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Stabilization of Black Cotton Soil by Using Terrazyme Chemical

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A B S T R A C T

In developing countries like India the most important requirement of any project after performance criteria is its economical , feasibility and serviceability criteria . The traditional methods are not economically feasible also time consuming . Hence , it has created a need to discover the other possible ways to satisfy the performance as well as economical criteria . The present paper describes a study carried out to check the improvements in the properties of black cotton soil (BCS) and red soil (RS) with a bio - enzyme , named Terrazyme .

Bio - enzyme improves the engineering qualities of soil , facilitates higher soil compaction densities and increases stability . Bio - enzyme helps in easy mixing with water at optimum moisture content (OMC) and then it is sprayed over soil and compacted . Soil with varying index properties have been tested for virgin as well as stabilized soil with different dosages .

The test results indicate that stabilization improves the soil strength up to great extent , which implies that the bearing capacity and the resistance to deformation increases in stabilized soil . The locally available material can be used , and in case of scarcity of granular material , only bio - enzyme stabilized thin bituminous surfacing can fulfill the pavement design requirement . Adopting the IRC method based on soil CBR , the pavement design thickness on stabilized soil also reduces 25 to 40 percent . The use of bio- enzyme in soil stabilization is not very popular due to lack of awareness between engineers and non - availability of standardized data.

Keywords: Components, Levels, R.C.C Elements, Plan, Section and 3D Model.

1. Introduction

Terrazyme is a chemical used for soil stabilization, particularly in black cotton soil. It helps enhance the soil's engineering properties, such as strength and durability, by reducing its plasticity and increasing its bearing capacity. This can be particularly beneficial for construction projects on such soil types, preventing issues like swelling and shrinking.

Black cotton soil, also known as expansive soil, is highly expansive and susceptible to volume changes due to moisture variations. Its instability poses challenges for construction projects, leading to cracks, settlements, and structural damage.

Terrazyme is a chemical agent specifically designed for soil stabilization. It typically consists of enzymes and polymers that interact with the soil particles, altering their properties to improve stability and strength.

Terrazyme is applied to the soil surface either through spraying, mixing, or injection methods, depending on the site conditions and project requirements. The chemical penetrates the soil, forming bonds between the soil particles and creating a stable matrix.[1],

2. Literature Review

1. ***Sandeep Panchal Et Al (2017):*** I this study the different type of Geo- technical test where pro-form on the soil sample under the study with and without enzyme. The duration of treating bio- enzymes on the local soil played important role to improvement of strength. The CBR value with third dose is having a two-week curing period, show a great outcome and percentage increase as compared to local soil sample without Terrazyme is 131.49%.
2. ***Riyanka Shaka Rt Al (2016):*** Base on IS classification. Red soil classified as clayey sand The black cotton soil highly compressible clay. the laboratory testing show that the decrease in liquid limit. The plastic index was observe with increase in doses of Terrazyme . also the Terrazyme doses of 200 ML 0.75m^3 of dry soil generate the best result. Further increase in the doses does not alter the plasticity

characteristics of soil substantially over whether CBR value of the soil sample was increase by 2.75%, 3.345%, 3.47% and 3.56% application of the bio enzyme with doses of 200 ML to 0.75m^3 with further increase in the doses of the enzyme, no substance increase was record it

3. ***Venika Saini Rt Al (2015):*** In this work the performance of bio enzymatic soil has been scrutinized. from the result obtained by the test conducted on the soil. The following observations were made the bio enzyme or organic non-toxic and biodegradable in nature. the end products obtained by use of Terrazyme and biodegradable in nature and their effect in perpetual. the initial cost for the application of the Terrazyme may be high as compared to other traditional proportional, but the benefit of using Terrazyme and such as the zero-maintenance cost, long durability, make this approach, economical, cost-effective

4. ***Vajay Rajorial Suneet Kaur (2014):*** The carried out the theoretical evaluation of enzyme, the reduction of about 18 to 26% in seen in cost of construction of road by using Terrazyme as a soil stabilizer, the constructed by public work the department in Maharashtra, the structure made of bio enzyme or economical and have a greater strength

5. ***Venkatasubramanian And Dinnakaran (2011***): Conducted test on three soils with varied properties and different doses of bio-enzyme. The three soil has liquid limit of 28,30 and 46% and plastic index of 6,5and 6 % increase in unconfined compressive strength. After a 4 week of curing was reported as 246 to 404%.

