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EFFICACY OF TERRAZYME –A BIO ENZYME ON STRENGTH CHARACTERISTICS OF EXPANSIVE SOIL

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ABSTRACT

In India vast area is occupied by black cotton soil mainly contains clay as chief constituent. They show minimal bearing capacity and low strength. These soils swell when comes in contact with water and shrink as they dry out. Engineers face problems with such type of soils, which do not posses sufficient strength to carry the imposed loads during construction and the life of the structure. Properties of the soil must be increased to achieve economy and to improve the performance of structure. Soil stabilization is the process of reducing undesirable behaviour of expansive soils. Conventional stabilization methods are time consuming and are proved to be not economical, it become necessary to look for alternative eco-friendly stabilizers like bio-enzymes. Different types of bio-enzymes available for soil stabilization are Renolith, Permazyme, Terrazyme and Fujibeton. The present study deals the effect of Terrazyme a bio-enzyme on shear strength and CBR value of expansive soil. Laboratory tests were conducted on various dosages, stabilizer was added by replacing 1, 2, 3 and 4 percentages of the optimum water content of the black cotton soil.

Keywords: *Terrazyme, Black Cotton Soil, Soil Stabilization, Shear Strength, CBR Value*

I. INTRODUCTION

Soil stabilization means altering the soil properties by different ways and means, mechanical or chemical to develop improved soil material which has all the intended engineering properties. Stabilization to the soil reduces permeability, compressibility and increases shear strength, bearing capacity. It is mainly used to improve1the1properties of1soil using in constructing highways and airfields.

Soil Stabilization Procedure is evaluating the properties of the soil, Adding stabilizing material to the soil and testing the specimens in the laboratory after stabilization for intended purpose. The concept of enzyme soil stabilization is demonstrated by the termites and white ants build their shelter by Ant drool which are rock hard and stand firm despite of heavy rainy seasons. The main objectives of the present study is quantitative changes in CBR values of soil treated with Terrazyme in different dosages and quantitative changes in UCS values of soil treated with Terrazyme in different dosages.

II. LITERATURE REVIEW

Bergmann (2000) through his experimental studies concluded that Bio-Enzymes need some percentage of clay to strengthen the soils. His results revealed that minimum clay content should be 2%, 10 to 15% of clay will show better results. Sharma (2006) has conducted experimental studies on Bio-Enzymatic stabilization of three variety type of soils namely high plastic clay (CH), low plastic clay (CL), and low plastic silt (ML). His results showed that CH soil showed improvement in CBR value. Also it was found that there was 100% improvement in UCS. Mithanthaya.I.R, Harsha Kumar Rai and Ravishankar.A.U (2009) investigated the geo-technical properties of the lateritic soil stabilized with enzyme. Quantity changes in CBR values, UCC and Permeability were observed with four different dosages of Terrazyme. 200ml of Terrazyme was added to 2, 2.5,3 and 3.5m^3 of soil. CBR value was increased by 400%, UCC value was increased by 450% and Permeability was decreased to 42%.

Sureka Naagesh and Gangadhara.S (2010) investigation on swelling properties of Terrazyme treated expansive soil, revealed that soil treated with Terrazyme showed less swelling pressure compared to original soil sample. Lekha.B.M, Ravi Shankar.A.U and Goutham.S (2013) in their work, laboratory tests were conducted on Black Cotton soil stabilized with Nano-chemicals. A chemical named Terrasil was used as stabilizer in varying percentages and the soil was cured for 7-28 days. It is noted that CBR value increases with the increase in percentage of soil stabilizer. Permeability is found to be nil for treated soil. Ramesh.H.N and Sagar.S.R (2015) experimental studies on strength properties of Terrazyme treated expansive and non-expansive soils revealed free swell index of soil decreased from 118% to 45% for desiccator and 27% to air dry conditions for third dosage of Terrazyme for at 30 days. Nandini.D.N, Vinoda.A and Prathap Kumar.M.T (2015), experimental studies on red soil stabilized with Terrazyme in three different levels revealed that dosage showed better compaction in terms of maximum dry density. Srinivasa.G and Amith Kadaba Sheshadri (2016), investigations on black cotton soil stabilization using Terrazyme revealed there is decrease in liquid limit and plastic limit from 61.40% to 56.49% and 34.00% to 31.70% respectively. CBR value increase of 387% compared to the untreated soil.

