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INFLUENCE OF TERRAZYME ON ENGINEERING PROPERTIES OF RED SOIL

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ABSTRACT

Improvement and stabilization of soils are widely used as an alternative to substitute the lacking of suitable material on site. In this paper, popularly available TerraZyme and their effect on engineering properties of soil are discussed. Consistency Limit, Modified Compaction, CBR and UCS tests were carried out in the laboratory for different mix proportions of TerraZyme with red soil and from the results addition of the TerraZyme to the soil reduces the clay content and increases in the % of coarser particles, reduces Liquid limit values are decreasing and plastic limit increasing irrespective of the percentage of addition of TerraZyme, Maximum Dry Density increasing and OMC goes decreasing with increase in % of TerraZyme. The CBR and UCS values are increased. From the above results, TerraZyme can be utilized for strengthening the red soil with an optimum of o.3 ml and substantial save in cost of construction.

Keyword: *Red Soil, TerraZyme, Compaction, CBR and UCS Test*

I. INTRODUCTION

The main aim of stabilization is cost reduction and to efficiently use the locally available material. The stabilization of soil with bioenzyme is a revolutionary technique which becoming popular worldwide. Bioenzymes are organic, liquid, natural, non-toxic, non-flammable non-corrosive and ecofriendly which are obtained from fermentation of organic matter. An effective technique of ground improvement using bio-enzyme with different dosage of TerraZyme mixed in the soil sample and result were analyzed. From the results significant increase is found in CBR value of the soil sample as the dosage of TerraZyme has been increased, Mixing of TerraZyme to local soil sample showed improvement in consistency limits, dry density and CBR values of the soil sample with mixing a different dosages of TerraZyme with different curing periods and best result of CBR value was observed with the third dosage with a two week curing period and percentage increment as compared to local soil sample without TerraZyme is 131.49 % [1]. The improvements in geotechnical properties of soils of Black cotton soils and red soil treated with Terra-Zyme stabilizer at different curing period 7, 14 and 21 days. The different mix proportions of enzyme used for stabilization on the are studied by Based on the experiments conducted on the soils with the application of Terra-Zyme best result for LL values was observed with the second dosage 200ml per. 0.75 m^3 of Terra-Zyme at curing period of twenty one days the value of LL was decreased for S1 as 21.14 %, S2 as 23.44%, S3 as 33.66 % and S4 as 16.36%. With the application of Terra-Zyme the UCS values increased around 94.86%, 114.69%, 150.28%, and 63.34% till twenty one days. Best result for UCS values was observed with third dosage 200 ml per 0.75m^3 of Terra-Zyme at curing period of twenty one days [2]. The effect of TerraZyme dosage at different dry densities to study its effect on compaction and strength characteristics of red soil. It is found that TerraZyme treated red soil shows significant increase in strength and the amount of dosage depends on dry density of compacted soil and has significant effect on strength of red soil. Though increase in curing period causes reduction in strength of TerraZyme treated soil, the strength is found to be significantly larger than that for untreated red soil, as the dosage increases for all the three conditions [3]. The effect of curing on the strength properties of TerraZyme treated black cotton soil and red earth for the curing periods from 7days to 60 days and concludes that, Air-dry curing simulating on-field conditions has shown enormous increment in strength of TerraZyme treated expansive and non-expansive soils as UCS and CBR compared to laboratory conditions of desiccator curing. The test results indicate that air-dry curing is best suited for TerraZyme stabilization of expansive and non-expansive soils and in order to use this technology for low cost soil stabilization techniques [4]. Bio-enzyme can also be used as a dust control agent, as 75% reduction in dust on unsurfaced roads is reported in many construction work where

bio-enzyme have been used. With the use of bio-enzyme, aggregate free pavement is possible as its use promotes the use of locally available material. Use of bio-enzymes results in higher compressive strength and increased hardness of stabilized soil. Bioenzymes provide flexibility and durability to the pavement and also reduce the formation of crack. Bio-enzymes reduce swelling and shrinkage properties of highly expansive clays. The use of bio-enzyme in pavement construction is proven to be very economical as compared to other traditional soil stabilization methods. The cost of construction project can be reduced considerably with the use of bio-enzyme [5]. Strength parameters on three different soils with four different dosages bio enzyme for 2 and 4 weeks and from the results that addition of bioenzyme significantly improves shear strength and CBR values of selected samples and soil-stabilizing enzymes catalyse the reactions between the clay and the organic cations and accelerate the cationic exchange without becoming part of the end product [6]. In this study Red soil with varying index properties have been tested for stabilization process and strength of the stabilized soil were evaluated after mixing various TerraZyme dosages 0.1, 0.2, 0.3 & 0.4 ml by dry unit weight of soil. Atterberg's limits, compaction, unsoaked and soaked CBR tests and UCS Tests were conducted mixing with different percentages of TerraZyme. The test results indicate that TerraZyme stabilization improves the strength of Red soil. A significant increase is found in the geotechnical properties of the soil sample as the dosage of TerraZyme has been increased.

