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EXPERIMENTAL STUDY ON STABILIZATION OF BLACK COTTON SOIL USING BIO-ENZYME AND MARBLE DUST

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Abstract:- Soil stabilization is the process of increasing the strength and durability of soil by altering the physical properties of the soil. It is necessary for the soil stabilization process to be cost efficient, eco-friendly and yield optimum results. For any construction project it is highly recommended to improve the strength of soil in order to increase the life of structure. Due to lack of strength possessed by soil, it fails to bear the loads imposed on it during or after the construction. There are many ways in which soil stabilization can be done like use of surfactants, biopolymers, synthetic polymers, copolymer based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fiber reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride etc. But terrazyme proves to be the best solution for this problem. It is natural, non-toxic, biodegradable liquid which significantly improves the strength of soil by reducing the voids. It increases the compaction of soil with minimal compactive efforts and its effect is permanent. After soil stabilization, Unconfined Compressive Strength (UCS), California Bearing Ratio (CBR) and Shear strength of in-situ soil are largely affected and can increase up to 4-6 times.

I.INTRODUCTION

The process of improving the strength and durability of soil is known as soil stabilization. The main aim of stabilization is cost reduction and to efficiently use the locally available material. Most common application of stabilization of soil is seen in construction of roads and airfields pavement. Enzymes enhance the soil properties and provide higher soil compaction and strength. Terrazyme is nontoxic, noncorrosive and inflammable liquid which can be easily mixed with water at the optimum moisture content. TerraZyme improves the properties of soil and strength of soil significantly. Life of a structure increases as CBR value is increased and consistency limits are decreased. The chemical bonding of the soil particles is increased by the use of TerraZyme and a permanent structure is formed which is resistant to wear and tear, weathering and infiltration of water in soil. Apart from improving

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strength of soil this bio enzyme replaces the need of granular base and sub base. Terrazyme dosage entirely depends on the type of soil, clay content and plasticity index of soil. Marble or real marble is a metamorphic rock that consists predominantly of calcite or dolomite. Marble may be considered as metamorphosed limestone. The production of fine particles while cutting marble is one of the major problems for the marble industry. While cutting of marble blocks water is used as a cooler. But the fine particles can be easily dispersed after losing humidity, under atmosphere conditions, such as wind and rain. Thus, fine particles can cause more pollution than other forms of marble wastes.

II.MATERIALS AND METHODOLOGY

BLACK COTTON SOIL

- Black soils are highly argillaceous, very fine grained and dark.
- It contain a high proportion of calcium and magnesium carbonates.
- They are very tenacious of moisture and exceedingly sticky, when wet. Due to considerable contraction on drying large and deep cracks are formed.
- These soils contain abundant iron and fairly high quantities of lime, magnesia and alumina. Black soils are poor in nitrogen, phosphorus and organic matter.
- The soils are generally rich in montmorillonitic and beidellitic group of clay minerals.
- Black soils are most suitable for the cotton crop hence it is also known as black cotton soil.
- Besides cotton, the soil is suitable for the cultivation of crops like wheat, groundnut, chillies, tobacco and jowar.

MARBLE DUST

TABLE I

Hardness	3 to 4 on Moh's scale
Density	2.5 to 2.65 Kg/m^3
Compressive strength	1800 to 2100 Kg/cm^2
Water absorption	Less than 1%
Streak	White
Specific gravity	2.86 – 2.87

BIO ENZYME

TABLE II

Boiling point	212 °F
Specific gravity	1.000 to 1.090
Melting point	Same as water
Vapor density	1
pH value	4.30 to 4.60
Appearance	Brown clear liquid
Solubility in water	Complete

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Odor	Non-obnoxious

III.EXPERIMENTAL INVESTIGATION

Tests on soil

Specific gravity test - The specific gravity of a soil is the ratio of the mass of a given volume of the material at a stated temperature to the mass of an equal volume of de-aired or gas-free distilled water at a stated temperature. The specific gravity of a soil is used in the phase relationship of air, water, and solids in a given volume of the soil.

Sieve analysis - Sieve analysis is an analytical technique used to determine the particle size distribution of a granular material with macroscopic granular sizes. The technique involves the layering of sieves with different grades of sieve opening sizes. Liquid limit - Liquid Limit is defined as the water content at which the soil changes from liquid state to plastic state.

Plastic limit - Plastic limit is defined as minimum water content at which soil remains in plastic state.

Plasticity index -The plasticity Index is defined as the numerical difference between its Liquid Limit and Plastic Limit.

Calculation

Plasticity Index = Liquid Limit - Plastic Limit.

Liquid Limit (W_L) = 71%.

Plastic Limit (W_P) = 36.7%

Plasticity Index $I_p = (W_L - W_P)$ = 71-36.7 = 32.33%

According to USUC classification of soils,

Soil sample is under **CH** : Clay , High Compression.

Standard proctor test

Proctor test is carried out to determine compaction of soil to understand compaction characteristics of different soils with change in moisture content. This method covers the determination of the relationship between the moisture content and density of soil compacted in a mould.

