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AN ANALYTICAL STUDY ON CONSISTENCY LIMITS AND UNCONFINED COMPRESSIVE STRENGTH (UCS) OF BLACK COTTON SOIL

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ABSTRACT

Construction on the black cotton soil, a form of troublesome expanding soil, has various difficulties. It has a swollen and impermeable nature with poor sub grade geotechnical properties. This study takes a stab at improving the different geotechnical qualities of black cotton soil, such as index values, swelling characteristics, and so on. In this study, the soil samples were subjected to UCS, and consistency limit tests (Terrazyme).

***KEYWORDS:* Terrazyme, Black cotton soil, consistency limit, UCS**

INTRODUCTION

One of India's most important sources of soil is black cotton soil. When exposed to fluctuations in moisture content, they expand and shrink dramatically, making them particularly problematic when used in construction. Land reclamation, embankment construction, and other geotechnical uses may reduce the amount of solid waste disposed of on the landfill by using trash with desirable qualities. Since traditional stabilizers such as Lime and Cement are becoming increasingly scarce and expensive, scientists have turned their attention to alternative stabilizers like “sugar cane bagasse ash and rice husk ash, which are less expensive, more readily available, and less harmful to the environment”. Rice husk ash stabilization with varying amounts of black cotton soil, as determined by laboratory tests. Black Cotton Soil is regarded as a flimsy substance because of its limited strength and capacity to withstand large loads. The soil must be stabilized to sustain the added weight. The soil's engineering qualities will improve as a result of stabilization. Throughout the monsoon season, BCS gathers rainwater from the surface and evaporates it during the summer. Expansive soil has a lot of water holding it together. It's a greyish-to-blackish mineral made of montmorillonite clay. It includes calcium carbonate. As a result of introducing stabilizers, weak or brittle expansive (weak) soils may be made stronger and stiffer overall. The study's stabilizers are made from rice husk ash.

SOIL STABILIZATION

The process of enhancing the geotechnical qualities of soil is known as soil stabilization. This process includes adding stabilizing chemicals (binder materials) to deficient soils to increase their compressibility, strength, permeability, and long-term performance. Using soil stabilization technology, soil strength and resistance to water softening may be improved by bonding soil particles together. Stabilization can be broadly classified into two types:

1. Mechanical stabilization
2. Chemical stabilization

LITERATURE REVIEW

Eliaslankaran, Z. (2021) Because some coastal sediments undergo alteration and stability, coastal accretion and erosion will continue to occur. “Soil from Bagan Lalang coast was used in this study to investigate the geotechnical behavior and develop a low-cost alternative combination with environmentally friendly properties by treating it with lime, cement, and rice husk ash (RHA). Using laboratory tests, the effects of different stabilizer/pozzolan ratios just on coastal soil as well as the best conditions for each mixture were determined by analyzing the physical properties of the soil (Atterberg limits and compaction properties) and their mechanical characteristics (direct shear and unconfined compressive strength (UCS) tests). An additional objective of this experiment was determining the maximum axial compressive stress that treated specimens can bear under zero confining pressure and investigating the coastal soil's shear behavior. There was a significant increase in shear stress in the lime-and-rice-husk ash-treated soil (LRHA) when subjected to a stress of 200 kPa, compared to the natural soil. Significant increases were seen in the measures measuring strength, such as those measuring cohesion (c) and the internal friction angle. Samples cured for 90 days had significantly higher cohesion values than those treated for 7 days with additional LRHA in a 1:2 ratio with additional LRHA (28 percent)”.

Prof. Vinay Kumar K S (2020) Safe, efficient, and pleasant traffic flow requires a well-maintained pavement. Some soils, on the other hand, show strong plasticity characteristics such as poor strength, excessive swelling, and shrinkage, all of which are problematic for buildings built using civil engineering. Terrazyme has been tested on black cotton soil to see whether it affects the soil's engineering qualities. When Terrazyme was combined with varying amounts of soil, the geotechnical qualities of the soil in its natural form were evaluated. There was a rise in the California Bearing Ratio of 300 percent and 200 percent, respectively, when Terrazyme was used at doses of 150 and 200 mg/m^3. Terrazyme dosages of $150ml/m^3$ and $200ml/m^3$ enhanced the unconfined compressive strength by 200 percent and 150 percent, respectively.

