Characterization of Black Cotton SoilStabilization Using Terazyme

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ABSTRACT

In developing countries like India the most important requirement of any project after performance criteria is its economical feasibility and serviceability criteria. The conventional methods are time consuming and are not economically feasible. Hence there is a need to find the other possible ways to satisfy the performance as well as economical criteria. These enzymes have been proven to be very effective and economical. Another advantage of the bio-enzyme is that these are environment friendly. The efficiency of bio enzyme depends upon theamount of dosage, type of soil and curing period. In our country vast areas consist of black cotton soils. As the conventional soil stabilizers like gravel, sand and others are depleting andbecoming expensive day by day at a very rapid pace, it becomes necessary to look towards for alternative eco-friendly stabilizers as their substitute. Recently many Bio-enzymes have emerged as cost effective stabilizers for soil stabilization. One such type of bio-enzyme, Terazyme, has been used in the present work. The Terazyme effect on the unconfined compressive strength and on the atterberg limits were studied. The enzyme treated soil showing significant improvement in unconfined compressive strength values. The untreated soil has compressive strength as 71 kN/m^2. After treating with Terazyme the soil showed significant improvement in strength. With curing period, the strength is increasing. The strength increment was found to be 300 percent. No significant improvement in liquid and plastic limit values with treatment of Terazyme enzyme. The compression index and coefficient of consolidation values decreasing with enzyme treatment for a prefixing curing period.

Keywords: Black Cotton Soil, Shear Strength, OMC, Unconfined Compressive Strength,Consolidation.

I. INTRODUCTION

Black cotton is one of the expansive soil available in India. Black cotton soil is an expansive soil that generally available in the tropical zones. Their appearance varies from black colour to brown colour. In our country black cotton soil occupies nearly 20% of the available land. A liquid chemical products are actively marketed for stabilizing soils on pavement projects. Normally supplied as concentrated fluids, these additives are mixed with water on the field and splashed on the soil to be dealt with before compaction. Pressure injection is sometimes used to treat deeper soil layers. The concept behind chemical stabilization is to keep the soil properties same, positive effects of the given engineering project with respect to changes of moisture in environment. As known in soil chemistry, clay minerals are arranged in layers with various ions and surrounded by absorbed water molecule. The absorbed water molecule strongly connected to clay surface.

In this present study, one type of Bio-enzyme that is Terazyme has been used for alerting the properties of black cotton soil. Detailed laboratory tests were carried out to ascertain the benefits in terms of engineering properties.

Soil stabilization

The mode of alteration and the degree of alteration necessarily depend on the character of the soil and its deficiencies. In general requirement is adequate strength. In the case of a cohesion less soils can be achieved by proper confinement or by mixing the cohesion lees soil with cohesion material. Here the cohesion material act like a cementing agent. In case of cohesive soil, we can improve the soil strength by drying process or make the soil water resistant, changing the soil electrolyte configuration by adding frictional properties. Stabilizing the soil is one of the technique to increase soil strength and maintain atterberg limits within inthe specified limit. Stabilization can be broadly classified into two type:

1. Mechanical stabilization
2. Chemical stabilization

Mechanical Stabilization

In general, weak aggregates are preferred for mechanical stabilization. Mechanical stabilization covers two strategies for changing soil properties

1.the soil particles rearrangement By improving the gradation of soil. Any material prone to weathering action is suitable for mechanical stabilization.

Chemical Stabilization

Chemical stabilization comprises of binding the soil particles by a cementing agent. The binding agent i.e. cementing agent can be produced chemical reaction within in the soil.The chemical reaction does

not as a matter of course incorporate the soil particles, although the holding involves intermolecular strengths of the soil.

