



SOIL STABILIZATION USING BIO-ENZYME

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May 1, 2018

Abstract

Chemicals stabilization is the most common and proven technique of stabilization which uses chemicals. Non traditional stabilizers are becoming more popular because of their numerous advantages like it is a natural substance, non toxic , non inflammable, non Corrosive liquid enzyme formulation fermented from vegetable extracts that improve the engineering properties of the soil. In the present study, an attempt is made to study the properties of soil stabilized with the Terrazyme , in order to use this technology for Geotechnical applications. Laboratory investigations are carried out blending Terrazyme with soil in different dosages and the effect is studies. A series of Standard Proctor tests, Soaked and Unsoaked California Bearing Ratio (CBR) test, and Unconfined Compressive Strength tests were conducted on locally available clayey soil as well as clayey soil mixed with different proportions of Terrazyme inorder to study

the improvement of strength properties of Terrazyme stabilized soil. The specimen are compacted to their respective MDD at optimum moisture content. Results show that the terrazyme can successfully be used to stabilize the soil. Significant improvement was found in both Soaked CBR and Unconfined Compressive Strength.

Key Words: Terrazyme, Soaked CBR, Unconfined Compressive strength, Curing time, stabilization.

1 Introduction

Soil stabilization is crucial for construction jobs such as road construction. In broader terms it indicates the altering the soils physical, geotechnical properties like gradation, permeability, swelling, shear strength etc to meet the design requirements of the proposed structure. Traditionally, there are various methodologies for soil stabilization like mechanical, chemical methods. There is continuous research for cost effective alternate materials and novel ecofriendly techniques to process the local materials. Acrylic polymers for soils stabilization that penetrate the surface and bind soil particles together strongly is one of the emerging techniques of soil stabilization. Unlike chemical methods, scientifically advanced polymers are environment friendly as well as cost effective, which is natural, non-toxic, non flammable, non-corrosive liquid enzyme can be used.

Some of these new stabilizing techniques create hydrophobic surfaces and mass that prevent water penetration or heavy frosts by inhibiting the ingress of water into the treated layer. Selecting the stabilizer type depends on number of factors including gradation, plasticity index, availability and cost of the stabilizer and appropriate construction equipment and its long term effect on strength etc. A balance between performance, economy and environmental harmony keeping in mind the limited natural and artificial resources is vital in maximizing efficiency of performance of structures.

Before deciding the type of stabilization, it becomes imperative to evaluating the various soil properties, identifying the deficient property of soil and choosing the effective and economical method of soil stabilization. Bio-enzymes are enzyme formulation fermented from vegetable extracts that improves the engineering properties of

the soil

Reference [1] conducted a comprehensive study of the Terrazyme soil stabilizer product and its effectiveness on sub-base and sub-grade soils and found that in the case of cohesive soils there was no much improvement on the properties during the early days but the soil showed improved performance with time. Reference [2] conducted field studies on Terrazyme treated road. The terrazyme treated showed a very good condition and no surface damage was observed even after two monsoon seasons in spite of heavy rainfall. Reference [3] conducted field experiments to study the use of Terrazyme as the bio-enzyme stabilizer for road construction. Different soils like sandy clay, silty clay, sandy silt, plastic and non-plastic clay, sandy loam, loam mixed with clay were selected as pavement materials and field stretches were periodically tested with Dynamic Cone Penetrometer and concluded that the enzyme stabilization is a good technique for the effective and economic solution for pavement construction.

Reference [4] conducted laboratory scale testing program to evaluate the effectiveness of enzyme treatment on sub grade soil. The effectiveness of enzyme treatment was evaluated on the basis of CBR, strength, soil stiffness and soil modulus. Reference [5] conducted a comprehensive study of the Terrazyme and its effectiveness on lateritic soil and clay type soil collected from Kerala. Terrazyme is useful for clay soil and sand but is less significant to silty soils and clayey and sandy soil had increase in CBR by 700 percent.