Datta Karthik Challa, Gottumukkala Rajeev Kumar (2019) Terrazyme is employed in the investigation of Black Cotton Soil stabilization. There is a lot of clay in the soils of Nature's Black Cotton (montmorillonite clay mineral). For Black Cotton Soils, Terrazyme may improve their moisture fluctuations, compressibility, and plasticity. This research includes an evaluation of soil properties such as ideal moisture content, dry density, and strength (California bearing ratio valve). Various methods of introducing Terrazyme (percent weight) into the soil in British Columbia are studied and compared. Terrazyme has had a considerable impact on soil CBR values, or the strength of the soil.

A. Raj et. Al. (2018) Black cotton soils are expanding clays that may shrink or expand significantly depending on the amount of moisture in the air. Surface cracks occur during dry seasons as a consequence of severe shrink-swell processes. During the wet season, cracks disappear, but the uneven soil surface remains due to the unpredictable swelling and heaving that occurs. “It is difficult to use black cotton soils for construction because of their low strength and high sensitivity to volume variations”. Globally, the problem of expansive soils has arisen as cracks and breaks in roads, railway and highway embankments, bridges and buildings as well as in irrigation systems and linings of canals and reservoirs.

RESEARCH METHODOLOGY

For this study, black cotton soil from Anna Nagar in the Chennai region of Tamil Nadu was obtained using a dispersed technique of sampling A layer of topsoil was removed before digging. It's because it's made out of real plants. An area of 1.5 meters in depth was excavated to conduct the investigation. The soil was placed in a polythene bag to determine its natural moisture content. To prevent future moisture loss, precautions were taken. For one day, the gathered dirt was allowed to air dry. Using a wooden hammer, the air-dried earth was ground into a fine powder. A 4.75 mm sieve was used to separate the crushed soil from the rest. To conduct this study, researchers collected soil that went through a 4.75mm screen.

RESULT AND DISCUSSION

Stabilizers might have varied effects on the same soil sample depending on the amount of stabiliser used. A lack of Enzyme (Terrazyme) in the soil may result in less stabilisation, whilst an abundance of the enzyme may make the stabilisation inefficient and expensive. As a consequence, in order to establish the ideal amount of Enzyme to use, the soil samples were subjected to UCS, and consistency limit tests (Terrazyme).

CONSISTENCYLIMITS

Table 1 shows the results of experimenting with soils' index properties (liquid limit, plastic limit, and plasticity index). Liquid and plastic limits are seen to have decreased marginally in Table 1. There is no evidence that Terrazyme can improve pharmaceutical formulations' ability to maintain their uniformity.

Table1:Soil enzymatic consistency limits

Dosagenumber	dosage of Enzyme	limit of Liquid(%)		limit of Plastic(%)		index of Plasticity	
0	Untreated Black cottonsoil	83.50		35.54		47.96	
		7days	14days	7days	14days	7days	14days
1	200ml/3.0 m^3	82.79	81.49	35.01	35.01	47.79	46.49
2	200ml/3.0 m^3	82.9	80.49	34.19	33.49	47.89	47.01
3	200ml/2.5 m^3	80.19	80.9	34.39	33.01	45.79	47.01
4	200ml/2.0 m^3	80.01	79.01	34.49	32.01	45.49	47.01
5	200ml/1.5 m^3	79.01	77.01	34.29	31.49	44.69	45.49

UNCONFINEDCOMPRESSIVESTRENGTH(UCS)

In order to create a consistent and homogenous combination of soil and Terrazyme, researchers tested soil-Terrazyme mixture samples that had been generated by completely combining the requisite quantity of soil and Terrazyme in dry condition as well as the amount of water that had to be sprinkled and mixed properly. Using varying enzyme doses and curing times ranging from 0 to 60 days, the unconfined compressive strength of black cotton was measured. To ensure that the interaction between soil particles and enzymes could continue, the specimens were prepared and stored in desiccators. It was determined that various enzyme dosages were used for each sample (200 ml for 1.5 to 2.0 to 2.5 to 3.0 to 3.0 million cubic feet). Using soil compacted to its maximum dry density and moisture content; UCS experiments were performed on both natural and treated samples.

Figure1:Experimentation with the UCS system

Figure2:This is the specimen's failure pattern.

