

Effect of Curing on Compaction Characteristics of Terrazyme Stabilized Soil

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Abstract: The conventional methods used nowadays are very much time consuming and not economically feasible. There is an urgent need for developing new technique to enhance the geotechnical properties of the soil. Bioenzyme is a natural and non-toxic material from vegetable extracts. Their efficiency will depend on the amount of dosage, type of soil and field conditions. Recently there are many bio-enzymes available for soil stabilization such as Renolith, Permazyme, Terrazyme, Fujibeton etc. As the enzyme is an organic liquid it doesn't have any impact on environment. The stabilization of soil with bio-enzyme is a revolutionary technique which is becoming popular. Some bio-enzyme stabilized roads have been constructed in various parts of India, which are performing well. The use of bioenzyme in soil stabilization is not very popular due to lack of awareness between engineers and non-availability of standardized data. This paper mainly focuses on kuttanad soil treated with terrazyme and shown significant improvement in strength characteristics.

Keywords: Kuttanad soil, Bioenzyme, Soil stabilization

1. Introduction

All civil engineering constructions are carried out on soil. The behavior of structures thus depends on the properties of the soil on which they are constructed. For structures to be safe and sound, they are to be built on good soils. Soft clay deposits, which are inherently very low in strength and very high in compressibility, are widespread in coastal and low land regions. The process of improving the strength and durability of soil is known as soil stabilization. It is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength and control the shrink-swell properties, thus improving the load bearing capacity of the soil.

Kuttanad is situated in the central half of Kerala covering an area of approximately 1100 sq. km and lies 0.6 m to 2.2 m below the mean sea level. Kuttanad clay is an important soil group, well known for its low shear strength and high compressibility. Soil in this region is soft black or grey marine clay composed of minerals such as montmorillonite, kaolinite, iron oxide and aluminum oxide (shrisath et al.,2017). The typical kuttanad soil consists primarily of silt and clay fraction. It is a weak foundation material, with a number of failures to structures and embankment reported. Since Kuttanad is the rice bowl of Kerala, any ground improvement technique

adopted in this region should be eco-friendly and should never cause any harm to the environment, especially to the soil and water. In particular, the paper focuses on bioenzyme an alternative sustainable technique which can be potentially utilized to improve Kuttanad clay. Bioenzymes are natural, non-toxic, non-flammable organic and liquid concentrated substances from vegetable extracts namely (Saini and Vaishnava,2015).Soil types stabilized by bioenzymes include sandy clay ,silty clay, sandy silt, plastic and non-plastic clay, sandy loam, fine loam, and loam mixed with clay. The dosage level of bioenzyme vary from 1 litres for 5m³of soil depending on the soil type and soil characteristics. Bio enzyme reduces the voids between the particles of soil and minimizes the amount of absorbed water in the soil so that compaction caused by enzymes can be maximum. These enzymes have been proven to be very effective and economical. The use of bioenzyme in soil stabilization is not very popular due to lack of awareness. Recently there are many bio-enzymes available for soil stabilization such as Renolith, Permazyme, Terrazyme, Fujibeton etc. Most commonly used one is terrazyme.

2. Terrazyme

Terrazyme modified from vegetable extracts is specially formulated to modify the engineering properties of soil, usually applied as a mixture with water. Terrazyme acts on the soil by reducing the void space between the particles minimizing the adsorbed layer of water and maximizing compaction. It reacts with the organic materials to form cementitious material, bringing about a decrease in permeability and increase in chemical bond, creating a permanent structure resistant to weather, wear and tear (Gupta et al.,2017). Table1 shows the properties of terrazyme (Shirsath et al.,2017).

Table 1
Properties of Terrazyme

Property	Value /specification
Boiling point	212°f
Specific gravity	1 to 1.09
Ph value	4.3 to 4.6
Hazardous content	None
Appearance	Brown coloured liquid
Reactivity data	Stable

A. Mechanism of terrazyme

Soil (clay) has surface negative charges particles making the soil attracted to the positive charge and get neutralized. It is found that the adsorbed layer of water contains metals like Na,K,Al,Mg which is the reason for the bond between negative clay particles and water molecules. Thus a significant layer of water is created around soil particles and to attain compaction it is necessary to eliminate the water layer around the parti-cle.terrazyme reduces the dielectric charge in water molecule thus creating pressure on the positive metal ions to release the free water. This breaks the electrostatic potential barrier thereby reducing the thickness of the diffusion double layer so that the soil particles come closer and attain greater compaction with less compactive effort.

