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EFFECT OF BIO-ENZYME (TERRAZYME) ON THE PROPERTIES OF SUB GRADE SOIL OF ROAD

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ABSTRACT

Stabilization of soil including various techniques for modifying the Geotechnical and Engineering properties of a soil to improve its engineering performance at a desired level in terms of shear strength, stiffness modulus, resistance to moisture etc. Road construction on soils with poor engineering properties necessitates adoption of Stabilization techniques. This research work investigates the effects of treating a soils having poor geotechnical properties with a bio-enzyme to determine its suitability for use as road pavement layer material. Bio-enzymes are found to improve the Geotechnical and Engineering properties of road sub grade and thus performance of roads. Terrazyme effect on soils depends on types of soil, dosage of bio-enzyme(Terrazyme), its curing period and amount of fines. To evaluate the effect of bio-enzyme, three soils were treated with varying dosages of Terrazyme, a commercial Bio-enzyme and the effect of Terrazyme dosage on plasticity characteristics,CBR and unconfined compressive strength of soils were evaluated. It was found that with increase in Bio-enzyme dosage, the plasticity index of the soils decreases upto certain limit and then the reduction was not substantial.

Keywords: soil stabilization, Bio-enzyme (terrazyme),Plasticity index, Modified Proctor test, Unconfined Compressive Strength,CBR.black cotton soil, red soil.

I. INTRODUCTION

The development of metropolitan cities necessarily more and number of good lands for both construction activities and road development. This is the major restriction for the construction industry since most of the good lands have already been built upon. Most of the Central part of India is covered with expansive black cotton soil and red earth appears in patches throughout the nation. Black cotton soil poses serious construction problems both to structures and highways whereas red soil is good for construction activities. Expansive soils show swell-shrink behaviour with the variation in moisture content whereas fluctuation in moisture has little effect on the properties of Red soil.. To utilize the full advantage of the technique, quality control must be adequate. Soil stabilization is a very useful technique for major civil engineering works 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. Soils may be stabilized 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 desired conditions for the design life of the project. Soil improvement by mechanical or chemical means is widely adopted in such cases. In order to stabilize soils for improving strength

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and durability, a number of chemical additives, both inorganic and organic, have also been used. Recently Bio-Enzymes have emerged as a new chemical for soil stabilization. Bio-Enzymes are chemical, organic, and liquid concentrated substances which are used to improve the stability of soil sub-base of pavement structures. TerraZyme has been used to improve engineering properties of black cotton soil collected from sagamner and Chandwad (MS) and red soil from Surgana (MS), and they have been widely reported. The present study aims to report the variations in the index properties and engineering properties of "two black cotton soil and red soil" when bio-enzymatic compound - TerraZyme, is added to the soil. The methodology involves laboratory experiments to determine the optimum additive contents for stabilizing the soil subgrades to obtain strength variations.

II. EXPERIMENT METHODOLOGY

Various laboratory and experimental work have been carried out in the present investigation. The work includes black cotton soil from sangamner, black cotton soil from chandwad, one red soil from surgana and one additive to treat all taken soil respectively. Specimens were prepared at three different dosages of the additive and cured up to 28 days. Tests were conducted at 7 day intervals. All experiments were carried out as per the standard procedures described in the Bureau of Indian Standards.

2.1Material Characterization

The soil used in the work was black cotton soil, black cotton soil and red soil obtained from Sangamnner,Chandwad and surgana, Maharashtra respecively. Samples were dried in oven for a 2days, and stored in regular temperature. Various tests were performed to establish the engineering properties of the untreated sample and are given below.

Table.1-Engineering Properties of soil without Terrazyme

Sr.No.	properties	Black cotton soil(sangamner)	Black cotton soil(chandwad)	Red soil(surgana)	IS Classification
1.	Specific Gravity	2.49	2.49	2.44	IS 2720 (part III)
3.	Liquid limit	51.13	51.13	42.14	IS 2720 (part V)
4.	Plastic limit	29.53	29.54	28.69	
5.	Plasticity index	21.6	21.5	13.45	
6.	IS Soil Classification	CI	CH	CI	
7.	Compaction Characteristics Maximum Dry Density (kN/m3) Optimum Moisture Content (%)	1.8 11.05	1.8 12.56	1.63 16.92	 IS 2720 (part VII) IS 2720 (part II)
8.	Unconfined Compressive Strength (kPa)	2.28	2.68	2.30	
9.	Free swell index	43	19	25	IS 2720(part XL)

2.2.Bio-Enzyme (Terrazyme)

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TerraZyme liquid stabilizer is specifically formulated to modify the engineering properties of soil and aggregate mixtures by catalyzing natural chemical reactions in the soil, converting poor materials into more water and load resistant forms to improve the structural properties of cohesive soils. One bottle of Terrazyme was purchased from Avineet Agencies, Chennai. Also referred to as TZ, it is a natural, non-toxic liquid, formulated from sugar molasses. Literature confirms that TZ improves the engineering qualities of the soil like CBR values and dry density. This in turn also decreases the OMC and plasticity index of soil.

