

Effect of bio-enzyme on geotechnical properties of Thonakkal clay

Ishwarya S Dhanesh^{#1}, Twinkle Vinu Mohandas^{*2}

[#] M Tech student, Department of Civil Engineering, Marian Engineering College, Thiruvananthapuram, Kerala, India

^{*}Assistant Professor, Department of Civil Engineering, Marian Engineering College, Thiruvananthapuram, Kerala, India

Abstract- Cost effective roads are very vital for economic growth in any country. For economical construction, the sub grade thickness of the pavement has to be reduced. Now a day, a lot of additives are used for achieving greater strength at low subgrade thickness. The purpose of this study is to access the strength of enzyme treated Thonakkal clay. Thus the aim of the study is to conduct laboratory studies on the effects of enzyme based liquid chemical as soil stabilizer and its effects on curing. The dosage of bio-enzyme added to the soil is varied. When the bio-enzyme is mixed with soil it might alter the engineering properties of soil. More independent investigations on the effects of enzyme-based liquid stabilizers on the strength of treated soils are to be done if the level of their acceptance in road construction is to be enhanced.

Keywords — Thonakkal clay, Soil stabilizer, bio-enzyme, sub grade

I. INTRODUCTION

In the construction industry, maintaining a balance between performance and cost, while at the same time satisfying environmental regulations, has become a challenge for building material and contractors. Soil improvement by chemical and mechanical means has been widely adopted. For improving the strength and durability, variety of chemical additives, both inorganic and organic have been used. Now a day in order to stabilize soils bio-enzymes have emerged as a new chemical. Bio-enzymes are organic, chemical and liquid concentrated substances which are used to improve the stability of soil sub-base of pavement structures. This allow the use of local soil for sub grade purposes at reduced maintenance costs. Bio-enzyme manufacturers claim that their products are effective, environment friendly (non-toxic), cost-effective, and convenient to use. They are extracted by the fermentation of vegetables and sugar canes. Thus they easily break down and dissolve with time. It does not harm humans, animals, fish or vegetation. Each enzyme promotes the chemical reaction within or between the other molecules. The enzymes remain unchanged by these reactions. They serve as the host for other molecules thus accelerating the rate of normal chemical and physical reactions. The enzyme allows soil materials to become more easily wet and more densely compacted. They improve the chemical bonding between soil particles and create

more permanent structure that is more resistant to weathering, water penetration and wear and tear. The main objective of this work is to determine the effect of bio-enzyme on Thonakkal clay. This concept might be used to improve the ability of soil sub-grade for pavement structures. Bio-enzyme is convenient to use, safe, effective and improves road quality.

II. OBJECTIVE

The main objective of this experimental study is to understand the stabilization effect of Terra Zyme at three different concentrations on the Thonakkal clay and to study the variation in strength behaviour at different curing periods.

III. METHODOLOGY

The soil used in the work was collected from Thonakkal, Trivandrum. Samples were air dried for a week and broken down into smaller pieces. The stabilizer used was an enzyme Terra Zyme and it was purchased from Avijeet Agencies, Chennai. It is also referred to as TZ. It is a natural, non-toxic liquid, formulated from sugar molasses. Terra Zyme catalyzes the reactions between clay and organic cations and accelerate cation exchange process. Terra Zyme alters the hydrophilic nature of clay minerals to hydrophobic, assisting in the expulsion of water from soils and aids in the interlocking of soil particles, thereby increasing friction. Terra Zyme, a cations-reactive synthetic compound forms a protective coating. Thereby clay is rendered inert to water. The soil mass is now a permanent stable, water repellent road surface similar to rigid pavement. The initial properties of soil were tested and the properties of the Terra Zyme were obtained from the manufacturer.

In the present study specimens were prepared at three different dosages (0.06ml, 0.12ml, 0.18ml) of the additive and cured up to 45 days. Optimum moisture content and maximum dry density of soil mixed with varying dosages was determined by conducting Indian standard light compaction test as per IS 2720 part 7 (1980). The variation of Atterberg's limit with different dosages of Terra Zyme at different curing periods was also determined by conducting Atterberg's limit test as per IS 2720 PART 5 (1991).

IV. RESULT AND DISCUSSIONS

The initial properties of Thonnakkal soil is given in Table I.

TABLE I
INITIAL PROPERTIES OF THONNAKKAL SOIL

Soil property	Value obtained
Field water content	23%
Specific gravity	2.58
Liquid limit	46.5%
Plastic limit	25%
Shrinkage limit	21.05%
Plasticity index	21.5%
OMC	26%
Maximum dry density	1.6g/cc
% sand	21%
% silt	26%
% clay	53%
IS Classification	CI
Unconfined Compressive Strength	1.27kg/cm ²
Permeability	1.025x10 ⁻⁹ m/s

The particle size distribution curve of soil is shown in Fig. 1.