Table2:Cotton soil that has been cured for a period of time

Dosagenumber	**Dosages**	**Soil UCS (in kPa) during the treatment period**					
		0day Curing	**7days curing**	**14days curing**	**21days curing**	**28days curing**	**56days curing**
0	**UnTreated**	71					
1	**200ml/3.5m^3**	97	121	137	146	166	225
2	**200ml/3.0m^3**	114	132	136	155	185	243
3	**200ml/2.5m^3**	118	140	168	178	213	273
4	**200ml/2.0 m^3**	122	187	213	225	278	314
5	**200ml/1.5 m^3**	126	174	202	212	249	263

- **Effect of 200 ml/3.5m^3 Unconfined compressive strength of black cotton soil influenced by enzymes.**

The effects of Terrazyme doses of 200 ml/3.5m^3 for cure durations of 0, 7, 14, 21, 28 and 60 days were presented in this section. Figure 3 depicts the black cotton soil sample's stress-strain behaviour during the UCS testing. When the soil specimens were exposed to stress values of 96-215-136-145-165-224 kPa for 0, 7, 14, 21, and 60 days, the treated black cotton soil specimens were found to fail (Fig. 3). For unconfined compressive strength, Terrazyme's 200 ml/3m3 dosage failed at 224 kg/cm2 after 60 days of cure (qu).

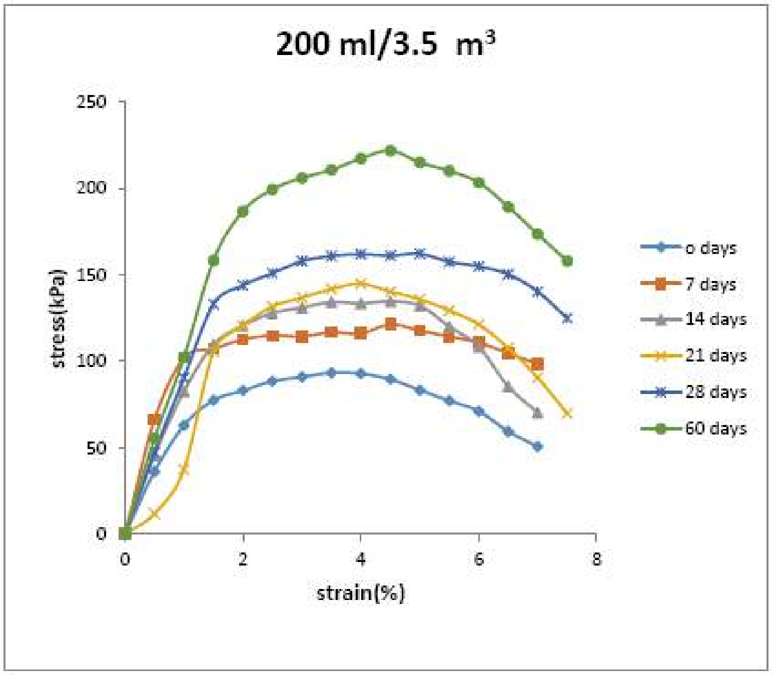

Figure3:Uncertainty in enzyme-treated UCS, BC soil of 200 ml/3.5 m^3.

- **On the unconfined compressive strength of a black cotton soil, the effects of a 200 ml/3.0m^3 enzyme solution**

Unconfined compressive strength is shown to be affected by the addition of 200 ml/2m3 Enzyme in different curing durations. Evaluation of the black cotton soil sample's stress-strain behavior for UCS is shown in Fig. 4.

(1) Figure 4 shows that For cure times of 0, 7, 14, 21, 28 and 60 days stress levels 113, 131, 135, 154, 184, and 242 kPa were too high for the treated black cotton soil samples.

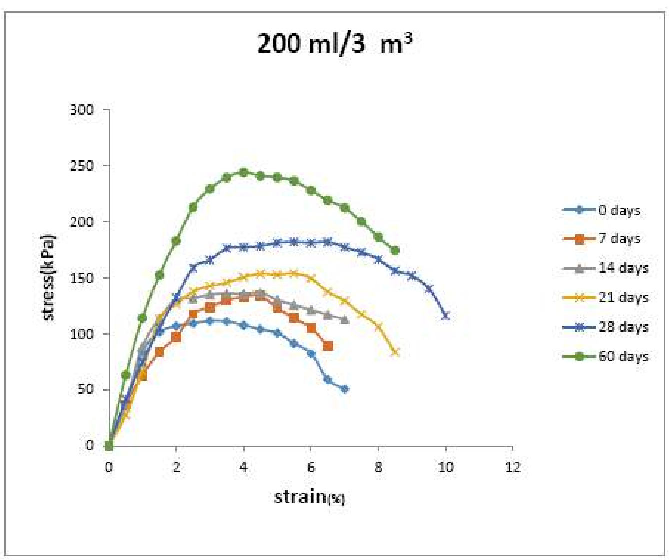

Figure4:Variation in the UCS of enzyme-treated BC soil containing 200 ml/3.0 m^3.