B. Effect of terrazyme on clays

Effect of terrazyme is different for different types of soil and mainly dependson dosage and curing time. With the addition of terrazyme a significant increase in the values of both soaked and unsoaked CBR has been observed ,by as much as 4 times for clayey silts(Saini and Vaishnava,2015). This is because of increased compaction creating stronger bond which resist penetration. The OMC and consistency limits have also been found to decrease, indicating the denseness of the soil. permeability of the soil also has decreased with the increase in curing time compared to that of sample untreated with terrazyme. It is due to the decrease in voids after enzyme action thereby not allow-ing the water to flow through the soil (Gupta et al., 2016). Terrazyme decreased liquid limit by as much as 28% and shrinkage limit by 30% in two weeks on high liquid limit clays but had little effect on plastic limit (Eujine et al.,2014)effect of terrazyme for different types of soil varies and it mainlydepends on dosage. Studies have been reporting the varia-tions on geotechnical properties for different dosage of terrazyme for (type of soil) (Saini and Vaishnava,2015).

3. Materials and experiments

The soil used in the work is kuttanad clay collected from pallipadu in, Alappuzha district Samples were air dried for a week and broken down into smaller pieces. As per the results of initial test soil was classified as MH as per Unified Classification System. The initial proper-ties of collected soil are given in table 2.

A. Specimen preperation

Table 2
Properties

PROPERTY	VALUE
SPECIFIC GRAVITY	2.6
SAND FRACTION (IS 2720 PART 4)(%)	9.5
SILT FRACTION (IS 2720 PART 4)(%)	72.5
CLAY FRACTION (IS 2720 PART 4)(%)	18
LIQUID LIMIT (IS 2720 PART 5)(%)	52
PLASTIC LIMIT (IS 2720 PART 5)(%)	30
SHRINKAGE LIMIT (IS 2720 PART 5)(%)	19.9
PLASTICITY INDEX (IS 2720 PART 5)(%)	22
OPTIMUM MOISTURE CONTENT (IS 2720 PART 7)(%)	22
MAXIMUM DRY DENSITY (IS 2720 PART 7)(g/cc)	1.35
IS CLASSIFICATION (IS 2720 PART 4)(%)	MH
UCC STRENGTH (IS 2720 PART 10) (kPa)	15.3

The soil is oven dried for 24 h. The bioenzyme used in this study is in liquid form and mixed with water and then poured on to the soil .bioenzyme concentrations of 0.5, 1, 1.5, 2ml were used in the study. The soil is treated with various dosages of terrazyme and studied with curing.

B. Test procedure

A modified Proctor Compaction test was performed for determining the maximum dry density and its corresponding optimum moisture content.

4. Results and discussions

A. Effect of bioenzyme on compaction characteristics

Compaction is a primary process used in improving surface soil layers, where the soil is compacted to a certain density level after being mixed with a stabilizing material. The achieved compaction will affect other mechanical characterizations such as shear strength, settlement, and bearing capacity.

The optimum moisture content (OMC) and maximum dry density(MDD) of soil without terrazyme are found to be 32% and 1.2g/cc with the addition of terrazyme the MDD in-creased to as much as 2 times and simultaneous decrease in OMC was observed from table 3.

5. Conclusion

Using experimental investigations, the following conclusions can be drawn:

Table 3
Variation of OMC and dry density with terrazyme dosages and curing

TERRAZYME DOSAGES (mL/m ³)	CURING PERIOD IN DAYS			
	0 TH DAY		7 TH DAY	
	DRY DENSITY (g/cc)	OMC(%)	DRY DENSITY(g/cc)	OMC(%)
0	1.35	22	-	-
0.25	1.69	21	1.825	18.5
0.5	1.71	20	1.88	18
0.75	1.77	18	1.92	18
1	1.83	16	1.94	17.8
1.25	1.85	15	1.982	16.4
1.5	1.725	15	1.876	16

- Bio enzyme are environmental friendly alternatives to conventional soil stabilizing agents like cement, lime etc.
- From the table 3 it is observed that the dry density increases with increase in terrazyme dosage and with curing
- The dry density of soil increases with dosage upto 1.25 ml and then it decreases at 1.5 ml signifying 1.25 ml as optimum dosage.
- The same optimum value is obtained with 7th day curing at 1.25 ml.
- Initial cost of bio enzyme is high but in the long-run it is economical.

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