III. METHODOLOGY & EXPERIMENTAL INVESTIGATION

1. Materials Used

Materials used in the present investigation are

Black-Cotton soil and
Terrazyme

2. Black Cotton Soil

The soil used in the present research was brought from Ramarajupalli village, near Fathima Institute of Medical Science. Maximum area of the village was covered by black cotton soil. Soil was taken by removing the top layer containing organic matter. After drying the soil, pulverised and stored in the laboratory and used for stabilization process.

3. Terrazyme

Terrazyme was bought from Avijeet Agencies Private Limited, Chennai. The cost economics of implementing Terrazyme in road building is yet another appealing characteristic of this technology. The overall cost reduction would be about 15 to 40% of the total cost of construction. The maintenance cost compared to the conventional system would be reduced from 50 % to 75%.

Given that there is an achievement in superior strength parameters at the base level of the Terrazyme road, further reduction in the bitumen layer is possible which would provide an over-all saving in surfacing costs.

4. Tests Conducted On Soil

In this investigation Terrazyme is used as a stabilizing agent and is added to the soil in the following manner. Initially the optimum moisture content was found from the standard compaction test, then Terrazyme was replaced in place of that optimum content by increasing the percentages as 1%,2%,3% and 4%. Terrazyme was diluted in water first and then mixed to the soil. Unconfined compression Test and California Bearing Ratio tests were conducted on soil specimens treated with Terrazyme. Specimens were soaked in soil for 4 days and 7 days and the results were obtained

5. Black Cotton Soil Properties

Different tests conducted on black cotton soils are shown in the below table 3.1 and 3.2

Table.No.3.1. List of Experiments

S. No.	Tests on soil
1	Specific Gravity of soil particles (IS-2720 Part-3, section 1-1980)
2	Liquid Limit and Plastic Limit (IS-2720, Part-5,1985)
3	Free Swell Index (IS-2720, Part-40, 1977)
4	Standard Proctor Compaction Test (IS-2720, Part-7, 1980/1987)
5	California Bearing Ratio (IS-2720, Part-16,1979)
6	Unconfined Compression Test (IS-2720, Part-10,1973)

Standard compaction test for the plain soil was conducted, it was observed that optimum moisture content was 26% and maximum dry density was found to be 1.36gm/cc.

Table No. 3.2. Soil Testing Results

S. No	Experiments	Results		
1	Specific Gravity of Soil Particles	2.34		
2	Liquid Limit, %	66		
3	Plastic Limit, %	28		
4	Plasticity Index, %	38		
5	Grain Size Analysis Clay % Silt % Sand %	 68 18 14		
6	IS Classification of Soil	CH		
7	Free Swell Index, %	85		
8	Standard Proctor Compaction Test	OMC-26%		
		MDD-13.6 kN/m^3		
9	California Bearing Ratio	Un-soaked- 3.93		
		Soaked-2.48		
10	Unconfined Compression Test	Un-soaked	4 days Curing	7 days Curing
	Shear Strength kPa	5.39	10.8	17.65

6. Enzyme Properties

Table. No. 3.3. Properties of Terrazyme

Colour	Dark Brown
p^H	3.5
Specific Gravity	1.414
Evaporation Rate	Same as Water
Odour	Smell like Molasses
Extracted from	Molasses

7. Tests Conducted On Terrazyme Treated Stabilized Soil

Terrazyme was added to the soil in the following manner, first optimum moisture content was found from standard compaction test, it was found to be 26% from graph. In every testing volume of water required to be added to the soil was found, to that volume of water 1%,2%,3% and 4% Terrazyme was added and the testing was carried out in every percentage. Unconfined Compression Test and California Bearing Ratio Test and Tri-Axial tests were carried

out in varying percentages of Terrazyme. To ascertain the behaviour of soil under soaked conditions the specimens were soaked in soil for a period of 4 days and results are obtained.