- **Black cotton soil's unconstrained compressive strength is affected by the addition of 200 ml/2.5m^3 Enzyme.**

It is shown here that the addition of Enzyme at 200 ml/2.5m^3 Cure periods of 0, 7, 14, 21, 28 and 60 days have an influence on unconfined compressive strength. UCS soil samples were tested for their stress-strain behaviour in Fig. 5.

As can be shown in Fig. 5Even after a period of 0, 7, 14, 21, 28 or 60 days at stress levels as high as 171, 213 or 272 kg/cm2, the treated black cotton soil specimens failed to cure.

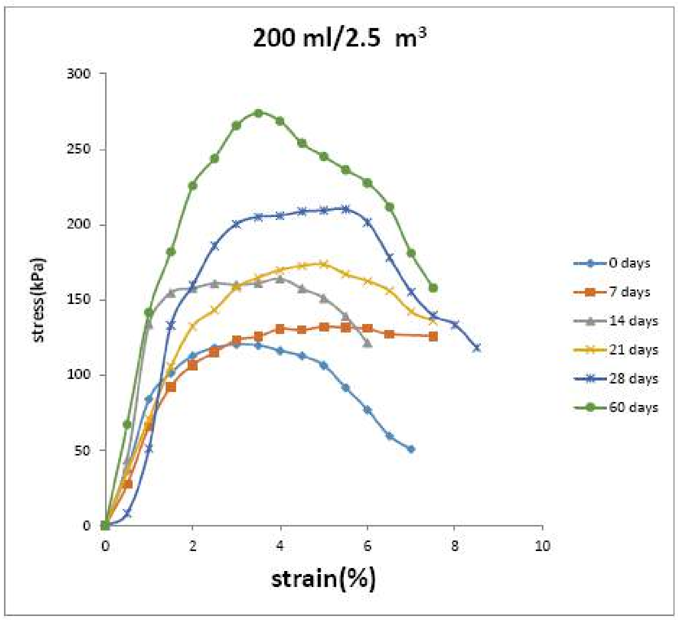

Figure5:Variation in UCS of enzyme treated BC soil of 200 ml/2.5 m^3.

- **Black cotton soil's compressive strength in limited spaces is affected by the addition of 200 ml/2m^3 Enzyme**

Topics in this section exhibit the impact of adding 200 ml/2m^3 Enzyme on compressive strength in the absence of restraint various curing periods. UCS black cotton soil sample' stress-strain behavior is shown in Fig. 6, which indicates the enzymes' impact.

(i) From curing periods of 0, 7, 14, 21, 28 and 60 days, the treated black cotton soil specimens showed failure at stress levels of 112, 186, 212, 226 as well as 277 and 313 kPa (see Fig. 6).

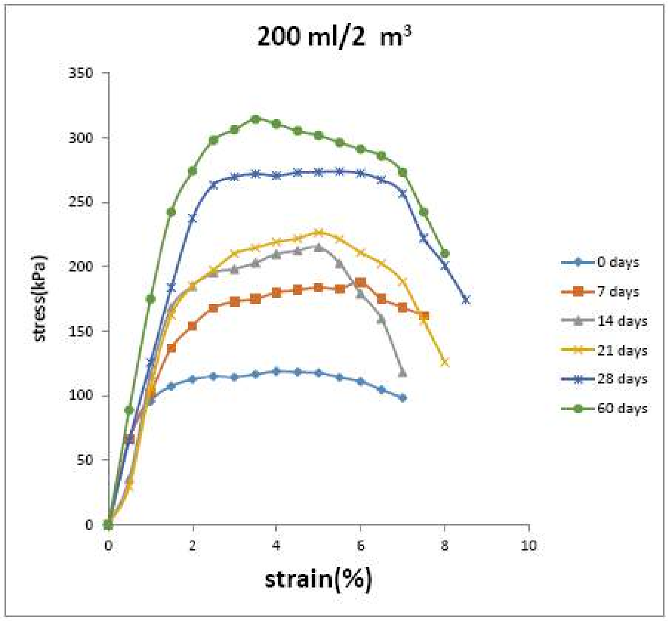

Figure6:Variation in the UCS of enzyme-treated BC soil at 200 ml/2 m^3 of water.

