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Stabilization of Black Cotton Soil using Terrazyme Enzyme

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Abstract: ***In India the construction work is gaining huge demand. This forces the engineers to carry out the construction in unstable soils like black cotton soil or the expansive soil as India consists of vast area 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 behavior 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. Bio-Enzyme namely Terrazyme has been used as stabilizer in this work. The locally available expansive soil was accumulated from field to study the geotechnical properties. The plasticity index is much more due to the high percentage of clay content in this type of soil. Various tests were carried out for the virgin soil and bio enzyme treated soils with variable dosages. The tests carried out were the consistency limits, compaction properties, and California bearing ratio. The aim of this study is to utilize bio enzyme to improve the engineering properties of expansive soil and to increase the compressive strength and CBR value of the compacted expansive soil.***
Keywords: Black cotton soil, Bio-enzyme, soil stabilization, CBR, Terrazyme.

I. INTRODUCTION

Soil stabilization is the alteration of one or more soil properties, by mechanical or chemical means, to create an improved soil material possessing the desired engineering properties. Soil may be stabilized to increase strength and durability or to prevent erosion and dust generation. Regardless of the purpose for stabilization, the desired result is the creation of a soil material or soil system that will remain in place under the design use conditions for the design life of the project.

Terrazyme is natural, non-toxic, non-corrosive, bio degradable liquid it can be easily mixed with water at the optimum moisture content. The main aim of this product is to efficiently use of locally available material. The most common application of stabilization of soil is seen in construction of road and air field pavement. The chemical stabilization is done by adding chemical additives to the soil that physically combines with soil particles and alter the geotechnical properties of soil. Enzymes enhance the soil properties and providing higher soil compaction and strength. The most commonly application of stabilization of soil is seen in construction road and air-filled pavement. This significantly improves the strength of soil by reducing voids. The process involved in soil stabilization must be eco-friendly, cost effective and efficient. The chemical bonding of the soil particles by the use of Terrazyme and a permanent structure is formed which is resistant to wear and tear, weathering and infiltration of water in soil. Terrazyme dosage entirely depends on the type of soil, clay content and plasticity index of soil. Different parameters were considered in the present work to check the effects of Terrazyme on local soil.

II. LITERATURE REVIEW

A. Effect of Bio-Enzyme (Terrazyme) On The Properties Of Sub Grade Soil Of Road: by Hiraman A. Shirsathet al. (2017)

In this paper, the author has conducted the experiment on suitability of Terrazyme for the modification of Geotechnical properties of expansive and non-expansive soils. And also the effect of TerraZyme on the index and engineering properties of two black cotton soil and one red soil collected from sangamner, chandwad and surgana respectively. Air-dry curing condition was adopted to study the suitability of TerraZyme for field conditions during treatment of soil. Based on the test results, Unconfined Compressive Strength of all three soils has shown increased with curing time with TerraZyme. The properties of all soil have been much improved by stabilizing with TerraZyme dosage of 200ml/1.5m3 of soil. Hence this dosage is considered as the optimum one. Compaction characteristics are not affected immediately after treatment with TerraZyme. Enzyme is found to be ineffective for improving consistency limits. The initial cost of using TerraZyme is high as compared to traditional approaches but the benefit of using TerraZyme is that the maintenance cost is zero, making this approach economically cost effective.

B. Stabilization of Soil using Bio-Enzyme Article by Sandeep Panchal,Md Mohsin khan, Anurag Sharma, IJCIET VOL 8 (2017).

In this study different type of geotechnical tests were performed on the soil sample under study with and without enzyme. Consistency limits, dry density and CBR values of a local soil sample by mixing different dosages of Terrazyme with different curing periods showed great improvement. The duration of treating bio-enzyme on the local soil played an important role in the improvement of strength. The CBR value with the third dosage having two week curing period showed great outcome and percentage increase as compared to local soil sample without Terrazyme is 131.49%.

C. Effect Of Terrazyme on CBR and SHEAR Strength of Expansive Soil: by Venkatesh A, Sreenivasa RG. Effect of Terrazyme on CBR and shear strength of expensive soil, MOJ Civil Eng. 2018.