Soil stabilization by enzyme

An organic catalyst that increases the rate of chemical reaction without being part of end product is called as enzyme. Initially the enzymes are used in treating the horticulture products. For roads to be stabilized by the enzymes require strength and durability. The enzymes are modified by little amount to keep the clay durable. The enzymes react with organic molecules and forms a compound. This compound plays an important role in ions exchange process. First step in ions exchange processes is break down the lattice structure and enzyme act like a surfactant. These surfactants will avoid the clay further gaining the moisture content. After mixing with soil, enzymes are adsorbed by the clay lattice structure. They play a vital role on lattice structure, at first making them to expand and afterwards to tighten. Colloids absorb the enzyme empowering them to be transported through the soil electrolyte media. Generally, soil bacteria release the hydrogen ions. The enzymes are catalyses the process.by chain reaction enzyme are regenerated and goes on reacting.th size of ions is large, so some amount of osmotic migration took place. For this enzyme requires better mixing process. After adding the enzyme to the soil immediately enzyme increases the clay particle wetting and bonding behaviour. For this reason, soil will be compacted to denser that will increase the density of soil Also. Enzymes enhance the chemical bonding. It will help to bind the soil particles more closely. So the clay structure becomes permanent structure; it becomes more durable to weathering conditions.

Scope and objective of research work

There are majorly 4 types of bio-enzymes till date are Renolith, Permazyme, Fujibeton and Terazyme. In the present investigation an attempt is made to stabilize the black cotton soil with bio Enzyme (Terazyme). Detailed laboratory tests were carried out to ascertain the benefits in terms of engineering properties**.**

(a) To evaluate physical properties of Black cotton soil.

(b) To determine the effects of adding enzyme to black cotton soil on its properties.

II. LITERATURE REVIEW

As a prelude to begin with a project it is more essential to have general and detailed information regarding the subject content, strategic approaches, available research in the subject area, interpreted results and drawn conclusions. This chapter reviews the attempts made by several researchers to understand the behaviour of Enzymes as reinforcing material in soil.

Isaac et al. (2003) had conducted laboratory study on five types of soil namely CL, OH, CH, CI SX.to improve the five soil properties they mixed with bio enzyme. They conducted CBR test for a pre fixing curing period. From the results it is clear that Terazyme is very effective, economical. most effective in case of silt content is more.

Velasquez et al. (2005) studied the enzyme mixing on soil stabilization. they used two types of enzymes namely enzyme A and enzyme B. They conducted chemical analysis of enzyme A before the mechanical testing. After that they conducted resilient modulus and shear strength test on two soils which were stabilized with two different enzymes. Two types of soil are used named as soil 1 and soil 2. soil 1 mechanical properties are not affected by the enzyme A with enzyme B. The stiffness of soil 1 was increased. The resilient modulus of soil 2 increases by the application of both enzymes A and B. With time the enzyme activity on the soil stabilizationincreases. From the observations minimum four months of time required to get improvement in the shear strength of the soil.

Shankar et al. (2009) studied the effect of Terazyme on locally available lateritic soil. The investigated lateritic soil was collected from udipi district region in Karnataka state. The lateritic soil is not full fill the requirements of sub base coarse.so to brought down the atterberg limits they mixed the lateritic soil with locally available river sand. The blended soil is mixed is stabilized by using Terazyme enzyme.

Faisal A (2012) studied the three different types of residual soils. These three soils named as soil 1 soil 2 and soil 3. They conducted the tests as per the British institution. To brought downthe residual soil atterberg limits, the residual soil is mixed with liquid chemical. The liquid chemical was mixed to the residual soil in four different proportions. The liquid chemical mixed residual soil is tested after 1, 7 and 14 days. It has been observed that the atterberg limit values is decreasing pattern. They conducted the proctor test. The liquid chemical soil showing.

Greeshma et al. (2014) conducted experimental work on high liquid limit clay. The liquid limit clay behaviour was investigated by using Bio enzyme Terazyme additive. With treatmentof Terazyme the liquid limit is about 30% increase in the first two weeks. After that liquid limit is decreased slightly. However, shrinkage limit was decreased. The ucs value enhanced twelvetimes the original value.

Agarwal p and Kaur S (2014) studied the effect of Terazyme effect on expansive soil. They conducted unconfined strength test to determine the optimum dosage value. To determine the optimum value of dosage totally 5 dosages are mixed to the soil. After that they tested with curing period of 1day and 7 days. From experiments concluded that UCS strength value increases about 200 percent. They give the reason for working mechanism of Terazyme.