Table.2-Bioenzyme (Terrazyme) properties

Property	value
Specific Gravity	1.05
pH value	3.50
Appearance/odour	Dark brown, Non obnoxious
Total dissolved solids	19.7ppm
Cation exchange capacity	3.87%
Hazardous content	none
Boiling point	212 ^{0}F
Evaporation Rate	Same as water
Solubility in water	Complete
Melting point	liquid
Reactivity data	stable
Materials to avoid	Caustics and strong bases

III. RESULTS AND DISCUSSIONS

This section expressed the experimental results of the Atterberg limits tests, modified compaction tests, unconfined compressive strength tests, free swell index test which are used as defining parameters for the optimization of the dosage of TerraZyme required to treat the soils. The differential free swell tests were conducted for the soils treated with optimized dosage of TerraZyme.

3.1 Atterberg limits:

The effect of Bioenzyme at different dosage on index properties (LL., P.L. and P.I.) of

Black Cotton soil from sangamer, from chandwad respectively and red soil from Surgana have been presented in table no. 3.1.The enzyme treated soil sample's consistency limits were tested immediately after the mixing.

Table 3.1 Consistency limits of stabilized black cotton soil

Dosage number	Enzyme dosage	B.C. soil(sagamner)			B.C. soil(chandwad)			Red soil(surgana)		
		L. L. (%)	P.L. (%)	P.I. (%)	L. L. (%)	P.L. (%)	P.I. (%)	L. L. (%)	P.L. (%)	P.I. (%)
0	Untreated	51.13	29.53	21.6	55.70	29.54	26.16	42.14	18.69	23.45
1	100ml/1.5m3	49.81	28.92	20.89	55.10	28.70	26.4	41.47	18.05	23.42
2	200ml/1.5m3	48.26	28.31	19.95	53.83	28.15	25.68	40.20	17.89	22.31
3	300ml/1.5m3	47.96	28.00	19.96	53.10	28.10	25	39.87	17.63	22.24

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3.2 Compaction Test:

Above mentioned twoBlack cotton (BC) soil with different dosage of Terrazyme, and Red with different dosage of Terrazyme , Modified Proctor's Test was conducted. Test results are presented in table 3.2.

Table 3.2 OMC and MDD of stabilized two Black Cotton soil and one red soil

Dosage No.	Enzyme Dasages	Heavy compaction		Heavy compaction		Heavy compaction	
		B.C. soil(sagamner)		B.C. soil(chandwad)		Red soil(surgana)	
		OMC(%)	MDD(kg/cm3)	OMC(%)	MDD(kg/cm3)	OMC(%)	MDD(kg/cm3)
1	Untreated	11.05	1.89	12.56	1.867	16.92	1.629
2	100ml/1.5m3	10.97	1.88	13.13	1.98	17.64	1.68
3	200ml/1.5m3	12.73	1.91	11.732	2.13	20.40	1.73
4	300ml/1.5m3	11.26	1.897	12.73	1.912	16.07	1.73

The increase in MDD with different dosages of Terrazyme is uniform till the final dosage 200ml/1.5m^3. This trend happens due to the formation of transitional compounds that had higher densities in the range of 3rd enzyme dosage.

3.3 Unconfined Compression Strength (UCS) Test:

Unconfined compression strength of two black cotton soil and one red soil have evaluated by stabilization with variable dosages of enzyme for 0 and 7 curing day. For 14, 21 and 28 days curing UCS calculation will be determined after completion of mention curing period. The specimens were prepared and kept in room temperature (air dry curing) to retain the moisture of the sample so that reaction between soil particle and enzyme may be continued. Number of samples were tested with different dosage of enzyme i.e 100ml,200ml and 300ml respectively for 1.5m^3 of soil. The test results are summarized in table 3.3.

Table 3.3 UCS value (kg/cm2) of two BC soil and one Red soil with varying enzyme dosage & curing time

Dosage No.	Enzyme dosage	B.C. soil(sagamner)					B.C. soil(chandwad)					Red soil(surgana)				
		Curing Period in days														
		0	7	14	21	28	0	7	14	21	28	0	7	14	21	28
1	Untreated	2.28	2.65				2.68	2.93				2.30	2.65			
2	100ml/1.5m3	3.35	4.78				3.80	4.62				2.95	4.18			
3	200ml/1.5m3	3.89	5.47				4.01	6.06				3.84	4.76			
4	300ml/1.5m3	3.98	5.67				4.15	6.53				4.01	5.08			

IV. CONCLUSIONS

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The suitability of TerraZyme for the modification of Geotechnical and engineering properties of expansive and non-expansive soils is concluded by studying 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 soils. Based on the test results, the following conclusions have been drawn.

- TerraZyme stabilization has shown good improvements in engineering properties of all three soil (two black cotton soil and one red soil).
- Unconfined Compressive Strength of all three soil 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.
- Free Swell Index of black cotton soil from sangamner and red soil from surgana showed reduction with treatment from TerraZyme especially with drying.
- 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.

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