6. ***Shankar Et.Al (2009):*** Conducted test on lateritic soil of Dakshina Kannada (District of India) the initial liquid limit and plastic limit soil were, 25% and 6% respectively. The lateritic soil of district Was not satisfying the sub base requirement. for satisfying the sub base course requirement. Sand is mixed with soil different proportion until specified volume where attend the study was done on the effect of enzyme on soil properties like CBR UCS permeability for a period of 4 weeks, the CBR volume increase by 300% with above 10% send 200 ML/m^3cube of enzyme mix with soil. After a 4 week of curing. It was a concluded from the CBR result on treated and untreated soil. The addition of enzyme and non-cohesive soil has not effective on the cohesion less soil [2],

7. ***Harma (2006):*** Has conducted laboratory studies on use of bio- enzyme and stabilisation of three types of soil namely clay of highly plastics (CH) play low plastic (CL) and silt Low plastic (ML). It was found that the(CH) soil hard increase in CBR value with reduction in the saturation moisture from 40 to 21% after a 4 week of stabilisation also it was found that there was 100% increase in unconfined compression strength.

3. Materials

TERRAZYME – Terrazyme is a liquid enzyme which is organic in nature and is formulated form the vegetable and fruit exact. It is brown in color with smell of molasses and can be easily use without the need of masks or gloves. It is easily mixed with water for optimal result should be diluted with optimum moisture content of that soil. This decreases the swelling capacity of soil particles and reduces Permeability

Terrazyme is a proprietary blend of enzymes developed by doters, a company known for its essential oils and wellness products. Enzymes are proteins that catalyse biochemical reactions in living organisms, and Terrazyme is specifically designed to support healthy digestion and metabolism.

Terrazyme contains enzymes that catalysis biochemical reactions in the soil. These enzymes accelerate the breakdown of organic materials present in the soil, such as plant residues and other organic matter. As these organic compounds decompose, they release nutrients and create a more favorable environment for soil

Table No -1 Components

Identify (as it appears on lead)	**N-Zyme**
Hazardous components	None
Boiling Point	100 Degree Celsius
Specifics gravity	1.05
Melting Point	Liquid
Ph value	4.4
Evaporating Rate	Same as water
Solubility in water	Complete
Solubility in water	Brown Liquid obnoxious

Mechanism of Terrazyme - n clay water mixture positively charged ions (cat ions) Are present around the clay particle. Creating a film of water around the clay particle that remains attach or absorbed on the clay surface. the absorbed of water or double layer gives clay particle their plasticity. Terrazyme replace absorb water with organic content. Those neutralizing the negative clay particles. The the organic cations also reduce the thickness of electrical double layer. This allowed the Terrazyme treated soil to be compact it more tightly together. Terrazyme resist being replaced by water thus reducing a tendency of some clay to swell. Terrazyme promote the development of cementitious compounds using the following general reaction

H2O+Clay ⟶ Calcium Silicate hydrate (1)

Calculation of Terrazyme Dosage –

1. Determine quality of soil to be treated with 1 liter of terrazyme of Terrazyme in cubic meters based on plasticity and graduation
2. Red 0.01 ml of TZ Concentrate per kg of soil mix.
3. Lab preparation = 0.01 ml of TZ concentrate +100 ml water (1:100 dilution)
4. Withdraw from the lab preparation that ml as required and add to the water required to bring sample to within 2 percent below optimum moisture content
5. Mix water required + mls of lab application mixture with soil sample
6. The dosage used in experiments is 0.01ml to 0.02ml and 0.03 ml on trial and error basis

4. Methodology

It is necessary for both consultants and contractors, as executors involved in a production process that is making use of Terrazyme, to understand that significant cost savings that can be achieved through the relatively fast speed of construction with Terrazyme.

4.1 Pre-construction-

For companies or organisation without prior experience with Terrazyme , it is advisable to contact a certified consultant or the manufacturer for advice on the dilution ratio and the crust thickness of the sub - base and base layers of the road structure . The certified consultants or the manufacture can provide design assistance to determine the need for pavement on the stabilized soil layers and the type of pavement that can be selected.