Reference [6] conducted a study to assess the suitability of bio-enzyme as soil stabilizer on five types of soils with low clay content to very high clay

Laboratory tests were conducted to determine the engineering properties of soil and strength characteristics of soil with and without stabilization with bio-enzyme. The Bio-Enzyme stabilization has shown little to very high improvement in physical properties of soil. This little improvement may be due to chemical constituent of the soil, which has low reactivity with Bio-Enzyme. In the cases of highly clay moderate soil, like silty soil to sandy soil, the effect of stabilization has improved the CBR and unconfined compression strength. Reference [7] concluded that the Bio-Enzymes require some clay content in order to create the reaction that will

strengthen the soil. The successful stabilization could be achieved with as little as 2 percent clay but best result with 10 to 15 percent clay. It was reported that 7 days, 14 days, 21 days and 98 days CBR was found as 37, 62, 66 and 100 respectively as compared to 28 % of untreated soil. Reference [8] found that the optimum dosage of Terrazyme for improvement of UCS of Black Cotton soil is 1ml/per 5kg of soil. Reference [9] concluded that application of enzyme Terrazyme on soil showed significant changes in all the test characteristics. Addition of Dosage 2 (200 ml/m³ of TZ), yielded the maximum improvement, enhancing the UCS up to 12 times the untreated strength. Reference [10] conducted tests on lateritic soil with a higher dosage of 200 ml/ 2 m³ of soil, the CBR value of lateritic soil increased by 300% after four weeks of curing, permeability decreased by 42 percent. Studies on clayey soil, silty clay and sandy soil revealed that the addition of bio-enzyme increases the UCS of the soil. The silty clay Exhibited higher CBR value and UCS value when compared with clay and sandy soil [11]. In the light of above, an attempt is made to study the effect of terrazyme enzyme on the soaked CBR and Unconfined Compressive Strength for different curing periods.

2 MATERIAL USED

A. Soil

The soil sample is collected from Kausalya Ganga, Dhauli, Odisha. The soil sample is a finely-grained natural soil material and the properties are given in Table 1

Table 1 Geotechnical Properties of the native Soil

Specific Gravity	2.67
Grain-Size Distribution	
Gravel (%)	5.4
Sand (%)	27.7
Silt (%) & Clay (%)	66.9
Maximum Dry Density(Mg/cum)	1.68
O.M.C. (%)	21.5
Liquid Limit (%)	68
Plastic Limit (%)	32
Plasticity Index (%)	36
IS Classification	MH

B. Terrazyme

Terrazyme is a natural Bio-Enzymatic Soil Stabilizer non-toxic, noncorrosive and inflammable liquid, produced by formulating vegetable extracts. The properties are given in Table 2.

Table 2 Properties of Terrazyme

Identify (AS it appears on the Label)	N-Zyme
Hazardous Components	None
Boiling Point	100 degree Celsius
Specific Gravity	1.04
Melting Point	Liquid
Evaporation Rate	Same as water
Solubility in water	Complete
Appearance/Odour	Brown liquid, Non-obnoxious

3 OBJECTIVES

To study the behavior of soil with the addition of terrazyme enzyme in different dosages. To study the improvement in soaked CBR and Unconfined Compressive strength with the addition of terrazyme enzyme.

4 METHODOLOGY

The total study is carried out in two stages. In the first stage the soil characterization is done. In the second stage, Terrazyme is added to the soil in two dosages, 0.05% and 0.1% and studies are conducted. Tests are conducted with soil alone as well as soil stabilized with terrazyme containing different dosages. The soil is oven dried and pulverized then mixed with the desired amount of terrazyme. Water is added to the mixture and mixed until it becomes homogenous. The laboratory tests carried out on the natural soil include particle size distribution as per IS: 1498-1970, Specific Gravity as per IS: 2720 Part III section 1-1980, Atterbergs limits test as per IS: 2720-part V 1985, Compaction test as per IS: 2720 part VII-1980, Unconfined compressive strength test as per IS:2720-part X. CBR tests as per IS: 2720 part XVI. Unconfined compression tests are conducted on soil and terrazyme mixes compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC) [12]-[18].