California bearing ratio test

California Bearing Ratio (CBR) is defined as the ratio expressed in percentage of force per unit area required penetrating a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. Tests are performed out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test.

Mould Specification

Diameter of the mould = 150mm; Height of the mould = 175mm ;Height of the CBR soil specimen = 125mm

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Soil specification

Particle size = should pass through 19mm sieve Soil particles of size greater than 19mm should be replaced by particles of size between 4.75mm and 19mm

IV.RESULT & DISCUSSION

Natural moisture content

The natural water content also called the natural moisture content is the ratio of the weight of water to the weight of the solids in a given mass of soil this ratio is usually expressed as %.

Table III

Sample	1	2	3

TEST No.	1	2	3
WEIGHT OF SP. GR. BOTTLE (W1) (g)	483.5	483.5	483.5
WEIGHT OF SP. GR. BOTTLE + SOIL (W2) (g)	1289	1276	1282
WEIGHT OF SP. GR. BOTTLE + SOIL + WATER (W3) (g)	1750.5	1705	1761

Empty weight of container with lid(w_1)g	25	25	25
weight of container &sample before drying(w_2)g	160	165	168
weight of container &sample after drying(w_3)g	150	147	153
G=(w_2- w_3)/ ((w_2- $w_{1)X100)}$	7.40	12.85	11.71
Average	10.65		

Specific gravity of soil sample

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WEIGHT OF SP. GR. BOTTLE + WATE (W4) (g)	1218	1218	1218
$G = \frac{(W2 - W1)}{(W2 - W1) - (W3 - W4)}$	2.95	2.59	2.94
AVERAGE	**2.83**		

The specific gravity of the soil sample is = **2.83** (No unit)
As per IS 2720(Part 3):1980 the tested sample soil is clay & silty clay

Table IV

Sand	2.63-2.67
Silt	2.65-2.7
Clay&silt clay	2.67-2.9
Organic soil	<2.0

Liquid limit of the soil sample is = 71.66%

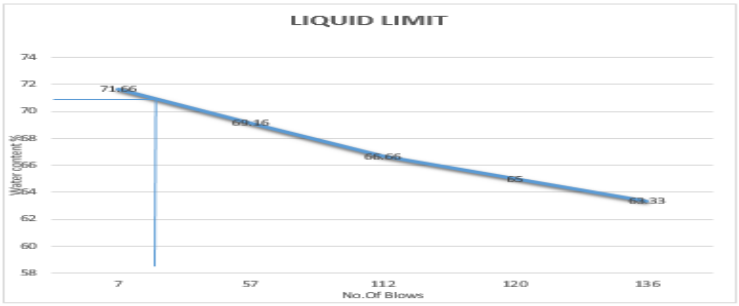

Fig.1. Liquid limit graph

Plastic limit of soil sample Wp=36.7%

Plasticity index

$$I_p = W_L - W_P$$

Liquid Limit (W_L) = 71%.

Plastic Limit (W_P) = 36.7%

Plasticity Index I_p= (W_L- W_P) = 71-36.7 = 32.33%

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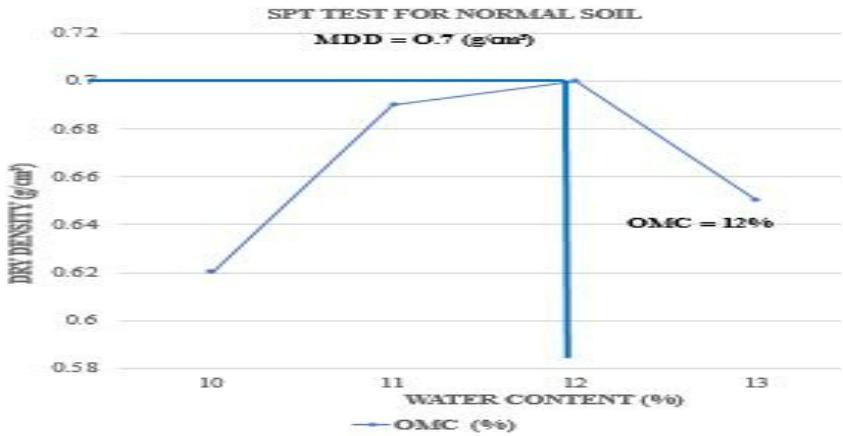