It is imperative to properly study the characteristics of the selected soil to insure its suitability for treatment. Depending on characteristics of the soil information on the plasticity and load bearing capacity, it is necessary and prudent in some cases to submit the soil prior to the initiation of the project to laboratory or field trials to ensure its suitability. [3]–[10]

4.2 Quality control

Quality Control The quality control of structures constructed making use of the bio - enzymatic soil stabilizer, Terrazyme has to be done by engineers who have a proper understanding of soil mechanics and road construction.

Attention can be given to the fact that the proper soil that was selected is also actually used during the construction of the road structures. After the construction of Terrazyme layers, density test such as the Proctor density test can provide information on the quality of compaction while load bearing test such as CBR or DCP test can provide information on the strength increase of the soil during its curing period.

After the embankment or the box cutting has been made according to the conventional construction methods, the construction team puts a layer of scarified soil on top of the sub - grade soil and remove all the large stones, roots and trash from the loosened soil . Road grader or farm tractor with teeth is used.

Pulverize the scarified soil , so that the mass separated from particles rather than breaking down of individual particles with the help of either road grader or farm tractor with roto - tiller , or any other mixing equipment. [11]–[16]

5. Test Results

Table No 2 – Properties of black cotton soil

SR.NO	PROPERTY	VALUE
1	Specifics gravity	2.23
2	Atterbergs limit	
	Liquid limit	42%
	Plastic limit	18.18%
	Plastics index	23.82%
3	Grain size	
	Distribution	
	a) Gravel (%)	52.50

	b)	Corse stone (%)	28.50
	c)	Fine stand (%)	13.75
	d)	Silt and clay (%)	03.25
4	Free swell index %		70%
5	Engineering properties		
	a)	M.D.D (KN/M^3)	1.5g/cc
	b)	O.M.C (%)	22.23%

Table N0 -3 Liquid limit black cotton soil

SR.NO	Particulars	Black Cotton soil		
1	**Container no**	8	25	12
2	**No of blows**	33	23	9
3	**Wt. of container (W1)**	11	10	10
4	**Wt. of container +wet soil gm**	29	30	30
5	**Wt. of container + wt. of dry soil (w3)**	24	24	23
6	**Wt. of water soil (gm)**	18	20	20
7	**wt. of water in gm**	5	6	7
8	**Wt. of soil (gm)**	13	14	13
9	**Water content (%)**	**38.57**	**42.88**	**53.84**

Table No 4- Plastics Limit Test

SR.NO	PARTICULAR	BLACK COTTON SOIL
1	Container no	27
2	Wt. of container (W1)	11
3	wt. Of container +wt. of wet soil(W2)	24
4	Wt. of container +wet of dry of soil (W3)	22
5	Wt of wet of soil (gm)	13
6	Wt of water (gm)	2
7	Wt of dry soil (gm)	11
8	**Water content (%)**	**18.18**

Table No- 5 Unconfined Compressive Test

CURING PEIOD IN DAYS	UNCONFINED COMPRESSIVE STRENGHT (KPA)			
	BCA ALONE	**BCS+TZ (1)**	**BCS+TZ (2)**	**BCS+TZ (3)**
0	147	163	184	174
7	-	180	234	218
15	-	240	309	276

