

# Stabilisation of Black Cotton Soil using Bio-Enzyme

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**Abstract**— A large part of central India and south India are covered with black cotton soil such soil need to improved. The conventional methods are time consuming are not economically feasible. Hence there is need to discover the other possible ways to satisfy the performance as well as economical criteria. The stabilization soil with bio-enzymes is a revolutionary technique which is environment friendly, cost effective and convenient to use. There are many bio enzymes available for soil stabilization such as DZ-1X, Renolith, perma-zyme, terra-zyme and fujibeton. Bio-enzyme improves CBR value of soil. Increases strength of soil and decreases free swell index and cracks formation. It is economical and also reduces the pavement thickness. Bio-enzymes are largely use for stabilization of soil of roads. The present study deals with the effect of DZ-1X, a bio-enzyme on shear strength and CBR value of expansive soil. Their efficiency depends upon the amount of dose type of soil available and field conditions. 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.

**Key words:** Black Cotton Soil, Soil Stabilization, Bio-Enzyme, Dz-1X, CBR, FSI & Revolutionary Technique

## I. INTRODUCTION

The process of improving the strength and durability of soil is known as soil stabilization. An enzyme is by definition an organic catalyst that accelerate a chemical reaction, that otherwise would happen at much slower rate, without becoming a part of the end product.

DZ-1X is nontoxic, non-corrosive and inflammable liquid which can be easily mixed with water at the optimum moisture content. The enzyme allows soil material to become easily wet, more densely compacted and also improves chemical bonding between soil particles. A bio-enzyme improves strength of soil and replaces the need of granular base and sub base. DZ-1X dosage entirely depends on the type of soil, clay content and plasticity index of soil. Enzyme is convenient to use safe, effective and dramatically improve roads quality.

It increase CBR value, higher compressive strength and increase hardness of soil. bio-enzyme provide flexibility and durability to the pavement and also reduce the formation of cracks. The use of bio-enzyme in the pavement construction is proven to very economical as compare to other traditional soil stabilization method.

### A. DZ-1X

DZ-1X is non toxic, non corrosive and inflammable liquid natural material which is formulated from vegetable extracts. It is brown in color with smell of molasses and can be easily used without the need of mask or gloves. It is easily mixed with water and optimal result should be diluted with optimum moisture content of that soil. DZ-1X act on

the soil to reduce the voids between soil particles therefore minimizing the absorbed water in the soil and maximizing compaction. DZ-1X as an unique multi enzyme product specifically developed as an effective aid to the workability, mixability, binding and compaction of soil. it significantly improves stability in construction of roads, dams and many other related projects. DZ-1X is a completely natural biodegradable product .by its action, it alters and improve the local soils physical and chemical properties which result in significantly less mechanical effort to achieve greater densities for compaction.

It offers a convenient and low cost method for improving a soils strength and durability, enabling lower construction costs, less maintenance and greater road performance.

DZ-1X reacts with absorbed water layer of clay particle and causes reduction in the thickness around particle of soil, this result in the reduction of voids between the particles of soil, thereby giving soil particle a closer orientation with low compaction this ultimately results in the decrease in swelling capacity of soil and it also reduces permeability of soil.

### B. Properties of DZ-1X

It is an organic liquid formulated from vegetable extract.

Boiling point	121
Specific gravity	1.00 to 1.09
Melting point	Liquid
Vapor density	1
PH value	4.30 to 4.60
appearance	Brown color liquid

Table 1: Property of liquid

## II. LITERATURE REVIEW

Lacuoture and Gonzalez (1995) conducted study on the effects of TerraZyme on sub-base and subgrade. The reaction of the soil treated with Bio Enzyme was observed and compared with soil without Bio Enzyme. It was concluded that soil showed improvement in short duration of time but the cohesive soils showed improvement successively.

Bergmann (2000) concluded from his study on bio-enzyme that for imparting strength to the soil, bio enzyme requires some clay content. He stated that for successful stabilization of soil minimum 2% clay content is required and 10 to 15 % of clay content gives good results. Compared to 28 % of untreated soil CBR after 1, 2, 3, 14 week was found as 37, 62, 66 and 100 respectively.

Manoj Shukla et al. (2003) carried out test on five different type of soil. The clay content in soil varies from low to high. Tests were conducted on soil samples with and without Bio Enzymes to determine different engineering properties, Atterbergs limit, CBR and UCS at different curing period in laboratory. Little to high improvement is

seen in the physical properties of soil with Bio Enzyme. The reason behind this little improvement is the chemical composition of soil which is less reactive with the Bio Enzyme. Sandy to silty type soil showed improvement in the CBR and UCS. It was observed that pavement thickness is reduced by 24 to 48 %. In places where the availability of granular material is less, Bio Enzyme treated soil with thin bituminous coating can satisfactorily fulfill the pavement requirement.