Rajoria V and Kaur S (2014) presented a research paper on soil stabilization by using enzymes. In this research paper four different types of enzymes were discussed. These enzymes are practised in different

countries. The four enzymes are Renolith, Permazyme, Fujibeto and Terazyme. Renolith enzyme was developed in Germany country. Renolith is mixed with water in a predetermined quantity. This water mixture was sprinkled over the soil. This type of enzyme is suitable in cement stabilized soil. By using Renolith enzyme cost reduction is reduced about 20 to 40 percent. This enzyme was helpful in arresting cracks.

II. MATERIAL AND METHODOLOGY

MATERIALS

For the present research work, black cotton soil was collected from Ambedkar nagar Balaghat Madhya Pradesh by method of distributed method of sampling black cotton soil was collected. Before the digging Top soil layer was removed. Because it contains naturalvegetation. The soil was taken at a depth of 1.5-meter for the research work. To know the natural moisture content soil was sealed in a polythene bag. Measures were taken for there is no further loss of moisture content. The collected soil was air dried for 1 day. The air dried soilwas pulverized using wooden hammer. The pulverized soil was passed through 4.75 mm sieve.Soil passed through 4.75mm sieve was taken in this research work.

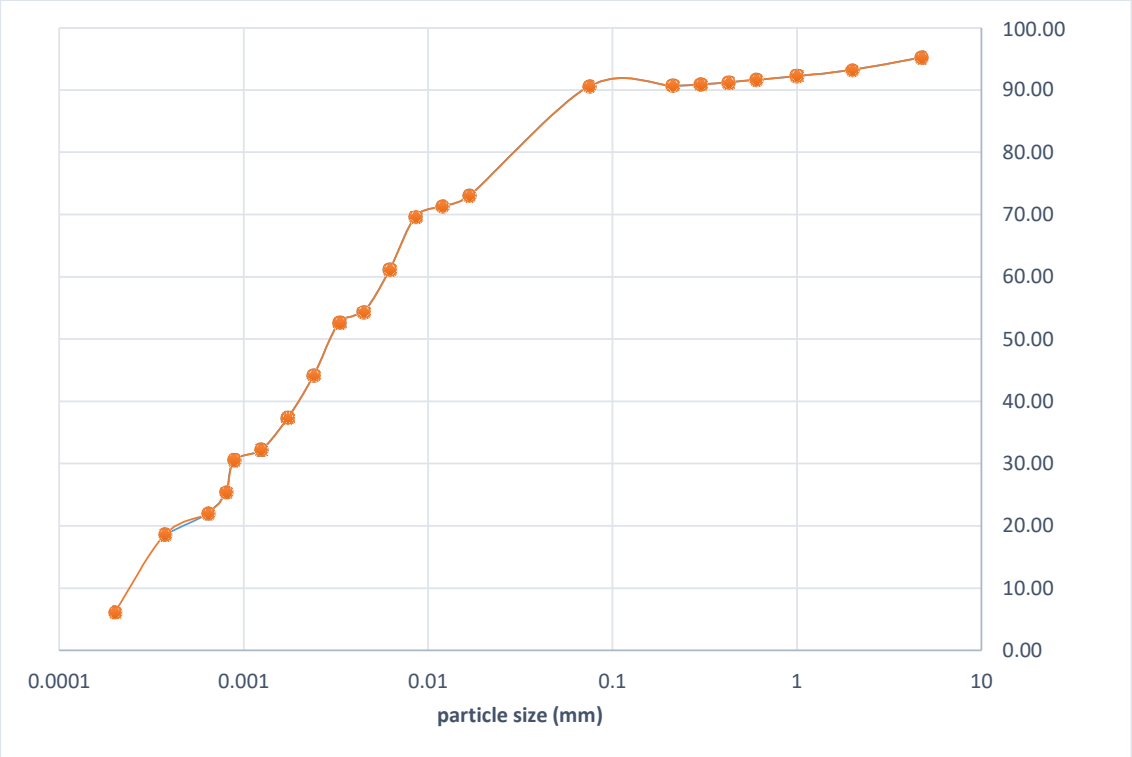

Fig 3.1 Grain size distribution curve

From the graph it is observed that coefficient of uniformity was 2.4 and coefficient of curvaturewas 0.54

