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Soil Stabilization using Terrazyme for Road Construction

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***Abstract*--- The growth of population has created for better and economical vehicular operations, which require good highways. Sub-base is a main part of road pavement structure, which act as a stress transmitting medium and spread the wheel load in such a manner that it prevents shear and consolidated deformation. There is an urgent need for the development of new technique which improves the geotechnical properties of the sub-base soil. Laterite soil being a widely available soil in Kerala is used for this study. Even though this soil exhibit satisfactory strength and permeability characteristics it can undergo property changes during construction, in which gradation being considered as most sensitive. So an attempt is made to stabilize the soil with readily available bio-enzyme, which will be highly beneficial for engineers. Terrazyme, a bio-enzyme is a material which drastically improve the properties of the soil, is eco-friendly and economical for long run. This paper deals with the study of the effect of Laterite soil, collected from Aduvaserry of Ernakulam district, was mixed with Terrazyme for different dosages and different curing period. It was found that with time Terrazyme have significant impact on improving Unconfined compressive strength (UCC) and California bearing ratio (CBR) values of the soil.**

Keywords—soil stabilization; Terrazyme; laterite soil; CBR; UCC

I. INTRODUCTION

The strength and shear characteristics of the pavement are essential for the good quality of the road.It promotes for the social, economic, cultural development of the country. Most of the areas in Kerala are found with laterite soil. But researchers have found that this soil do not satisfy the conventional requirement for the highway material [1]. So it is essential to stabilize the soil. The process of increasing the durability and strength of soil is called soil stabilization. The main aim of this study is to effectively stabilize the locally available material in the most cost reducing manner. There are many stabilizing agents available like Renolith, Permazyme, Fujibeton. Among these Terrazyme is used in the study. It is a noncorrosive, non toxic, inflammable liquid which enhances the soil properties and improve the strength and compaction properties. In this study initially virgin soil is tested for the basic properties and then the enzymatic soil is tested for unconfined compressive strength (UCC), Proctor test and California bearing ratio test (CBR) as shown in figure 1.

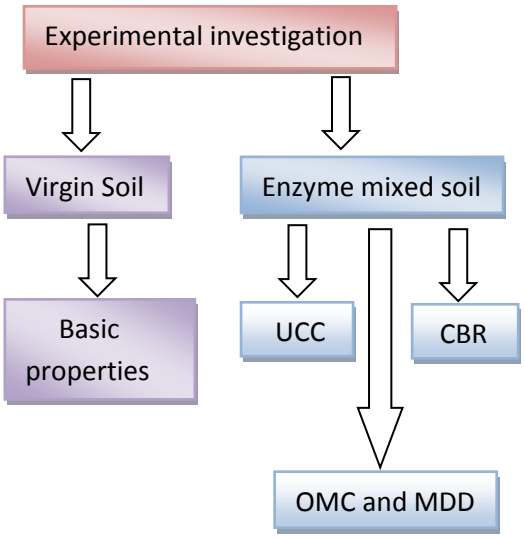

Fig. 1.Experiments performed on soil

II. MATERIALS REQUIRED

A. Terrazyme

Terrazyme is a brown clear liquid which is organic in nature and is formulated using fruit and vegetable extract [2]. The effect of terrazyme is due to the enzymatic reaction on the soil taking place between clay and organic cat-ion and forming a protective coating around clay particles and making clay particle water repellent. Since cationic interexchange take place, it reduces the thickening of absorbed layer [3]. Ithelps in reducing the void in the soil and thereby achieving maximum compaction. It improves the load bearing capacity of soil as well as reduce the pavement thickness and maintenance cost [2].The terrazyme is obtained from Avijjeet agencies, Chennai. The basic properties of Terrazyme as from manufacture's information is listed below in table no.1

Table1. Properties of Terrazyme

Property	Value
Specific gravity	1.05
pH value	3.50
Appearance	Dark brown
Total dissolved salts	19.7ppm
Hazardous content	None
Boiling point	212˚F
Evaporation rate	Same as water
Solubility in water	Complete
Reactivity data	Stable

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B. Laterite soil

Soil is collected from Aduvaserry, Aluva of Ernakulam district (10.1167˚N 76.350˚E).This type of soil is widely available in region of Aluva and greatly used for road construction. Even though this soil has a tendency to achieve strength with time, literature studies showed that these soil could exhibit higher strength characteristic upon stabilization.

III. RESULTS AND DISCUSSIONS

A. Physical Properties

The preliminary test was conducted on the sample to determine its engineering properties. The various properties such as determination of its liquid limit, plastic limit, specific gravity and dry density, particle size distribution were determined. The liquid limit was determined using Casagrande's apparatus. Plastic limit was found by following the procedure enlisted in IS: 2720 (Part5) – 1985. Sieve analysis was conducted to know the gradation of the particle by following the procedure enlisted inIS: 2720 (Part 4). Dry sieve analysis was conducted to know the fraction of gravel and sand. Wet sieve analysis was done to know the clay and silt content. The standard proctor test was conducted to determine the optimum moisture content(OMC) and maximum dry density(MDD). Specific gravity of the sample was found using pyconometer test and its value marked presence of organic matter. The unconfined compressive strength of soil was found using UCC test.California bearing ratio test was done to determine the mechanical strength of soil sub grade by following the procedure enlisted inIS: 2720 (Part 16)-1987. The shear parameters of the soil were found using direct shear test. The test results are tabulated and shown in table 2.