5 RESULTS AND DISCUSSION

A. Unconfined Compression Strength Tests

Unconfined compressive strength of black cotton soil was evaluated by stabilization with two different dosages of TerraZyme 0.05% and 0.1% and cured in desiccators up to 7 days of curing. Fig. 2 presents the unconfined compressive strength for treated black cotton soil with terrazyme and the effect of curing on the UCS value. The unconfined compressive strength of TerraZyme treated black cotton soil has shown tremendous improvement. With increase in curing periods, UCS has increased and also with increase in dosage amount. The unconfined compressive strength of native soil is 120kN/m² and with the addition of 0.05% by weight of terrazyme, the UCS increase to 122.5kN/m² with 7 days of curing, the UCS increases to 151kN/m². With the addition of 0.1% by weight of terrazyme, the UCS was observed to be 133.5kN/m² and upon curing for 7 days, the UCS was found to be 173kN/m². With the addition of 0.05% of terrazyme, there is an improvement of 25.8% and with 0.1%, the improvement was 44.2%. The stress strain curves of terrazyme stabilized soils indicate that, the soils treated with terrazyme shows a ductile behaviour when compared with the untreated soil which ensures the treated soils undergo large deformation before failure. The plasticity index is another important parameter that affects Unconfined compressive strength. The terrazyme treated soils showed higher the plasticity Index when compared with the untreated soils. For a curing period of 7 days, however, the stiffness of the stress-strain curve for the untreated specimen is initially lower, whereas the strength of the treated specimen is greater than that of the untreated specimens. Thus, the treated soil exhibits an increase in stiffness, ductility, or strength in the first 7 days of curing. This may be due to enzyme proteins adsorbed by the clay particles, thus, modify the clay particle [19]. This kind of large improvement demonstrates the effectiveness of enzymatic treatment of clay soils.

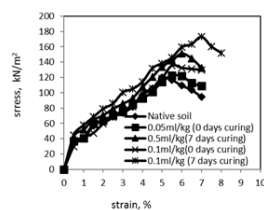


Fig.1 Stress Strain curves with different dosages and curing periods

B. CBR tests

The two different dosages of Terrazyme were added and Soaked California Bearing Ratio test was done. The CBR values obtained are shown graphically in Fig. 2. From the figure, it is evident that the soaked CBR increases with the increase in Terrazyme dose. Enzyme primarily attaches to the clay molecule, alters clay molecule, and later attaches itself from the modified clay by shifting to its original form after the completion of the reaction [20]. When an enzyme-substrate complex is formed, the enzymes convert the local conditions in the reaction site entirely different to those outside the reaction site [21]. This way, the changes in pH and temperature do not hinder the clay modification. The improvement in soaked CBR is occurring because of modification of clay molecule. The CBR values for unsoaked sample with native soil was found to be 3.79% at 2.5mm and when soaked for 4 days the values were 2.286% at 2.5mm. With the addition of Terrazyme by 0.05%, the soaked CBR value increased to 5.3% at 2.5mm penetration and it further increased with the increase in dosage by 0.1%. With 0.1% Terrazyme, the soaked CBR value was found to be 6.6% Thus there is an increase of about 50% in the value of CBR with addition of Terrazyme. The soaked CBR increased by 3 times when compared with the untreated soil.

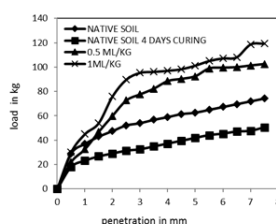


Fig. 2 Penetration curves of stabilized and unstabilized soil

6 CONCLUSIONS

The test results of three different samples i.e. the soil without the Terrazyme stabiliser and the soil with two different dosages of Terrazyme stabilizer were compared to the influence of stabilizer on

the soil and the to choose the appropriate dosage of the stabilizer depending on the application. It is found that the Terrazyme stabilizer can effectively be used to stabilize the soil.

The Unconfined Compressive Strength for native soil was found to be 120 KN/m² which increased to 122.5 KN/m² with addition of Terrazyme in dosage 0.05ml/kg. With the same dosage and 7 days curing the UCS was found to be 151 KN/m². Again when the dosage was increased to 0.1ml/kg, the UCS was found to be 135.5 KN/m² and increased to 173 KN/m² with the same dosage after 7 days curing.

The CBR values for unsoaked sample with native soil was found to be 3.79% at 2.5mm and when soaked for 4 days the values were 2.286% at 2.5mm. With the addition of Terrazyme by 0.05%, the soaked CBR value increased to 5.3% at 2.5mm penetration and it further increased with the increase in dosage by 0.1%. With 0.1% Terrazyme, the soaked CBR value was found to be 6.6%. Thus there is an increase of about 50% in the value of CBR with addition of Terrazyme. The soaked CBR increased by 3 times when compared with the untreated soil.

Thus it can be concluded that Terrazyme is a satisfactory stabilizing agent for clayey soils. The utilization of the enzyme like Terrazyme is an alternative to reduce construction cost of the roads particularly in low volume roads.

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