IV. RESULTS AND DISCUSSIONS

The design and construction of pavements on expansive clayey sub-grades pose problems to Civil Engineers and to Geotechnical Engineer in particular. Methods used for the design of flexible pavements are grouped under empirical, semi-empirical and theoretical methods. CBR method is employed for the design of flexible pavements in most of the designs even though it is empirical in nature. It is simple and convenient, its value directly gives the strength of sub-grade layer. The thickness of pavement decreases as the CBR value increases and vice-versa. CBR value was improved to achieve economy in construction. There are many techniques to improve the CBR value of the sub-grade, in the present investigation, Terrazyme is tried.

1. Results and discussion on strength characteristics

The unconfined compression test is a special case of tri-axial compression test, the confining pressure being zero. A cylindrical soil specimen usually of the same standard size as that for the tri-axial compression is loaded axially by a compressive force until failure takes place. Since the specimen is not confined laterally the test is known as unconfined compression test. No rubber membrane is necessary to encase the specimen. The unconfined compression tests were performed both on untreated and treated soil of diameter 38.1 mm and 76.2 mm high prepared at their respective Proctor's maximum dry densities and optimum moisture contents.

The samples are tested in an unconfined compression testing machine with a strain rate of 1.25mm/min. Three specimens were tested at each percentage of admixtures.

2. Effect of terrazyme on shear strength of soil

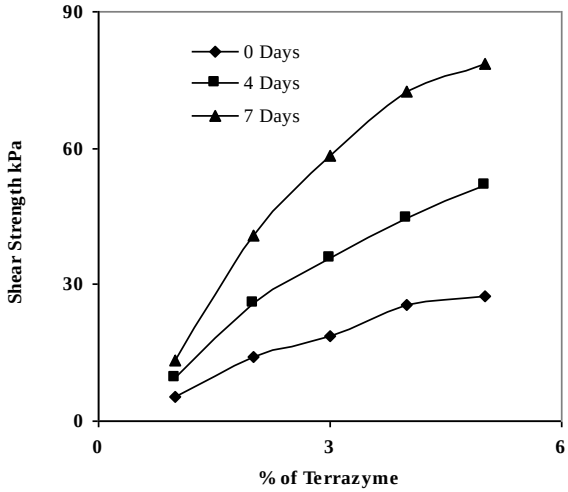

Figure 4.1 Percentage of Terrazyme vs Shear Strength – Effect of Curing Days

From the investigations it was observed that Shear Strength of the soil increased on increasing the percentage of Terrazyme and number of days. The shear strength increases from 5.39, 14.0, 18.5, 25.5 and 27.5 for zero, one, two ,three and four percentage of Terrazyme. The shear strength increases with increasing curing days i.e from 27.5, 52.2 and 78.5 for zero, four and seven days. Maximum shear strength of 78.48 kPa obtained at 7 days curing period.

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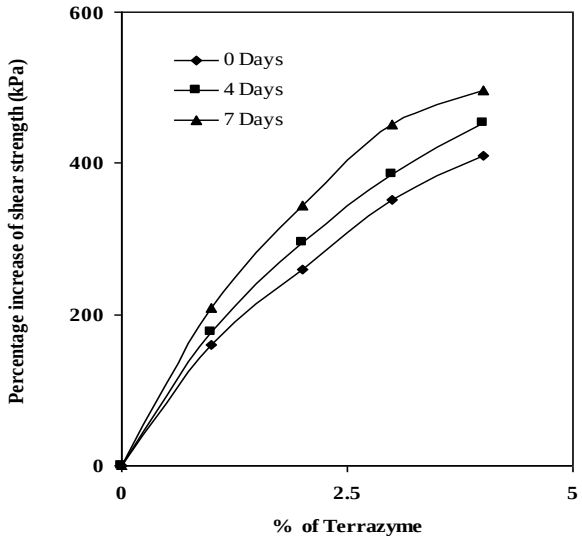