Table 2. Physical Properties of laterite soil

Sl.no	Properties	Test Result
1.	Natural water content(%)	16.39
2.	Specific gravity	2.56
3.	Liquid limit(%)	38
4.	Plastic limit(%)	33
5.	Plasticity index(%)	5
6.	Percentage of gravel	0
7.	Percentage of sand	59
8.	Percentage of silt	29
9.	Percentage of clay	21
10.	OMC(%)	16%
11.	Max.dry density(g/cc)	1.17
12.	UCC(KN/m^2)	20
!3.	Cohesion(KN/m^2)	10
14.	CBR value(%)	2.141
15.	Angle of friction(degree)	46.39

B.Unconfined compressive strength test on Enzymatic Soil

UCC test was conducted for different dosage level on same quantity of soil. Treated soil was then tested at optimum dosagefor curing periods of 0, 7, 14, 28 days. This test results was compared with untreated soil for the same curing period. The test results are tabulated and shown in table 3 and presented graphically in figure 2.

C. Standard Proctor Test

Proctor test is done to determine the maximum dry density and optimum moisture content. The test was done for light compaction using 2.6kg rammer and 310mm free fall. The proctor test is done for enzyme treated soil at optimum dosage, for curing period of 0, 7, 14, 28 days. The test result is tabulated and compared with untreated sample in table 4.

Table 3. Unconfined Compressive Strength (q_u)

Curing period (days)	0	7	14	28
Unconfined compressive streng (kN\m^2)				
a) Untreated	20.0	22	28.01	28.65
b) Treated	30.26	36.17	69.25	76.3

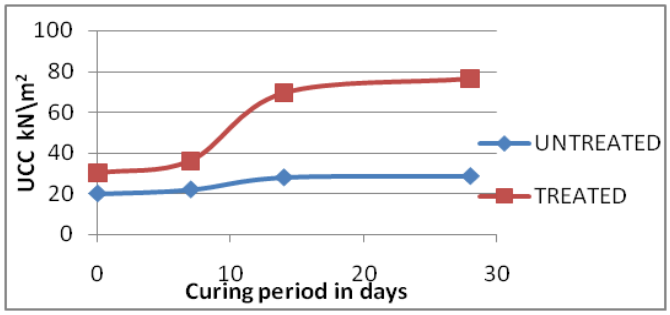

Fig 2. Variation of UCC in treated and untreated sample

Table 4. Standard proctor test

Sample	Curing period(days)	OMC (%)	MDD(g/cc)
Untreated	0	16	1.177
Treated	0	14.4	1.8
	7	14.1	1.845
	14	13.8	1.889
	28	13.63	1.902

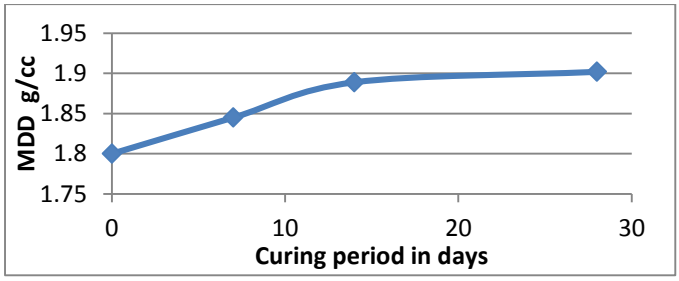

Fig. 3. Variation of MDD in treated sample

D.California Bearing Ratio

CBR is a penetration test used for evaluating the mechanical strength of base course,sub grade beneath the carriageway. The CBR value is found for enzyme treated soil at optimum dosage for curing period of 0, 7, 14, 28 days.The test result is tabulated and compared with untreated sample in table 5.

Table 5. CBR values for treated and untreated samples

Curing period(days)	0	7	14	28
CBR value in %				
a) untreated	2.141			
b) treated	2.38	3.963	4.659	5.124

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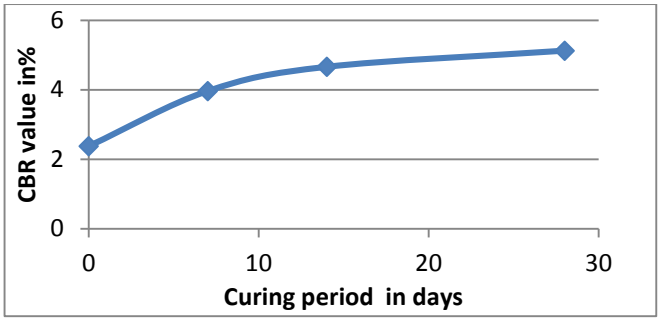

Fig 4. Variation of MDD in treated sample

IV. CONCLUSION

Based on the test conducted following conclusions have been drawn:

- There is an increase in UCC value by 51.3% when 0^{th}day untreated and 0th day treated was compared.
- The UCC sample at 28^{th} day curing for treated soil showed an increase of 281.5% when compared to 0^{th} day untreated sample.
- The UCC sample at 28^{th} day treated and 28^{th} day untreated showed an increase of 166.3%.
- As Terrazyme was added to soil,the OMC decreased and MDD value increased.
- There was a decrease of 14.8% in OMC value and an increase by 61.59% in MDD value after 28 days of curing
- The CBR value was increased by 11.16% from 0^{th} day untreated to 0^{th} day treated.
- There was increase in CBR value as days of curing were increased. 139.32% increase was observed at 28^{th} day curing for treated soil when compared to the 0^{th} day untreated.

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