Shankar et al. (2009) conducted tests on lateritic soil of Dakshina Kannad (district of India). The initial liquid limit and plastic limit of soil were 25 % and 6% respectively. The lateritic soil of the district was not satisfying the sub base requirement. For satisfying the sub base course requirements sand is mixed with soil in different proportions until specified values were attained.. Study was done on the effect of enzyme, on soil properties like CBR, UCS and permeability for a period of 4 weeks. CBR value increased by 300% with about 10 % sand and 200ml/m<sup>3</sup> of enzyme mixed with soil after 4 week of curing. An increase of 300% is seen the CBR value , increase of 450% in unconfined compressive strength value and decrease of 42 % in permeability of soil was seen with high dosage of enzyme of 200ml/2m<sup>3</sup> after 4 weeks of curing . It was concluded from the CBR results of treated and untreated soil that addition of enzyme in noncohesive soil has no effect on the cohesion less soil. It was also stated that the bio enzyme used shall be checked for its effect on type of soil in laboratory prior to the field application. In order to check the efficiency of Bio Enzyme in field, test were performed on National Highway which affirms that soil blended with enzyme shows high CBR value than ordinary soil.

Venkatasubramanian & Dhinakaran (2011) performed test on 3 different soils with different properties. These soils were tested with different dosage of enzyme. The liquid limit and plasticity index of soil were reported as 28, 30, 46 % and 6, 5 and 6 % respectively. An increase of

157 to 673 % is seen in CBR after 4 weeks of curing and 152 to 200 % in UCS.

Vijay Rajorial, Suneet Kaur (2014) carried out a theoretical evaluation of enzyme. Reduction of about 18 to 26 % is seen in cost of construction of roads by using TerraZyme as a soil stabilizer, constructed by public work department in Maharashtra. Structures made of bio enzyme are economical and have greater strength.

Sandeep Panchal, Md. Mohsin Khan and Anurag Sharma, Stabilization of Soil Using Bio-enzyme, (2017) This paper presents the result that after addition of varying amount of terrazyme, the effect on the characteristics of soil is analysed & the results are shown in grafical form. Variation of load w.r.t. penetration in CBR test is shown for normal soil. Ishwarya S Dhanesh, Twinkle Vinu mohandas(2016) Effect Of Bio-enzyme Stabilization On Geotechnical Properties of Thonnakal Clay, this study suggested that the variation of maximum dry density & optimum moisture content at varying dosages of enzyme treated soil for different curing periods is obtained. Saurabh B. Gautam, C.B. Mishra, N. F. Umrigar (2016) Subgrade Soil Stabilization using Terrazyme, this study suggested that the CBR value of soil have significant rise and swelling property FSI comes down to 24% of treated soil from 50% of untreated soil. Joydeep Sen, Jitendra Prasad Singh, Stabilization of Black cotton soil using Bio-enzyme for a Highway Material, (2015).

### III. RESULT

- 1) Use of bio enzymes results in higher compressive strength and increased hardness of stabilized.
- 2) Bio-enzymes provide flexibility and durability to the pavement and also reduce formation of cracks.
- 3) Considerable improvement in soil CBR.
- 4) Minimum loss of gravel due to erosion or abrasion by the traffic transverse section of slopes.
- 5) Impediment of widespread occurrence of dust from loose fine material on the road surface.

S N	Property	Value	IS Codes
1	Atterberg limits Liquid limit (%) Plastic limit (%) Plasticity index Shrinkage limit (%)	61.40 34.00 27.40 16.60	IS 2720 (part V)
2	Grain size distribution a) Gravel (%) b) Coarse Sand (%) c) Fine sand (%) d) Silt & Clay (%)	0.00 10.17 20.87 68.70	IS 2720 (part IV)
3	USCS Soil Classification	CH	
4	Free Swell Index %	72.80	IS 2720 (part XL)
5	Engineering Properties Light Compaction a) Max dry density, (kN/m <sup>3</sup> ) b) O.M.C %	14.80 23.0091	IS 2720 (part VII) IS 2720 (part II)91
6	CBR Value (%) IS Standard Compaction a) Un-soaked condition91	2.86	
7	Specific Gravity	2.48	IS 2720 (part III)

Table 3.1: Properties of black cotton soil.

S N	Property	Value	IS Codes
1	Atterberg limits Liquid limit (%) Plastic limit (%) Plasticity index	42.5 25.97 16.53	IS 2720 (part V)
2	Free Swell Index %	58.81	IS 2720 (part XL)
3	Engineering Properties Light Compaction a) Max dry density, (kN/m <sup>3</sup> ) b) O.M.C %	1.62gm/cc 13.23%	IS 2720 (part VII) IS 2720 (part II)91
4	CBR Value (%) IS Standard Compaction a) Un-soaked	8.83%	

	condition92		
5	Specific Gravity	2.5	IS 2720 (part III)
6	Unconfined compressive strength	0.32 gm/cm.sq	IS 2720 (part X)

Table 3.2: properties of black cotton soil using Bio-enzyme

#### IV. CONCLUSIONS

- 1) Duration of treatment of soil with Bio-enzyme played a vital role in improvement of strength and soil treated with bio-enzyme for 7 days gives higher strength. The cost of construction project can be reduced considerably with use of bio-enzyme.
- 2) With increase in percentage of Dz-1X 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 354.1%.
- 3) The use of bio-enzyme in pavement construction is proven to be very economical as compared to other traditional soil stabilization methods.
- 4) With increase in percentage of Dz-1X the un-soaked CBR value was increased from 3.93 to 8.03. Percentage increase is 104.32.
- 5) With increase in soaking period CBR values are increased when compared with untreated soaked soil samples.
- 6) Tri-Axial results showed, with increase in percentage of DZ-1X shear strength of the soil increased from 6.40 kPa to 35.32 kPa, percentage increase is 451.87.
- 7) Tri-Axial results showed with increase in percentage of Dz-1X , cohesion of the soil increased.

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