Table 3.1 Properties of black cotton soil

SL.NO	PROPERTIES	CONFIRMING TO ISCODE	VALUE
1	Coefficient of uniformity(Cu)	IS: 2720 (Part 4) -1985	2.65
2	Coefficient of curvature (Cc)	IS: 2720 (Part 4)-1985	0.54
3	Specific gravity (G)	IS: 2720 (Part 3)-1980	2.65
4	Maximum dry density (MDD),kN/m^3	IS: 2720 (Part 7)-1980	14.10
5	Optimum moisture content(OMC), per cent	IS: 2720 (Part 7)-1983	30.00
6	Modified proctor test, kN/m^3	IS: 2720 (Part 8)-1983	16.70
7	Modified proctor moisturecontent, per cent	IS: 2720 (Part 8)-1983	20.00
8	Natural moisture content, percent	IS: 2720 (Part 2)-1973	7.00
9	Free swell index, per cent	IS: 2720 (Part 25)-1977	78.00
10	Liquid limit ,per cent	IS: 2720 (Part 5)-1985	83.00
11	Plastic limit, per cent	IS: 2720 (Part 5)-1985	35.00
12	Unconfined compression test,kN/m^2	IS: 2720 (Part 10)-1991	71.00
13	classification	IS: 2720 (part 4)-1985	CH
14	Swelling pressure, kN/m^2	IS: 2720 (part 41)-1977	180

TERAZYME ENZYME

Terazyme is a natural enzyme. Terazyme was prepared from molasses from fermentation process. Terazyme is a nontoxic, eco-friendly non-flammable material. Generally chemical products stored with care. In case of Terazyme no need of special care. While handling Terazyme product no gloves were required. The use of Terazyme in the construction of base and sub-base structures removes the need for the use of a sand/gravel mix, soling or water bound macadam in the construction of road structures. The base and sub-base constructed with Terazyme are built up immediately from the sub-grade level. When compared to conventional structures Terazyme constructed structures showing a much greater flexural strength and a higher CBR % than the conventional structures.

Table3.2 properties of Terazyme

S.No.	PROPERTY	VALUE OR DESCRIPTION
1	Identity(appeared on label)	N-zyme
2	Specific gravity	1.05
3	pH value	3.50
4	Appearance/Odour	Dark Brown liquid/ Non-obnoxious
5	Hazardous components	None
6	Boiling point	100^0c
7	Evaporation rate	Same as water
8	Solubility in water	Complete
9	Melting point	Liquid
10	Reactivity data	Stable
11	Materials to avoid	Caustics and strong bases

IV. RESULTS AND DISCUSSION

Varying quantities of stabilizers can cause different effect in the same soil sample. Insufficient quantity of Enzyme (Terazyme) may lead to less stabilization of the soil where as excess quantities may result the stabilization ineffective and uneconomical. Hence, to determine the optimum quantity of Enzyme for best results, UCS, Swell pressure, consistency limit tests were conducted on each of the soil samples with varying quantity of Enzyme (Terazyme).

CONSISTENCY LIMITS

The effect of Enzyme at different dosage on index properties (Liquid limit, Plastic limit and Plasticity index) of investigating soils have been presented in Table 4.1. From this table 4.1 it is observed that liquid limit decreases marginally and plastic limit also decreases marginally. Terazyme is found to be insignificant for improving consistency limits.

Table 4.1 Consistency limits of enzymatic soil

Dosage number	**Enzyme dosage**	**Liquid limit (%)**		**Plastic limit (%)**		**Plasticity index**	
0	**Un treated**	83.50		35.54		47.96	
	Black cotton soil	7 days	14 days	7 days	14 days	7 days	14 days
1	**200 ml/3.0 m^3**	82.80	81.50	35.00	35.00	47.80	46.50
2	**200 ml/3.0 m^3**	82.10	80.50	34.20	33.50	47.90	47.00
3	**200 ml/2.5 m^3**	80.20	80.10	34.40	33.00	45.80	47.00
4	**200 ml/2.0 m^3**	80.00	79.00	34.50	32.00	45.50	47.00
5	**200 ml/1.5 m^3**	79.00	77.00	34.30	31.50	44.70	45.50

UNCONFINED COMPRESSIVE STRENGTH (UCS)

For tests of specimen of soil– Terazyme mixtures, specimens were prepared by thoroughly mixing the required quantity of soil and Terazyme as per preselected proportion in dry state and then calculated quantity of water to be sprinkled and mixed thoroughly to get a homogeneous and uniform mixture of soil and Terazyme, and the test results obtained are discussed as follows.