II. MATERIALS USED

Properties of various materials used during the laboratory experimentation are reported in the following section.

A. Red Soil

The soil used in this study was a typical Red soil which was brought from Dwarapudi (village), East Godavari Dt. AP shown in Fig.1. This soil is classified according to I.S classification as inorganic clay of low compressibility (CL).

Fig.1 Red Soil

B. TerraZyme

TerraZyme used as stabilizer was procured by Avijeet agencies, Anna nagar, Chennai. It was in liquid state with the appearance of brown colour. It is a natural, non-toxic, non-corrosive and non-inflammable liquid, produced by formulating vegetable and fruit extracts. TerraZyme is specially formulated to modify the engineering properties of soil. They require dilution in water before application. The physical properties of TerraZyme presented in the Table.1

TABLE.1: PHYSICAL PROPERTIES OF TERRAZYME

Identity	***TerraZyme***
Hazardous Components	None
Boiling Point	212°F
Specific Gravity	1.05
Melting Point	Liquid
Evaporation Rate	Same as water
Solubility in Water	Complete
Appearance/Od	Brown liquid, Non-

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or	obnoxious
Unstable or Stable	Stable
Conditions Avoid	> 45°C ; pH below 3.5, above 9.5
Incompatibility	Caustics, Strong bases
Health Hazards (Acute and Chronic)	None
Disposal Method	Flush into any sewage system
Storing	Store at temperatures below 45°C
Respiratory Protection	Not required
Working	Normal good practices

III. LABORATORY EXPERIMENTATION

Various tests were carried out in the laboratory for finding the index and Engineering properties of the materials used during the study. CBR, UCS, consistency limits and compaction tests were conducted by using different percentages of TerraZyme mixed with red soil for finding optimum percentage of TerraZyme. The details of these tests are given in the following sections.

Index Properties
I.S. Codes of practice [IS: 2720 (Part-5)-1985; IS: 2720 (Part-6)-1972], were followed while finding the Index properties viz. Liquid Limit and Plastic Limit and of the samples tried in this investigation.

Compaction Properties
Optimum moisture content and maximum dry density of red soil and TerraZyme mixes were determined according to I.S heavy compaction test IS: 2720 (Part VIII).

California Bearing Ratio (CBR)Tests
Different samples were prepared for CBR test using red soil with different dosages of TerraZyme and unsoaked & soaked CBR tests were conducted in the laboratory as per IS Code (IS: 2720 (Part-16)-1979) as shown in the Fig.2.

Fig. 2 California Bearing Ratio Test Apparatus

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Unconfined Compression Strength Test

The unconfined compression strength tests were conducted in the laboratory as per IS Code (IS: 2720, Part X (1991). For strength testing, specimens are generally tested at their maximum dry density and optimum moisture content. The load frame of compression testing machine apparatus was used for conducting the unconfined compressive strength test. The strain rate was kept as 1.2 mm/min in all the experiments. The proving ring of capacity 2 kN was used for testing specimens as shown in the Fig.3.

Fig 3 Unconfined Compressive Testing Machines

IV. RESULTS AND DISCUSSIONS

Various tests were conducted in the laboratory as per I S Code provisions and the test results are furnished below with a view to determine the optimum percentage. After mixing of TerraZyme with red soil sample showed proper improvement in consistency limits, dry density, CBR and Unconfined Compressive Strength values of red soil mixing with different dosages of TerraZyme.

Consistency Characteristics

Atterberg limit test on the treated soil sample decreased with increasing dosage of TerraZyme. Liquid limit values are decreasing from 31, 30.64, 30.44, 30 and 29.85 and the plastic limit values are increasing from 19.84, 20. 33, 20.64, 20.89 and 21.1 by adding 0 ml, 0.1 ml, 0.2 ml and 0.3 of TerraZyme respectively when added with the red soil as shown in the Figs. 4&5