Figure 4.2 Percentage of Terrazyme vs Percentage Increases in Shear Strength – Effect of Curing Days

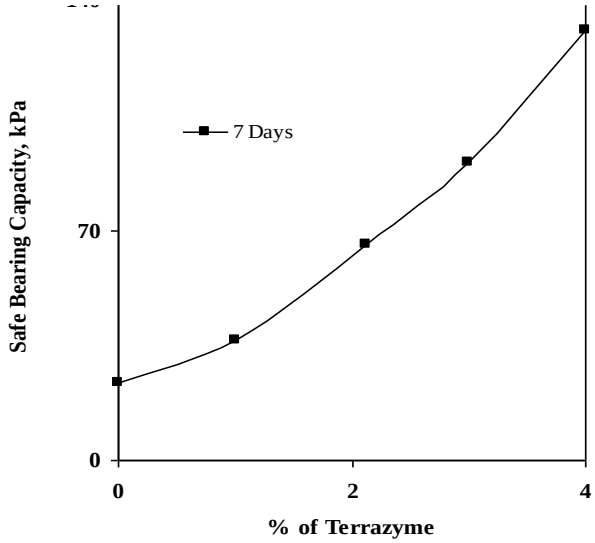

Figure 4.3 Percentage of Terrazyme vs Safe Bearing Capacity– Effect of Curing Days

With increase in percentage of Terrazyme and days of curing the percentage of shear strength of the soil increased from 176.1, 296.0, 385 and 453.3, for four days of curing. The percentage of shear strength increases with increasing the days of curing from 410.2, 453.3 and 496.3 for zero, four and seven days with 4 percentage of Terrazyme.

Figure 4.3 shows the percentage of Terrazyme vs safe bearing capacity with effect of days of curing for seven days. The safe bearing capacity is calculated based on the Terzaghi's bearing capacity for strip footing assuming that angle of internal friction is zero, the Terzaghi's bearing capacity factors N_c and N_q and $N_{\square}$ is 5.3, zero and zero. The safe bearing capacity is 23.7, 36.5, 65.7, 90.7 and 130.8 for zero, one, two, three and four at seven days of curing. The factor of safety considered is 3 for ultimate bearing capacity.

3. Effect of terrazyme on cbr value of soil

The strength of subgrade plays a vital role in the determination of thickness of the pavement. It is expressed in terms of California Bearing Ratio abbreviated as CBR. CBR is defined as the rate of force per unit area required to penetrate a soil mass with a standard circular plunger of 50 mm diameter at the rate of 1.25 mm/min required for the corresponding penetration of standard material. CBR value is determined corresponding to both 2.5 mm and 5 mm penetration and the greater value is used for the design of pavement. Generally, CBR at 2.5 mm is more than 5 mm penetration. If 5 mm penetration is greater than 2.5 mm the test is repeated, if the results are unchanged the value of 5 mm penetration is defined as CBR value.

