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STABILIZATION OF BLACK COTTON SOIL BY USING TERRAZYME

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Abstract: ***The most important aspect of any project is it's cost, performance , durability and time. As the methods used conventionally were very uneconomical and time consuming, so there is a need to development of new techniques which enhances the geotechnical properties of soil. The bio enzyme has used as a material which improves the properties of soil and is eco friendly and it is economical in long run. In the present study the virgin soil was mixed with various dosages of Terrazyme with different durations and had shown significant improvement in index properties of soil example- specific gravity, moisture content, maximum dry density, liquid limit plastic limit, plasticity index, CBR test . On the basis of experimental results the optimum dosage of terrazyme was obtained. As the enzyme added is organic liquid, it is biodegradable in nature and it does not have any harmful effect on environment . These bio enzymes reduces the void spaces present between the particles of soil and reduce the amount of absorbed water in the soil so the compaction caused by enzyme can be maximum .***

Bio-enzyme is a naturally available non toxic and non flammable liquid enzyme formulation which is fermented from vegetable extracts resulting into the higher soil compaction densities and increases the soil stability. The main functions are catalyzing the reactions between the clay and the organic cations and to increase the speed of the cationic exchange process. It can be mixed with water at optimum moisture content and then it is sprayed over compacted soil. In present study, black cotton soil with varying index properties have been tested for stabilization process and the strengths of the stabilized soil were evaluated after the curing period of 0 days, 14 days, 21 days and 28 days for various enzyme quantities 200ml/3m3, 200ml/2.5m3, 200ml/2m3, 200ml/1.5m3. The California Bearing Ratio (CBR) test and Unconfined Compressive strength (UCS) test done for the soil specimen. From the test results, it is clear that bio-enzyme stabilization improves the strength of black cotton soil up to great extent, which indicate the bearing capacity and the resistance to deformation increases in case of stabilized soil.

Keywords: Black cotton Soil, Soil expansion, Stabilization, Terrazyme.

I. INTRODUCTION

Black cotton is one of the expansive soil available in India. Black cotton soil is an expansive soil that generally available in the tropical zones. Their appearance varies from black colour to brown colour. In our country black cotton soil occupies nearly 20% of the available land. Expansive soil major portion generally found in central part and some places in south India. Expansive soils known by black cotton soil are available in the Deccan plateau fields (Deccan Trap) including Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh and in some parts of Odisha, in the Indian sub-continent. Black cotton soil available in the valley of river Tapti, Narmada, Godavari and Krishna. The west side of Deccan plateau and in upper portion of Krishna and Godavari basin. In this area the black cotton soil depth is very narrow. These soils formed by the residual action of basalt or trap rocks. The other reason behind formation of these soils is weathering of igneous rocks, after volcanic eruption by the cooling action of lava. These soil shows high plasticity nature. The major clay mineral is montmorillonite. Because of montmorillonite group mineral these clays exhibit more swelling and shrinkage characteristic. The main problem with this type of minerals is instability of earth material. Expansive soils are hard when they lose water content, and the another day if they capture water they become soft in nature.

It is reported that damage to the structures due to expansive soils has been the most costly natural hazard in some countries. In the United States damage caused by expansive clays exceeds the combined average annual damage from floods, hurricanes, earthquakes, and tornadoes (Jones and Holtz, 1973). Documented evidence of the problems associated with expansive clays is worldwide, having occurred in such countries as the United States, China,Australia, India, Canada, and regions in Europe. (Popescu, 1986) It is reasonable that studies on the problem of expansive soils become more important day by day if the durative deficit of world resources and economy is taken into consideration. (Cited in Ipek, 1998)

When geotechnical engineers are faced with expansive soils, the engineering properties of those soils may need to be improved to make them suitable for construction. (Muntohar and Hantoro, 2002).