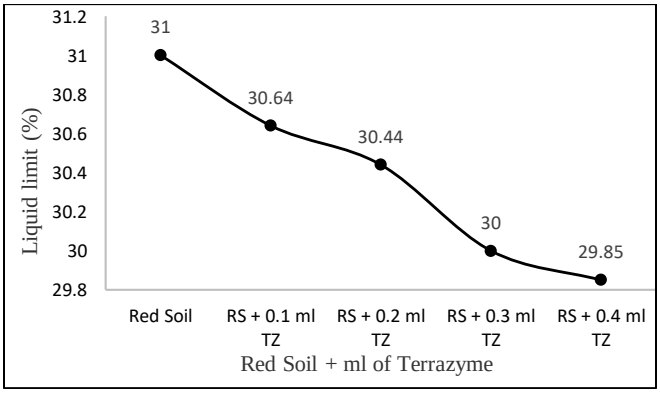

Fig.4 Variation of Liquid Limit for Red Soil Treated with Different ml of TerraZyme

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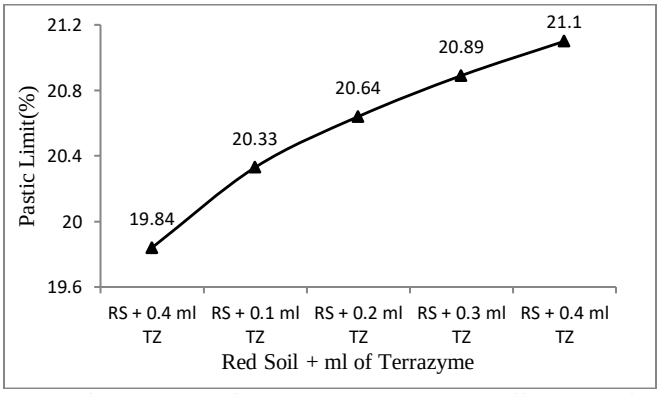

Fig.5 Variation of Plastic Limit for Red Soil Treated with Different ml of TerraZyme

Compaction Characteristics:

The optimum moisture content (OMC) of the treated soil samples decreased and maximum dry density (MDD) increased as the dosage of TerraZyme increased as shown in Figs. 6 & 7. The MDD values are 20.5, 20.6, 20.69, 29.8 and 20.716 kN/m^3 and OMC values are, 16%, 16.16%, 12.35%, 10.39% and 8.91% respectively y adding 0 ml, 0.1 ml, 0.2 ml and 0.3 of TerraZyme. Increase in the density of the soil sample, as the dosage increased may be attributed to aggregation and cementation of the soil particles. Based on the investigation it can be concluded that the increase in MDD is due to the decrease in void ratio when enzyme is added to the soil. It is observed that there is a decrease in OMC due to the effective cation exchange process which generally takes longer period in the absence of such stabilizers.

California Bearing Ratio (CBR) Test

The CBR tests were conducted in the laboratory for all the red soil samples treated with different percentages of Terrazyme and from the results of unsoaked and soaked CBR values go increasing from 4.46 to 10.3 and 3.14 to 7.67 respectively up to the addition of 0.3 ml of TerraZyme and beyond it decreases as shown in the Fig 8.

Unconfined Compressive Strength(UCS)Test

Unconfined compressive strength of soil has been done to determine the shear parameter of cohesive soil. The unconfined compressive strength of Red soil was found to be increased from 0.44, 0.68, 0.91, 1.56 and 1.4 N/mm^2 with the addition 0 ml, 0.1 ml, 0.2 ml and 0.3 of TerraZyme respectively when added with the red soil as optimum dosage of TerraZyme is 0.3 ml as shown in the Fig. 9.