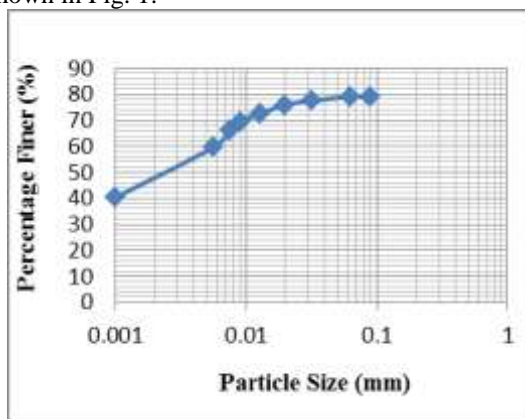


Fig. 1. Particle size distribution curve of soil

The properties of Terra Zyme are given in Table II.

TABLE II
PROPERTIES OF TERRA ZYME

Identity(As it appears on label)	N-Zyme
Hazardous Components	None
Boiling Point	100 degree Celsius
Specific Gravity	1.05
Melting Point	Liquid
Evaporation rate	Same as water
Solubility in Water	Complete
Appearance/Odour	Brown liquid, Non-obnoxious

Dosage rates applied to soil sample are given in Table III.

TABLE III
PROPERTIES OF TERRA ZYME

No.	Dose	ml/kg of soil
1	Dosage 1	0.06
2	Dosage 2	0.12
3	Dosage 3	0.18

The variation of maximum dry density and optimum moisture content at varying dosages of enzyme treated soil for different curing periods is given in Table IV.

TABLE IV
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT OF SOIL TREATED WITH VARYING DOSAGES OF TERRA ZYME AT DIFFERENT CURING PERIODS

Days of curing	Dosage(ml)	OMC (%)	MDD (g/cc)
0	0.06	25.9	1.95
	0.12	25	1.96
	0.18	24	1.97
7	0.06	24.3	1.97
	0.12	23.9	1.98
	0.18	22.9	1.99
21	0.06	24	1.98
	0.12	23.5	1.99
	0.18	22.1	2.01
28	0.06	23.2	2.10
	0.12	22.6	2.3
	0.18	21.7	2.58
45	0.06	22.4	2.4
	0.12	21.8	2.5
	0.18	21.3	2.7

The variation of MDD with curing days is shown in fig 2.

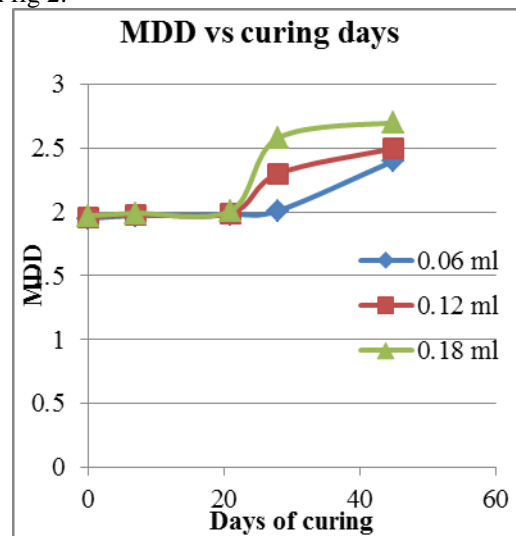


Fig. 2. Graph showing the variation of MDD with curing days

The variation of Atterberg's limit at varying dosages of enzyme treated soil for different curing periods are given in Table V.

TABLE V
ATTERBERGS LIMIT OF SOIL TREATED WITH VARYING DOSAGE OF TERRAZYME

DOSAGE	PROPERTY	TREATED DAYS		
		0	7	21
0.06	LL	39.1	24	15.1
	PL	36.6	23	13.6
	PI	34	21	13

0.12	LL	38	23	15
	PL	35	22.5	12.5
	PI	33	21	12
0.18	LL	36.5	22	14.5
	PL	33.5	21	12.5
	PI	31	19	12

The variation of LL with curing days is shown in fig 3.

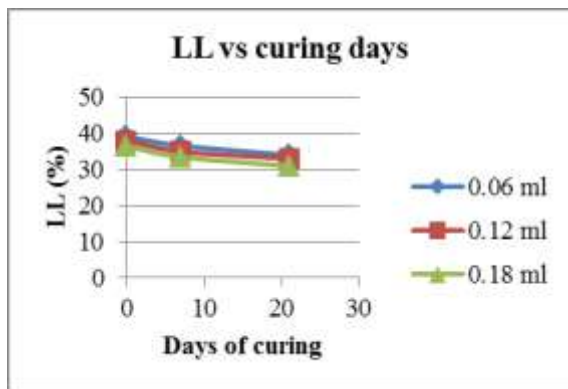


Fig. 3. Graph showing the variation of LL with curing days.

V. CONCLUSIONS

Performance of soil stabilized with bio-enzyme has been investigated in this work. The addition of varying dosages of Terra Zyme to Thonnakkal clay caused the optimum moisture content to decrease and maximum dry density to increase with increasing dosages of Terra Zyme and also for increasing curing period

Based on the investigation it can be concluded that the increase in MDD is due to the decrease in void ratio when enzyme is added to the soil. It is observed that there is a decrease in OMC due to the effective cation exchange process which generally takes longer period in the absence of such stabilizers. The Atterberg's limit values increases when compared to the original soil after 21 days of curing. This is due to the reaction of enzyme with clay which results in cementation effect.

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