BLACK COTTON SOIL

Black cotton soil is very favourable for the cultivation of cotton. It is called black cotton soil because it is black in colour formed by the presence of titaniferous magnetite. Black cotton soil is clay-rich soil i.e. it contains calcium, carbonate, potash, and holds moisture and is mainly formed in the tropics and subtropics region. Black cotton soil is also rich in lime, iron, and magnesium but contains a low amount of phosphorous, nitrogen, and organic matter. So, it is more fertile in low lands than on the uplands. We can see the cracks in many lands having black soil, this is because during the dry season they form the crack for the circulation of the air. Though it is very good soil for cultivation but is problematic soil for civil engineering work due to its swelling and shrinkage property.

Properties of black cotton soil

1. Black soil has a texture like clayey and is highly fertile.
2. Black soil structure is cloddish or sometimes friable.
3. Black soil when dry gets a contract and develops deep wide cracks.
4. Black soil expands when they are wet and they are hard to plough.
5. Black soil contains almost 50% of clay and can hold water for a long time.

Terrazyme enzyme

Terazyme is a natural enzyme. Terazyme was prepared from molasses from fermentation process. Terazyme is a nontoxic, eco-friendly non-flammable material. Generally chemical products stored with care. In case of Terazyme no need of special care. While handling Terazyme product no gloves were required. The use of Terazyme in the construction of base and sub-base structures removes the need5for the use of a sand/gravel mix, soling or water bound macadam in the construction4of road structures. The base and sub-base7constructed with Terazyme are built up immediately from the sub-grade level. When compared to conventional2structures Terazyme constructed structures showing a much greater flexural strength5and a higher CBR % than the conventional structures. TerraZyme is a natural, non-toxic, liquid enzyme formulation that alters the physical and chemical features of soil.This enzymatic process improves the engineering qualities in the soil facilitating higher compaction densities and increasing the soil stability through closer bonding of particles When TerraZyme is added to soil, it catalyzes the breakdown of organic materials and increases the wetting and bonding capacity of the soil particles. It allows soil materials to become more easily wet and more densely compacted. Also, it improved chemical bonding helps to fuse the soil particles together, creating a more permanent structure that is more resistant to weathering, wear and water penetration.

Figure 1.Terrazyme

Objectives of the study

The objectives of the present laboratory experimental study

• To study the basic engineering properties of the Black Cotton Soil.

• To study the basic engineering properties of the pond ash.

• To evaluate the properties of the expansive soil treated with different percentages of pond ash.

• To evaluate the dry density & optimum moisture content & CBR Percentage of expansive soil treated with different percentages of pond ash.

• To evaluate the properties of the expansive soil treated with an optimum percentage of pond ash on addition of woven geotextile.

• To evaluate the strength characteristics & CBR values of black cotton soil with addition of optimum pond ash & woven geotextile at different depths.

II.METHODOLOGY

Methodology mainly consist of material collection that is black cotton soil and terrazyme, later tests are conducted to Improve the index and engineering properties of black cotton soil

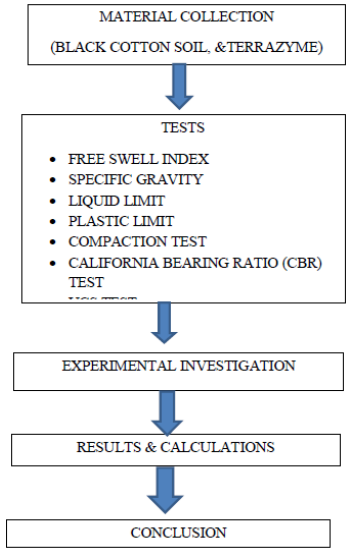

Figure 2.Flow Chart

Collection of Materials

The Black cotton soil used for this project was taken from Telaprolu Place Surroundings Krishna District. The locations had been selected for collecting one soil sample from the particular area. The black cotton soil was collected from a depth of 1.5m. About 150kg of soil sample was collected.

Laboratory California bearing ratio (CBR) (IS 2720-Part 16)

APPARATUS:

1. Loading machine: This is compression machine, which can operate at a constant rate of 1.25mm per minute. A metal penetration piston or plunger of diameter 50mm is attached to the loading machine.

2. Cylindrical mould: Mould of 150mm diameter and 175mm diameter provided with a collar of about 50mm length and a detachable base. A spacer disc of 148mm diameter and 47.7mm thickness is used to obtain a specimen of exactly 127.3mm height.