- **Compressive strength of black cotton soil in limited spaces is affected by the addition of 200 ml/1.5 m^3 of enzyme.**

This study illustrates the impact of adding 200 ml/1.5m^3 the effect of enzyme on unconfined compressive strength across a range of curing times. An enzyme effect on stress-strain behavior of black cotton soil samples tested for UCS is shown in Figure 7.

According to the figure, treated black cotton soil specimens were found to fail at a stress level of 248kPa during 0, 7, 14, 21, 30 or 60 days of curing.

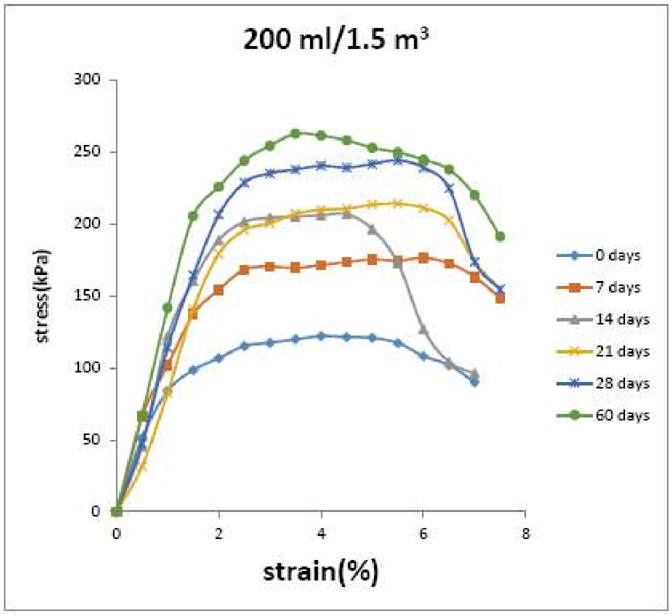

Figure7:Differentiation in the enzyme's UCS -treated BC soil at 200 ml/1.5 m^3.

- **Various Terrazyme dosages have different effects on UCS values Throughout different cure periods.**

UCS values for black cotton soil are shown in Figure 8 under a variety of curing conditions times and Terrazyme dosages. For dosages 1 and 2, the UCS value increases uniformly over time, while dosages 3 and 4 show a similar trend over time. The strength gains for dosages 3 and 4 are significantly better than those for dosages 1 and 2. Figure 8 shows that the UCS value increases uniformly over time for untreated soil.

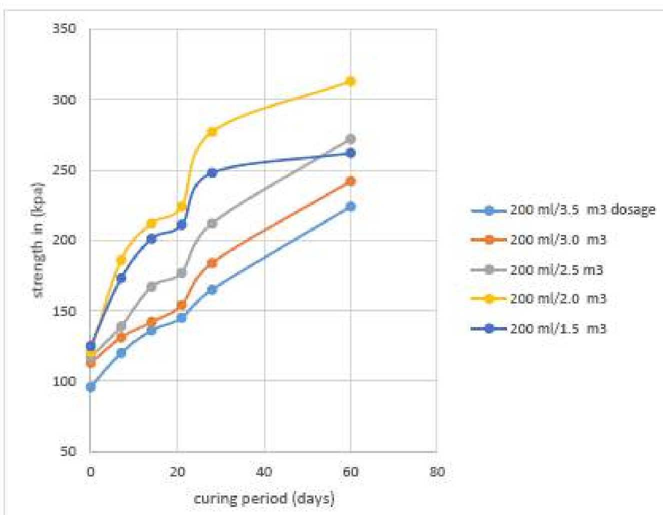

Figure8:Curing time on black cotton soil affects the UCS.

No substantial change in the UCS value can be shown for zero days of cure with varied dosages (i.e., 1, 2, 3, 4 and 5). The same holds true for dosages 1 to 2 as well as 3 to 4. Figure 8 shows that the 60-day cure duration for all dosages of Terrazyme is more important.