30	-	283	352	305

Table No -6 CBR Determination for Bcs

PENETRATION (mm)	**CBR (%) BCS+TZ**	**BCS+TZ**	**BCS+TZ**	**BCS+TZ**
2.5	2	3	3.5	2.98
5	3	4	5	4.24
7.5	-	8	9	5.02

Cost Comparison

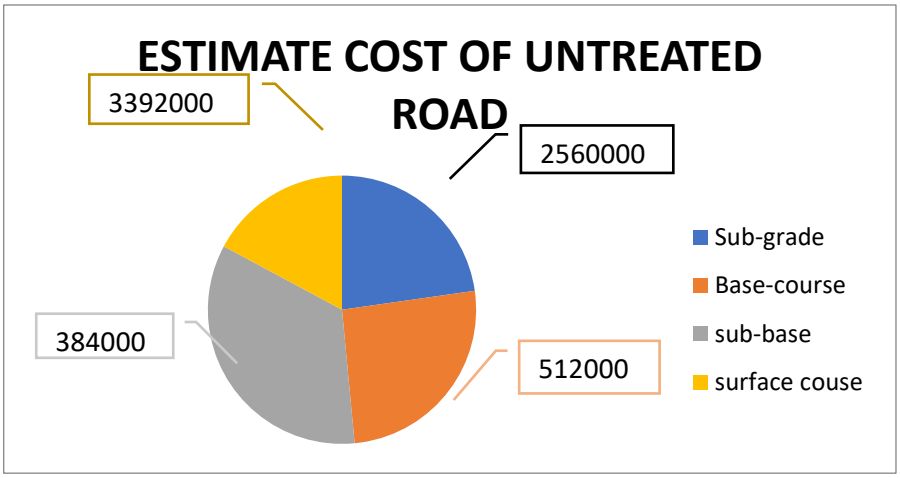

Chart no. 1 Estimated cost untreated Road

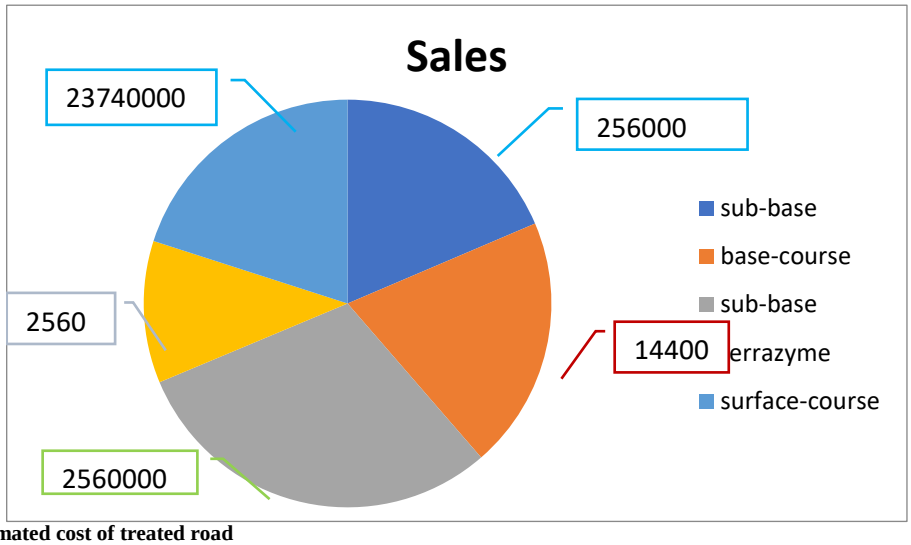

Chart No-2 Estimated cost of treated road

Table No. 7 Estimated Costs

Sr.No	**Layer of Road**	**ESTIMATED COST**			
		Without treatment		**With treatment**	
		Depth (m)	Cost in K (Rs)	Depth h(m)	Cost in k (Rs)

1	Sub-grade	0.1	2560	0.1	2560
2	Terrazyme				1440
3	Sub-base	0.2	5120	0.15	3840
4	Base-course	0.15	3840	0.1	2560
5	Surface course	0.1	3392	0.07	2374
Total cost		1,49,12,000		1,27,74,000	
Cost saving		21,37,600			

6. Conclusion

In reality and practice, addition of bio enzyme gives better performance in the field and ultimate insure durable and maintenance free payment

Improved Soil Stability: Terrazyme chemical treatment enhances the stability of black cotton soil by increasing its load-bearing capacity and reducing susceptibility to volume changes caused by moisture variations.

Minimized Swell-Shrink Potential: The application of Terrazyme helps minimize the swell-shrink potential of black cotton soil, reducing the risk of foundation distress and structural damage

Enhanced Shear Strength: Terrazyme treatment improves the shear strength of the soil, providing better support for structural loads and preventing slope instability.

Reduced Permeability: By modifying the soil's properties, Terrazyme reduces soil permeability, improving drainage and erosion resistance to mitigate waterlogging and erosion issues.

Long-Term Durability: Stabilizer black cotton soil exhibits increased durability, ensuring the longevity of constructed facilities and minimizing maintenance requirements over time.

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