3. Compaction rammer

4. Annual weight: In order to simulate the effect of the overlying pavement weight, annular weights each of 2.5kg weight and 147mm diameter are placed on the top of the specimen, at the time of testing the sample, as surcharge.

PROCEDURE:
a. Preparation of sample:
1. Take about 5 kg air dried soil which is pulverized and passed through 4.75mm sieve.

2. Add to this soil a certain percentage of water based on the optimum moisture content found out by the compaction test. Sprinkle this water uniformly on the soil and mix it carefully.

3. Divide the wet soil into five equal parts fill the mould with one part of soil and compaction it with 55 evenly distributed blows with the rammer.

4. Repeat the above process with the second, third, fourth and fifth parts of the soil.

5. Before each subsequent layer of the soil is placed the top of the previously compacted layer is scratched with a spatula. This ensures a thorough bonding of one layer with the other. The mould is thus filled with all the five soil layers.

6. Once the sample is prepared the mould with base plate is immersed in a soaked beaker full of water with a circular on it for a period of 4days.

b. CBR test:
1. After 4 days take out the sample and leave it in the atmosphere for the period of half an hour.

2. Remove the base plate and place the mould in the CBR apparatus and place surcharge weights of 2.5 or 5kgs.

3. Make sure that the plunger touches the top surface of the soil. Attach the dial gauge and proving ring.

4. Switch on the lever and set the application load as per penetration rate 1.25mm per minute.

5. Observe the reading dial gauge at every 0.5mm and note the corresponding proving ring dial reading. Until the failure occurs.

FORMULA:
CBR (%) = Load carried by soil sample at defined penetration level /
Load carried by standard crushed stones at the above penetration level

CALCULATION
The load penetration curve is plotted in natural scale for the taken specimen. If the curve is uniformly convex upwards no correction is needed. In case there is a reverse curve or the initial portion of the curve is concave upwards necessity of correction is indicated. A tangent is drawn from the steepest position on the curve to intersect the base at point y which is corrected origin corresponding into zero penetration. The load values corresponding to 2.5 and 5mm penetration values are found from graph. The CBR value is calculated by the above formula.

Generally the CBR value at 2.5 mm is higher and this value is adopted .However if higher CBR value is obtained at 5mm penetration the test is repeated to verify the results. If the value is 5mm is again higher this is adopted as CBR value of the soil sample

Figure 3. CBR apparatus

Figure4.Taking values

UNCONFINED COMPRESSION TEST
APPARATUS:
• Loading frame with constant rate of movement
• Proving ring of 0.01 kg sensitivity for soft soils ; 0.05 kg for stiff soils
• Soil trimmer, evaporating dish
• Frictionless end plates of required diameter
• Dial gauge (0.01 mm), vernier calipers
• Balance of capacity 200 g and sensitivity to weigh 0.01 g
• Oven ,thermostatically controlled with interior of non-corroding material
• Soil sample of required dimensions, sample extractor and split sampler

PROCEDURE
• In this test, a cylinder of soil without lateral support is tested to failure in simple compression ,at a constant rate of strain.

• The compressive load per unit area required to fail the specimen as called unconfined compressive strength.
• Take two frictionless bearing plates of 75mm diameter.
• Place the specimen on the base plate of the load frame.
• Place a hardened steel ball on the bearing plate.
• Adjust the center line of the specimen such that the proving ring and steel bar are in same line.
• Fix a dial gauge to measure the vertical compression of the specimen.
• Adjust the gear position on the load frame to give suitable vertical displacement.
• Start applying the load and record the readings of the proving ring dial and compression dial for every 5mm.
• Continue loading till failure is completed.

Figure 5.UCS Test

III. RESULTS & DISCUSSION

INDEX PROPERTIES OF BLACK COTTON SOIL
Free Swell index Test:
APPARATUS:

- 425 micron IS sieve.
- Graduated glass cylinders 100 ml capacity 2Nos (IS: 878 -1956).
- Glass rod for stirring.
- Balance of capacity 500grams and sensitivity 0.01 gram.

