with the clay particles it is necessary for the soil to have higher clay content to get required results.

## **VIII. OPTIMUM DOSAGE**

Terrazyme dosage entirely depends upon the type of soil, clay content and plasticity index of soil. It can be easily acquired from different research studies according to the soil type. For example for black cotton soil in pavements optimum dosage is found to be 200ml/1.5 m<sup>3</sup>.

## **IX. FUTURE SCOPE IN INDIA**

There is a very good opportunity in India for terrazyme due to its advantageous results. It is a revolutionary technique and can be easily opted as a prime method for soil stabilization. Due to its cost effectiveness and higher strength especially in the case of highways, it is being currently used in India in Maharashtra, Kerala and Karnataka. But as for different types of soil different dosages are required, there is a need for research to be done in this field.

## **X. CONCLUSION**

- Terrazyme is natural, non-toxic, non-corrosive biodegradable liquid. It is eco-friendly and does not pose any harm to the user.
- With the use of Terrazyme the strength of the soil increases which is evident by the increase in UCS and CBR values.
- Terrazyme decreases the voids between the soil particles and thus increases the compaction and density of the soil.
- Optimum Moisture Content and Consistency Limits of the soil are decreased due terrazyme action as it increases the density of soil.
- It makes the soil water resistive by decreasing the permeability of the soil.

- Terrazyme reacts with the clay particles only so before using it, it is necessary to know the clay content of the soil.
- Effect of terrazyme increases with increase in time i.e. with time the strength of terrazyme treated soil increases.

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