In this study CBR, Unconsolidated Undrained Tri–Axial Test was conducted to find the shear strength on the Terrazyme treated stabilized soil. The Properties of the soil were increased because when Terrazyme reacts with clay it forms a compound called Calcium Silicate Hydrate which results to impart the strength of soil and it also reacts with the adsorbed water layer present between the clay particles and reduces its thickness. When the external load is applied on the soil the particles come closer and will get a closer arrangement which helps to increase the density of the soil.

Through this experimental studies it was concluded that Shear Strength of the soil increased from 5.39 KPa at 0% Terrazyme to 27.5 KPa at 4% Terrazyme, percentage increase is 410%.And With increase in percentage of Terrazyme the un–soaked CBR values are also increased from 3.93 to 8.03, percentage increase is 104%.When compared the results of soaked CBR of both treated and un–treated soil samples an improvement was found from 2.48% to 5.89%, percentage increase is 138%.

D. Stabilization of Black Cotton Soil Using BIO-Enzyme for A Highway Material: Article by Joydeep sen and Jitendra Prasad Singh, International Journal Of Innovative Research in Science, Engineering and

In order to use this technology for low volume roads, the properties of soil modified with the bio-enzyme have been studied. Based on results from the testing done on soil treated with bio-enzyme, field trials were carried out using bio-enzyme on some of the roads in India. Also, it was found that in the dearth of granular sub-grades, bio-enzyme treated soil surfaces can be used to realize the pavement design requirement, provided with a thin bituminous surfacing. It was also found that after adaptation of the IRC method for soil CBR, the thickness of bio-enzyme stabilized soil reduces around 25 to 40 percent

III. MATERIAL & METHODOLOGY

A. Black Cotton Soil

The Black cotton soil which is used in this experiment is collected from Kunigal town, Tumkur district of Karnataka, India. The black cotton soil was collected by method of disturbed sampling after removing the topsoil at 500mm depth and transported to laboratory. The soil was air dried, pulverized and sieved as required for laboratory tests

Table 1. Properties of black cotton soil.

Sl. No	Property	Value	I S Codes
1	Specific gravity	2.49	IS 2720 (part III)
2	Atterberg limits Liquid limit (%) Plastic limit (%) plasticity index	 53 28.5 23.8	IS 2720 (part V)
3	Grain size distribution a) Gravel (%) b) Coarse Sand (%) c) Fine sand (%) d) Silt & Clay (%)	 0 10.17 20.18 68.7	IS 2720 (part IV)
4	Engineering Properties Light Compaction a) Max dry density(gm/cc) b) O.M.C %	 1.54 22.5	 IS 2720 (Part VII) IS 2720 (Part II)
5	CBR Value (%) a) Light Compaction (soaked)	 2.2	IS 2720 (part XVI)

B. Bio-enzyme

The Enzyme used for this experiment to stabilize the black cotton soil was Terrazyme

Table 2. Properties of Bio-Enzyme (Terrazyme)

Sl. No	Property	Value
1	Specific gravity	1.000-1.090
2	pH value	3.10 - 5.00
3	Appearance	Liquid
4	Odour	characteristic odor
5	Flammability	Inflammable
6	Solubility	Infinite
7	Color	Brown
8	Boiling point	212^0f

C. Enzyme Dosage

Terrazyme, has been used in the present work to study its effect on the CBR value of the Black Cotton soil. The tests conducted in this project are specific gravity, plastic limit, liquid limit, CBR and standard proctor test. In this project, local soil was mixed with Terrazyme with different dosages i.e. 0.25 ml per 100 ml of water, 0.50 ml per 100 ml of water, 0.75 ml per 100 ml of water, and 1 ml per 100 ml of water was mixed subjected to various tests as mentioned.