Fig.2. standard proctor graph

From the graph, it is evident that,

I. Optimum Moisture Content (**OMC**) = 12%

II. Maximum Dry Density (**MDD**) = 0.70 g/cc

California bearing ratio test

SOAKED CBR

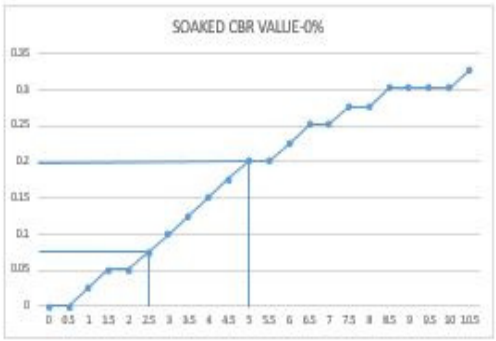

Fig.3. Soaked CBR graph

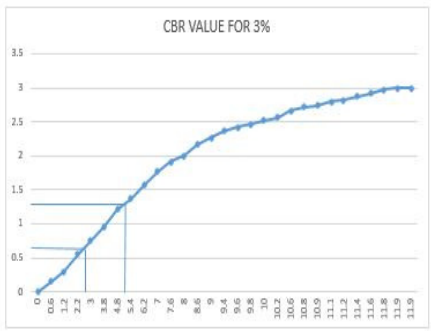

Fig.4. CBR value for 3%M.D graph

CBR VALUE FOR 6% OF MD&5ML OF BIO-ENZYME

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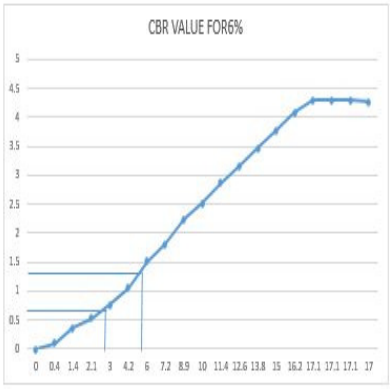

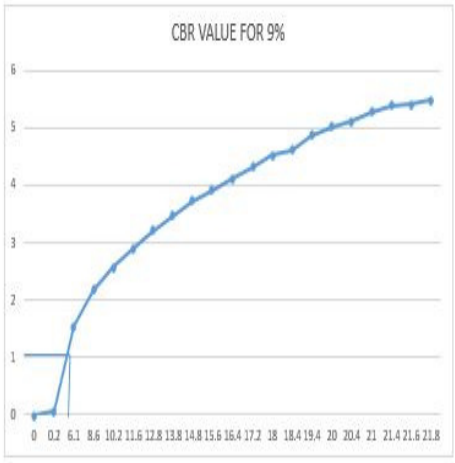

Fig.5. CBR value for 6%

Fig.6. CBR graph for 9% of MD&Bio-enzyme

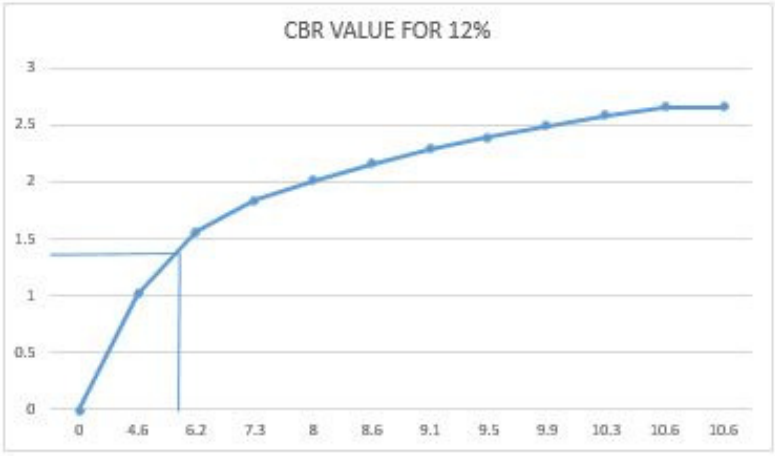

Fig.7. CBR graph for 12% of MD&Bio-Enzyme

V.CONCLUSION

This study investigated the effect of marble dust &bio-enzyme and strength behavior of black cotton soil. The effect of stabilized on clayey soil was studied by using the results obtained from a series of liquid limit , plastic limit,Standard proctor test , California bearing ratio test . Based on the result presented in this project the following conclusions are drawn.

- The specific Gravity of the soil is 2.83, from the result it is finally concluded the sample soil is clay and silty clay .
- Due to increase in the marble dust&bio-enzyme content , the liquid limit of black cotton soil increases due to the replacement of soil grains by marble dust.
- The maximum Dry Density of the soil increases with the addition of marble dust&bio-enzyme content

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up to 9% of marble dust&bio-enzyme and then decreased with the addition of 12% of marble dust. This is due to the fact that the dry unit weight of marble dust&bio-enzyme is more than that of the soil.

- In view of increase in bio-enzyme& marble dustcontent , the CBR value of black cotton soil increased up to 9 % marble dust&bio-enzyme and decreases with the addition of 12% of marble dust&bio-enzyme.
- At the result from Standard proctor test , the optimum moisture content will increased up to 9 % of marble dust&bio-enzyme and decreased with the addition of 12% of marble dust&bio-enzyme .
- The CBR value of black cotton soil is 5.89%. On the addition of marble dust &bio-enzyme, the CBR value increased and the maximum value of CBR is 15.87 % at addition of 9% of marble dust&bio-enzyme respectively.
- At this experiment study, i.e. based on CBR test , it can be concluded that thickness of pavement decreases with less penetration with stabilized.

From the above discussion it can be concluded that there is a need to utilize the marble dust&bio-enzymefor the stabilization of the soil , which will directly help in decreasing the requirement of the valuable land for their disposal and also decline the hazardous environmental impacts.

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