Unconfined compressive strength of black cotton was evaluated by stabilization with variable dosages of enzyme for 0, 7, 14, 21, 28 and 60 days curing. The specimens were prepared and kept in desiccator to retain moisture of the sample so that reaction between soil particle and enzyme would be continued. Numbers of samples were tested with different dosage of enzyme i.e., 200 ml for 1.5, 2.0, 2.5, 3.0, 3.5 m^3. The results of the UCS tests for natural and treated soil compacted at maximum dry density and optimum moisture content

Fig 4.1 Experimental setup for UCS

Fig 4.2 Failure pattern of the specimen

Table 4.2 UCS of black cotton soil with curing period

Dosage number	Dosages	UCS of soil in (kPa) for period of treatment					
		0 day Curing	7 days curing	14 days curing	21 days curing	28 days curing	56 days curing
0	Un Treated	71					
1	200 ml/3.5 m^3	96	120	136	145	165	224
2	200 ml/3.0 m^3	113	131	135	154	184	242
3	200 ml/2.5 m^3	117	139	167	177	212	272
4	200 ml/2.0 m^3	121	186	212	224	277	313
5	200 ml/1.5 m^3	125	173	201	211	248	262

Table 4.2 Swell pressure test of black cotton soil with different enzyme dosage

Dosage number	Enzyme dosage	Swelling pressure (kN/m^2)		
0	**untreated**	180		
1	**200 ml/2.5 m^3**	7 days	14days	30days
		160	120	52
2	**200 ml/3.5 m^3**	162	127	64

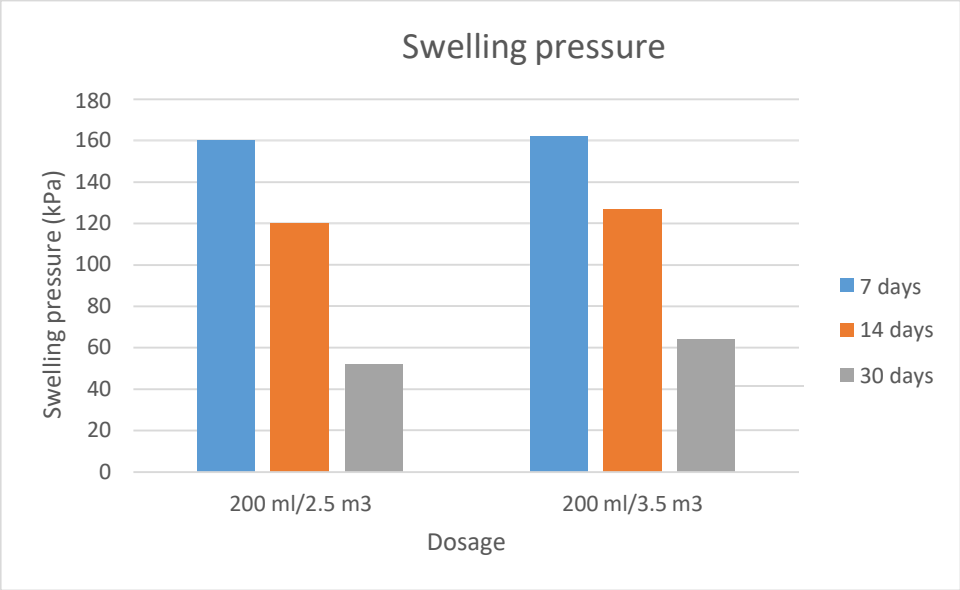

Fig 4.3 Variation in swelling pressure for different curing period

Effect of different dosage of Terazyme on UCS values for different curing period

Figure shows the UCS results of black cotton soil for different curing periods with different dosage of Terazyme. Fig 4.8 shows uniform increment in UCS along with increase incuring period, for untreated soil, UCS value increases as curing period increases up to 60 daysfor dosage number 1 and 2 there is uniform increase in UCS value along with curing period, and dosage number 3 and 4 shows similar trend along with curing period, strength gains have been much improved for dosage number 3 and 4 compared to dosage 1 and 2.