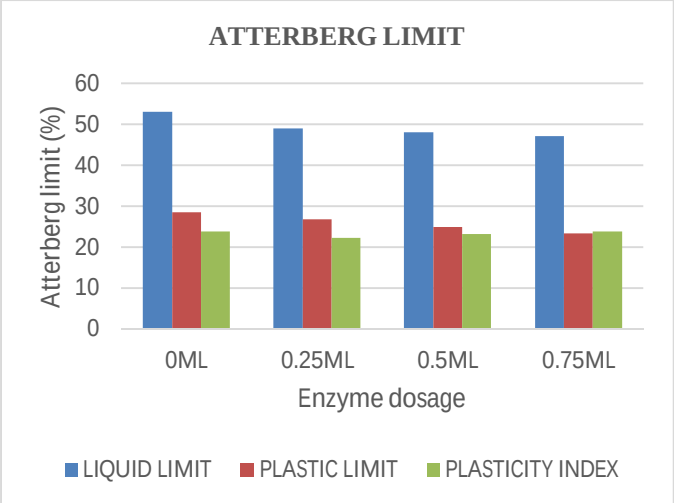
IV. EXPERIMENTAL RESULTS

A. Results on Stabilized Black Cotton Soil

1) Atterberg Limits: The experiment gives the results of consistency limit for various proportions of black cotton soil with Terrazyme.

Table 3. Atterberg limits of stabilized black cotton soil

Dosage number	Enzyme dosage	Black cotton soil		
		Liquid limit (%)	Plastic limit (%)	Plasticity index
0	0 ml	53	28.55	23.81
1	0.25 ml	49	26.70	22.3
2	0.5 ml	48	24.84	23.16
3	0.75 ml	47	23.25	23.75



Graph 1 . Atterberg limits of stabilized black cotton soil

2) *Compaction Test:* For black cotton soil with different proportions of Terrazyme, standard proctor test was conducted and resulted below.

Table 4. OMC of stabilized black cotton soil.

Dosage number	Enzyme dosages	Standard compaction (light) OMC (%)	Standard compaction (light) MDD (gm/cm^3)
0	0 ml	22	1.54
1	0.25 ml	21.40	1.56
2	0.5 ml	20	1.63
3	0.75 ml	21	1.58

3) *California Bearing Ratio (CBR) Test:* California Bearing Ratio test was conducted for different proportions of black cotton soil with Terrazyme. The mould is kept in water for 4 days and tested.

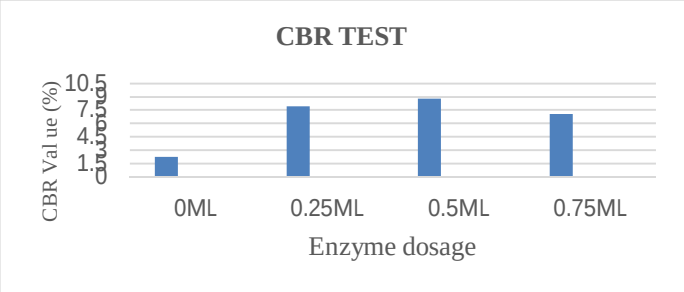
Table 5. CBR value of black cotton soil with varying enzyme dosage at 2.5&5mm penetration

Enzyme dosage	CBR @ 2.5mm penetration	CBR @ 5mm penetration	CBR value @ 2.5mm	CBR value @ 5mm
0ml	30.5	35	2.22	1.7
0.25ml	108.6	154.9	7.92	7.53
0.5ml	121	171.2	8.80	8.33
0.75ml	96	140.6	7.04	6.84

The C.B.R. values are usually calculated for penetration of 2.5 mm and 5 mm. Generally the C.B.R. value at 2.5 mm will be greater that at 5 mm and in such a case/the former shall be taken as C.B.R. for design purpose. If C.B.R. for 5 mm exceeds that for 2.5 mm, the test should be repeated. If identical results follow, the C.B.R. corresponding to 5 mm penetration should be taken for design.

Table 6. CBR value of black cotton soil with varying enzyme dosage

Dosage number	Enzyme dosage	C.B.R. value
0	0 ml	2.22
1	0.25 ml	7.928
2	0.5 ml	8.80
3	0.75 ml	7.04



Graph 2. CBR value of black cotton soil with varying enzyme dosage

V. CONCLUSION

Based on the tests conducted the following conclusions have been drawn which are applicable only to materials used and test conditions adapted in this study

A. Bio- Enzyme (Terrazyme) is found to be inadequate for consistency limits.

B. Terrazyme reduced the compaction effort and improved soil workability; where MDD increases and OMC decreases with addition of Terrazyme at Enzyme dosage of 0.5ml showed maximum density 1.63 gm/cc with 20% OMC.

C. For a higher dosage of 0.5 ml, the CBR value of BC soil increased by 8.80 percent.

D. The initial cost of using Terrazyme is high as compared to traditional approaches but the benefit of using Terrazyme is that the maintenance cost is zero , making this approach economically cost effective.