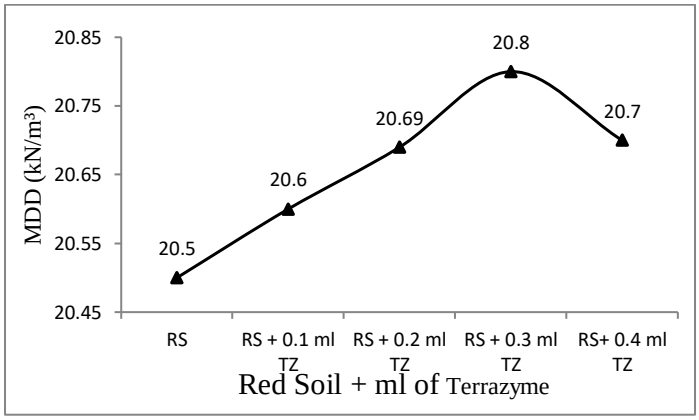

Fig. 6 Variation of MDD for Red Soil Treated with Different ml of TerraZyme

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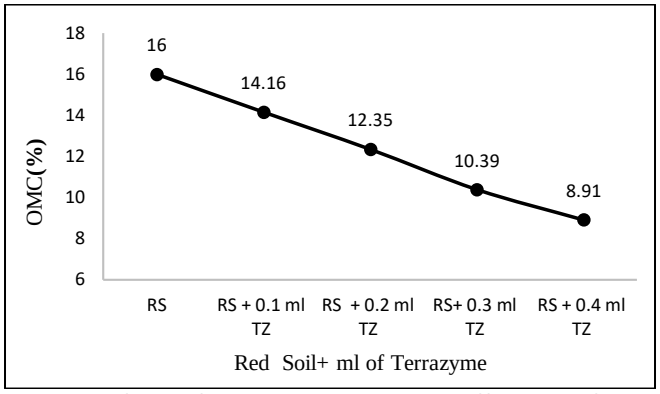

Fig.7 Variation of OMC for Red Soil Treated with Different ml of TerraZyme

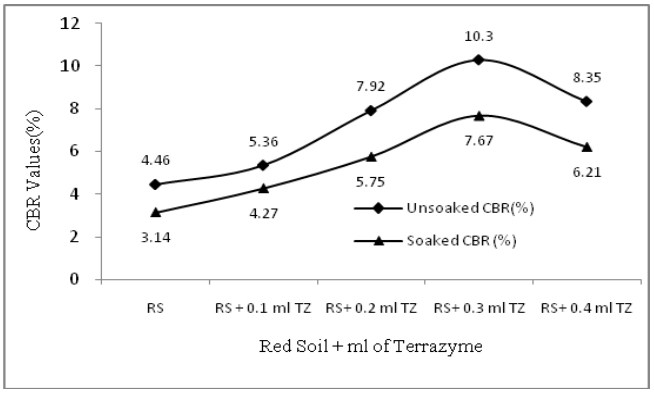

Fig. 8 Variation of CBR Values for Red Soil Treated with Different ml of TerraZyme

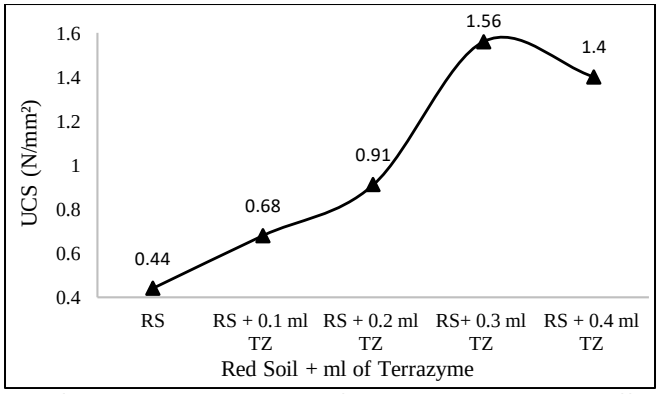

Fig.9 Variation of Unconfined Compressive Strength for Red Soil Treated with Different ml of TerraZyme

V. CONCLUSIONS

- ✓ The suitability of TerraZyme for the modification of Geotechnical properties of red soil is concluded by studying the effect of TerraZyme on the index and engineering properties of red soil. Based on the test results, the following conclusions have been drawn
- ✓ TerraZyme stabilization has shown good improvements in engineering properties of red soil.
- ✓ 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 increasing from 19.84 % to 21.10%, Liquid limit of soil goes on decreasing from 31% to 29.85% and Plasticity

index of soil decreases from 11.16% to 8.75% when TerraZyme is increased from 0 to 0.4 ml irrespective of the percentage of addition of TerraZyme.

- ✓ Compaction test result shows that liquid chemical caused a modest increase in maximum compacted density and slight decreases in optimum moisture. 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.
- ✓ The unsoaked and soaked CBR goes on increasing from 4.46 to 10.3 and 3.14 to 7.67 with increase in percentage of addition of TerraZyme up to 0.3 ml to the red soil with improved density values by reducing the void ratios. It is also identified that addition of 0.3 ml TerraZyme yield high CBR value in both conditions.
- ✓ The Unconfined Compressive Strength of red soil increased from 0.44 N/mm^2 to 1.56 N/mm^2 up to 0.3 ml of TerraZyme dosages with an improved strength of 2.5 times to normal red soil.
- ✓ From the above analysis it is found that TerraZyme up to 0.3 ml can be utilized for strengthening the red soil of flexible pavement with a substantial save in cost of construction.
- ✓ As the enzyme is an organic liquid, it is biodegradable in nature and it does not have any harmful effect on environment. 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.

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