Table 1: Free swell index For BCS with Different Percentages of Terrazyme

Test Specimen	Distilled water (Vd) ml	Kerosene (Vk) ml	Free swell index (%)
BCS	10	7	42.8%
BCS + 0.25ml TZ	10	7.5	33.3%
BCS + 0.5ml TZ	9.5	7	35.71%
BCS + 0.75ml TZ	9.5	7	35.71%
BCS + 1ml TZ	9	7.5	20%
BCS + 1.25ml TZ	9	8	12.5%

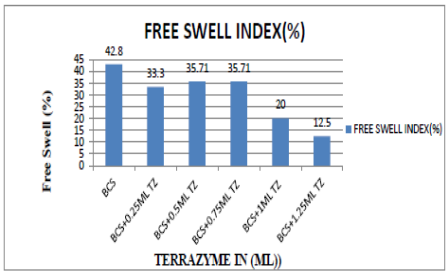

Figure 4.1: Free Swell index

Specific gravity of black cotton soil
Table 2: Specific gravity

Weight of empty density bottle (W_1 g)	29
Weight of density bottle+ soil (W_2g)	39
Weight of density bottle+ soil + water (W_3 g)	85
Weight of density bottle + water (W_4 g)	78.9
Specific gravity (G_s)	2.56

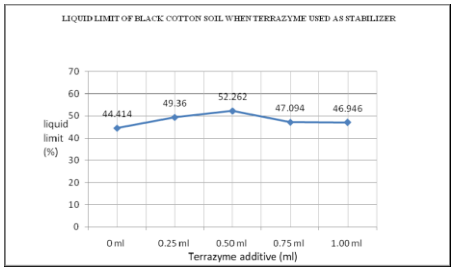

Fig. 6: Liquid Limit of Black Cotton Soil using Terrazyme as Stabilizer

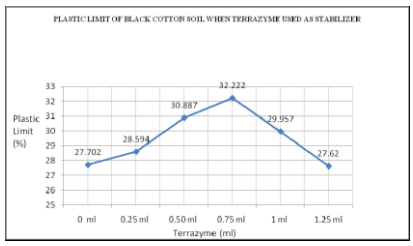

Fig. 7: Plastic Limit of Black Cotton Soil using Terrazyme

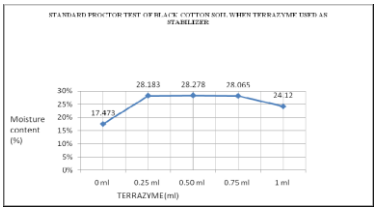

Fig. 8: Standard Proctor Test of Black Cotton Soil when Terrazyme using as Stabilizer

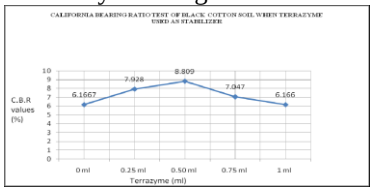

Fig. 9: CBR Test of Black Cotton Soil when Terrazyme used as Stabilizer

C.B.R Test

The addition of Terrazyme, increases C.B.R Test consistently from 6.1667 % to 8.809 %, the maximum C.B.R Test value is obtained at 0.5 ml is high with a value as 8.809 %.

IV. CONCLUSIONS

The addition of Terrazyme, increases C.B.R Test consistently from 6.1667 % to 8.809 %, the maximum C.B.R Test value is obtained at 0.5 ml is high with a value as 8.809 %.

The cost of the construction is reduced by using terrazyme as a admixture. The pavement construction value is reduced 30% of the total cost with the help of laboratory testing results. As a result of soil stabilization, the bearing capacity of the foundation of the structure is increased and its strength, water tightness, resistance to washout, and other properties are improved. Soil stabilization is widely used in the construction on sagging soils of industrial and civil buildings Terrazyme stabilization has shown little to very high improvement in

physical properties of soils. This little improvement may be due to chemical constituent of the soil, which has low reactivity with Bio-enzyme. Therefore, it is advisable to first examine the effect of Bio-enzyme on soil stabilization in the

laboratory before actual field trials. In some cases where the soil is very weak like highly clay to moderate soil, like silty soil to sandy soil, the effect of stabilization has improved the CBR and unconfined compression strength.

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