E. The 0.5ml dosage of enzyme is the optimum one because the consistency limits are reduced and the soaked CBR increased after curing period of two weeks.

The conclusions presented above refer to a limited number of tests and enzyme stabilizers combinations tested in laboratory conditions and should not be extrapolated to other combinations of materials. These results should be validated with field experiments that involve the same combination of materials used in this study.

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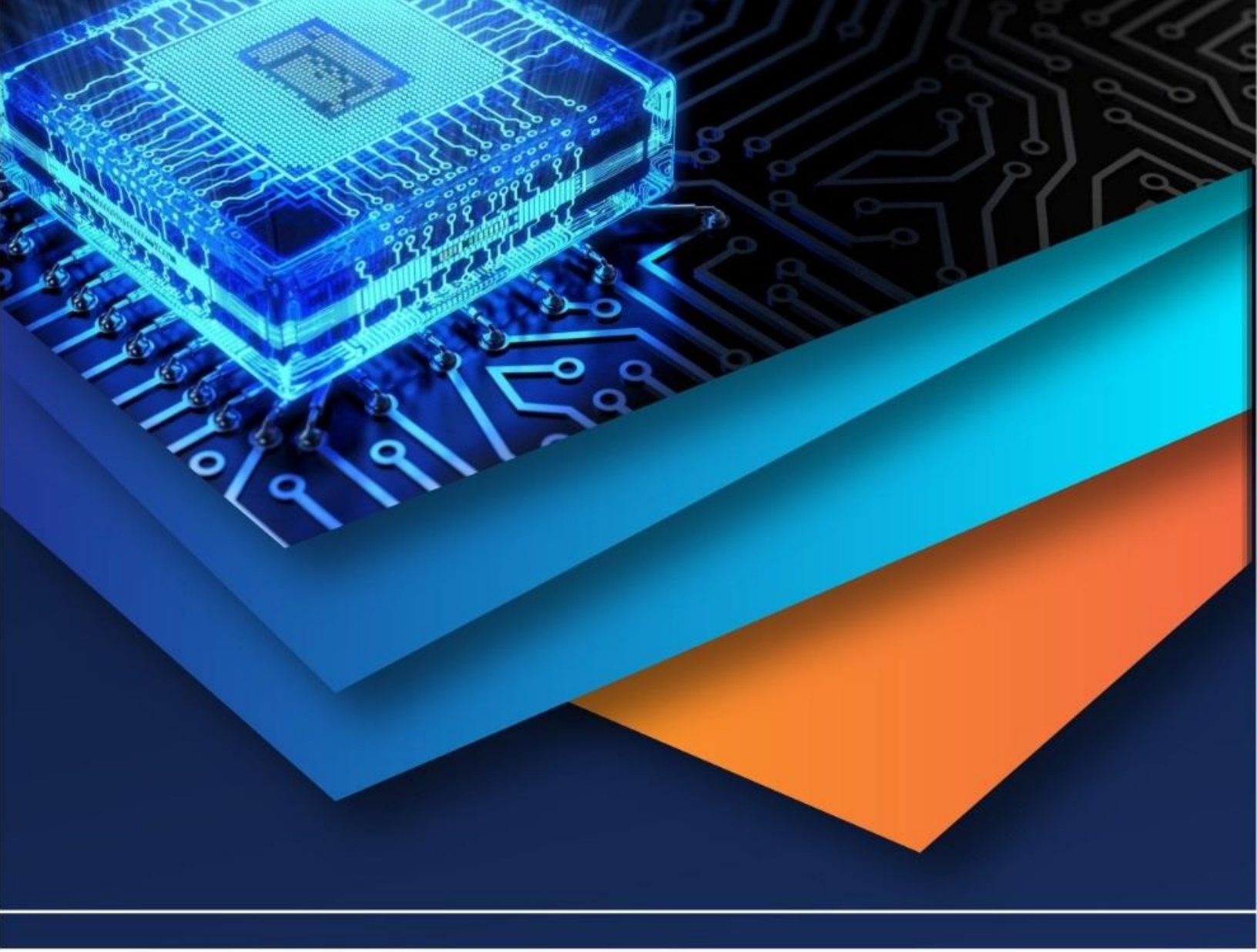

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