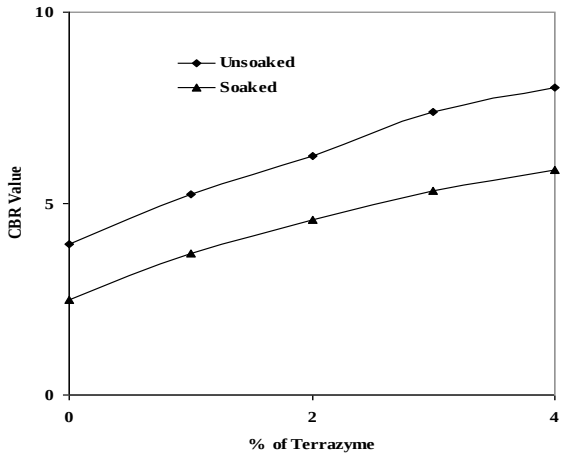

Figure 4.4 Percentage of Terrazyme vs CBR Value – Effect of Curing Days

From the investigations it was observed that CBR values of the soil were increased on increasing the percentage of Terrazyme from 3.93, 5.35, 6.23, 7.38 and 8.03 for zero, one, two, three and four percentage of Terrazyme to unsoaked CBR. Maximum CBR value of 8.03 and .6.39 is obtained at 4% Terrazyme for unsoaked and soaked CBR. With increase in percentage of Terrazyme and days of curing the change of CBR value increases from zero, 1.6, 2.62, 3.45 and 4.1 for zero, one, two, three and four percentage of Terrazyme with respected of unsoaked CBR value seven days of curing. The change of CBR values decreases from 4.1 and 3.4 for four percentage Terrazyme with respected to unsoaked and soaked CBR.

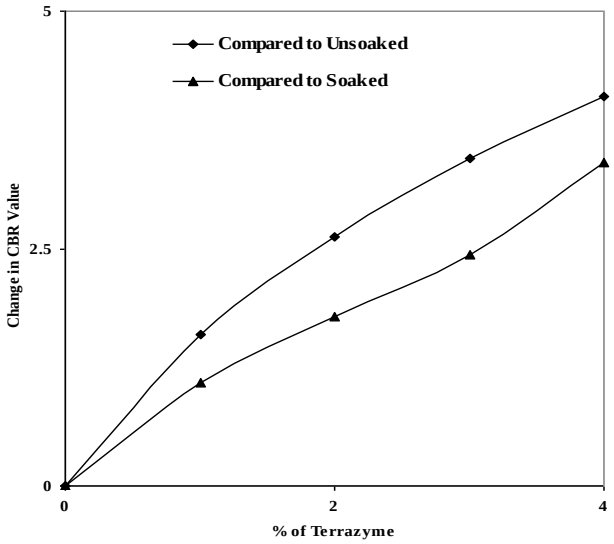

Figure 4.5 % of Terrazyme vs Change in CBR Values– Effect of Curing Days

V. CONCLUSIONS

The above conclusions are drawn from the experimental investigation using Terrazyme in varying proportions to the targeted soil. Terrazyme is the product obtained from molasses, used in the present study concludes that it is a potential stabilizer for expansive soils.

- Shear Strength of the soil increased form 5.39 kPa at 0% Terrazyme to 27.5 kPa at 4% Terrazyme, percentage increase is 410%.
- Table.No:7.1.Percentage increase of shear strength (kPa) with variation in percentage of Terrazyme for 0 days of curing.
- With increase in percentage of Terrazyme and days of curing shear strength of the soil increased from 10.8 kPa to 49.05 kPa, results are tabulated for 4 days of curing period. Percentage increase is 354%.
- With increase in percentage of Terrazyme and days of curing shear strength of the soil increased from 17.65 kPa to 78.48 kPa, results are tabulated for 7 days of curing period. Percentage increase is 345%.
- With increase in percentage of Terrazyme the un-soaked CBR value was increased from 3.93 to 8.03. Percentage increase is 104**%.**
- With increase in soaking period CBR values are increased when compared with untreated soaked soil samples.
- Tri-Axial results showed, with increase in percentage of Terrazyme shear strength of the soil increased from 6.40 kPa to 35.32 kPa, percentage increase is 451.87.
- Tri-Axial results showed with increase in percentage of Terrazyme, cohesion of the soil increased from 6.85 kPa at 0% Terrazyme to 38.60 kPa at 4% Terrazyme, percentage increase is 463.50

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