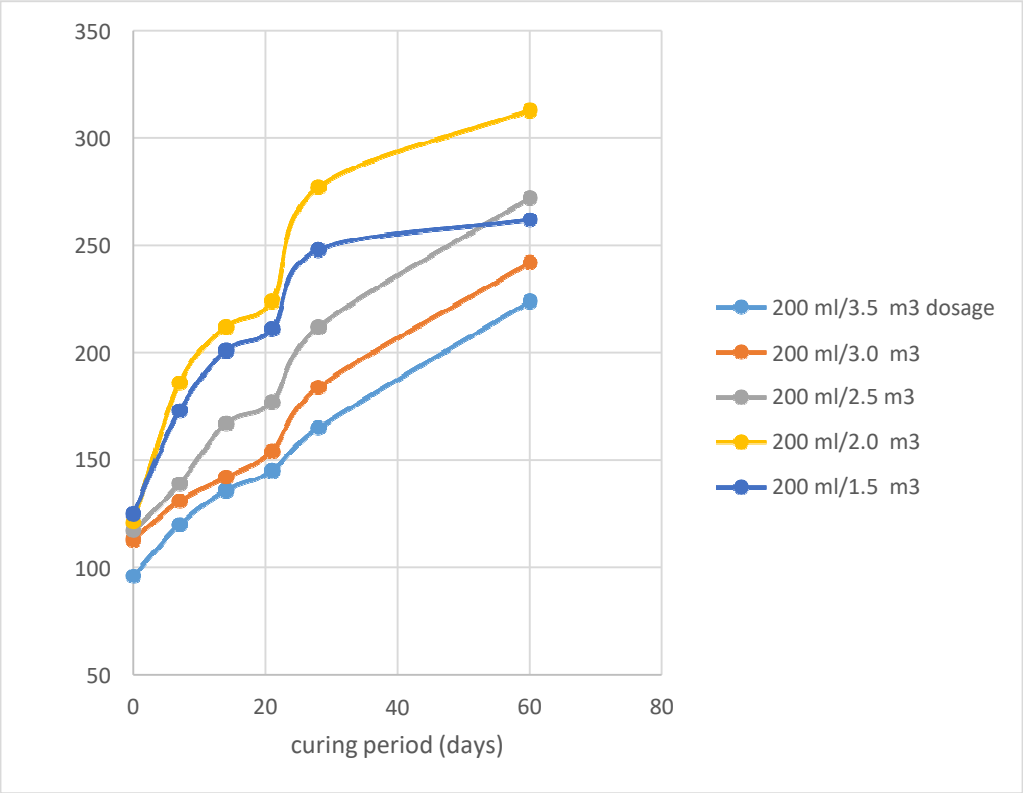

Fig 4.4 Variation of UCS for different curing period on black cotton soil

V. CONCLUSION AND FUTURE WORK

The present research work was done to improve the geotechnical properties of black cotton soil. To improve the geotechnical properties a bio enzyme called Terazyme had been used. The Terazyme enzyme was mixed to the soil for different dosage and different curing period were tested. From the experimental investigation and results obtained, the following conclusions are drawn.

1. Untreated black cotton soil has 83.50% liquid limit. After adding the enzyme there is slight change in liquid limit. The overall plasticity index is in between 43.00-48.00
2. The atterberg limits of the treated enzymatic soil not with in the specified limits. Sincethe enzymatic soil having liquid limit in the range of 83.00%-79.00%. plasticity index is in between 43.00-48.00. The values are not satisfying the subgrade of a pavement. So it is unsuitable to use as sub grade material of the pavement
3. The unconfined compressive strength of enzyme treated soil indicates good improvement with curing period

4. The coefficient of consolidation decreases with curing period. However, there is slightdownfall for first week curing period to second week curing period
5. The compression index values decreasing with curing period

A Scope for future work

The following aspects may be further investigated

1. Effect of some other additives like fly ash and lime with enzyme product.
2. Effect of different bio enzyme products.
3. Permeability, shear strength and CBR have to be conducted.
4. In the present research work for only black cotton soil was studied. There need to be check the enzyme suitability for different soils with different environmental conditions.

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