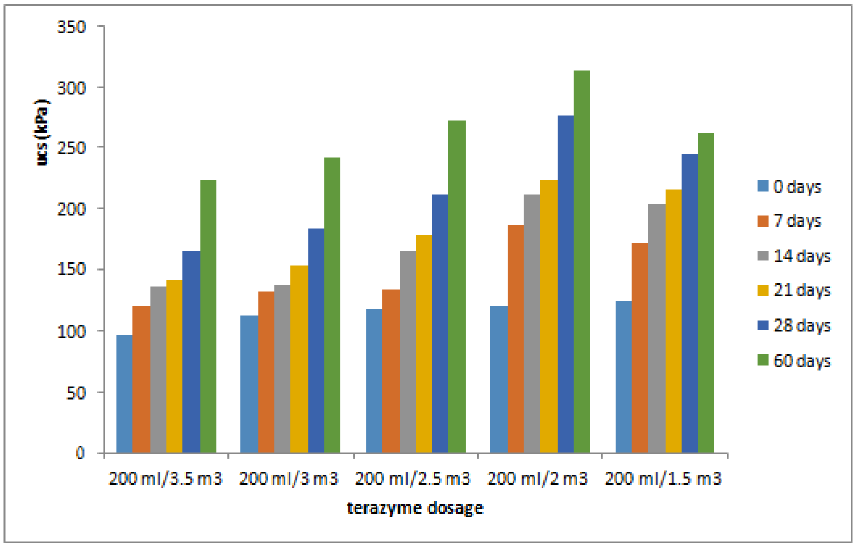

Figure9:Curing time on black cotton soil affects the UCS in a variety of ways.

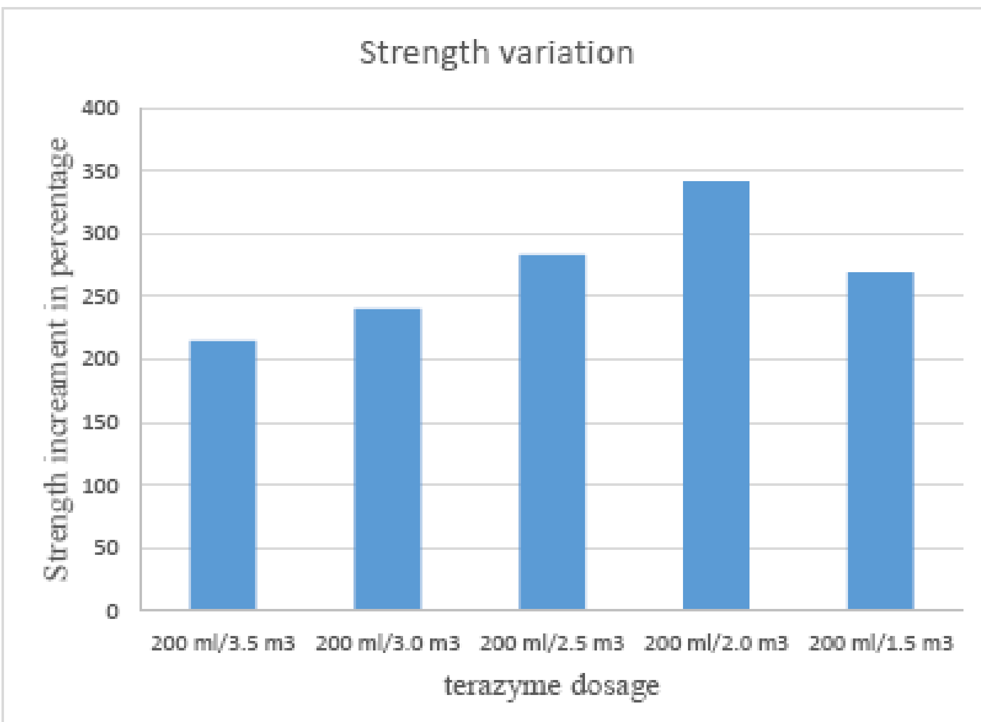

Figure10:Percentage increase in strength

CONCLUSION

In this study we have discussed about the black cotton soil in which the soil samples were subjected to UCS, and consistency limit tests (Terrazyme).The purpose of this study was to enhance the soil's geotechnical qualities. Terazyme, a bio enzyme, was employed to enhance the geotechnical qualities. Different concentrations of

Terazyme enzyme and curing times were evaluated in the soil.

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