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Stabilization of Black Cotton Soil Using Terrazyme and Rice Hush Ash

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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 using different quantities of Terrazyme and rice husk ash. 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 in order to sustain the added weight. The soils 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. An expansive soil is one that has a lot of water holding it together. Its 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. In this study stabilizers used are rice husk ash and Terrazyme.

KEYWORDS- Terrazyme, Rice Husk Ash, Black Cotton Soil, UCS, Stabilization.

I. INTRODUCTION

A. General

Black cotton soil represents a well known category of problematic soil from civil engineering point of view. They exhibit large volumetric changes shrinkage and swelling behaviour if the moisture content changed[1]. Due to this nature this type of soil is susceptible to damage to the structures and pavements founded on it. In India expansive soils cover about 0.8X106 km2 area approximately 20% of surface area .Structure founded in areas with soft or weak soil have need for improvement of soil properties by using additives. Soil stabilization techniques are used to improve shear strength, CBR, reducing expansive characteristics, etc[2]. The sharing strength of the soil is extremely low, is highly compressible and has very low bearing capacity. Recently bio-enzymes have emerged as a new chemical for soil stabilization. Bio-enzymes are chemical, organic, and liquid concentrated substances which are used to improve the stability of soil. Bio-enzyme is convenient to use, safe, effective and dramatically improves the soil quality. One such bio-enzyme, Terrazyme, has been used in the present work to study its effect on the Unconfined Compressive strength of the Black Cotton soil. It has been found that Terrazyme treated Black Cotton soil shows significant increase in Unconfined Compressive strength with longer curing period [3]. Rice husk ash is used in this study as a chemical stabilizer as it contains high silica content. If soil contain medium or coarse sandy particles then mixing of RHA will occupy the void created by coarser particles, further leads to increase in shearing and bearing capacity due to increase in chemical bonding other than gravitation force. If major particle of soil contain clay minerals like montmorilonite then RHA which is having high silica content, replace exchangeable ion further leads to decrease in cation exchange capacity (CEC). CEC decrease due to decrease in –ve ion as Si replace other metallic ion such as Na, Mg etc. Exchangeable ion present in the soil water leads to swelling of soil if it contain clay minerals like montmorilonite as they form week bond between clay particles[4-6]. As clay surface is negatively charged Si make stronger bond then other metallic ion present in clay minerals. A number of experiments were carried out on expansive soil treated with varying amounts of quarry dust and rice husk ash, and the findings show that as water content drops, the maximum dry density of the soil sample increases. Except for parent soil, the maximum water content during SPT is 28 at a dry density of 1.76 g/cc[7]. Except for parent soil, the minimum water content during SPT is 23 at a dry density of 1.79 g/cc. Mixture& 39;s maximum strength is derived from a 10% Stone dust/20% RHA (Rice Husk Ash) composition. Compressive strength rises for a certain composition before plummeting. Soil mixing with the correct composition is not a simple operation for this soil treatment, but it is crucial for the best results at the lowest cost. This study looked at how to implement a balanced bio-enzyme soil[8-9]. “Liquid limit value lowers for soil treated with Terrazyme, plastic limit value decreases; dry density of soil increases from 1.665 to 1.828 gm/cc optimal moisture level of 18.33 and 14.49, respectively. Swelling is much better now than it was before. The CBR value has also increased significantly in treated soil, from an average CBR of 2.49 in untreated soil samples”. As the percentage of RHA increased, the soil liquid limit and free swell index fell. For the same amount of RHA added to alluvial soil, the liquid limit dropped from 59 percent to 19.2 percent[10]. “The unconfined compressive index hit a new low of 13.6% after falling by 59%.

Terrazyme has a high upfront cost, however it has a low or nil on going maintenance cost. Terrazyme is cost-effective and efficient in sub-base preparation, consistency limitations, and CBR after a two-week curing period[11]. "Atterberg limits, compaction and CBR tests were carried out in this investigation using different percentages of Rice Husk Ash (0, 5,10, 15, and 20%) and Terrasil (0.04%, 0.06, 0.08, 1.0%), which were blended with the expansive soil and tested in the laboratory, and it was found that there is an improvement in geotechnical proper"[12]. According to the test findings, engineering qualities have improved, and the optimal percentages have been determined as a consequence. Black Cotton Soil is regarded as a flimsy substance because of its limited strength and capacity to withstand large loads[13]. The soil must be stabilized in order to sustain the added weight. The soils engineering qualities will improve as a result of stabilization[14]. Throughout the monsoon season, BCS gathers rainwater from the surface and evaporates it during the summer[15]. An expansive soil is one that has a lot of water holding it together. Its 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[16].

II. 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 soils 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)[18]

Rao, Narasimha et. Al. (2020): Its a real problem to use expansive soil on the construction site because of the way it shrinks and expands. It is necessary to treat the expanding soil adequately in order to remove these variations and make it acceptable for the construction. Black cotton soils have a low bearing capacity due to their expansive nature. Montmorillonite clay mineral is often found in dark cotton soils due to its soils shrinkage and swelling properties. "Swelling nature will increase if the moisture content in black cotton soil changes. To improve the quality of black cotton soil (Problematic soil) for use as a construction material, fly ash (FA) and rice husk ash are added as stabilizing agents (RHA)" Certain Admixtures may stabilize soil by adding variable amounts of Fly ash (FA) and Rice Husk ash (RHA) (2,4, 6, 8, 10 percent)[17]

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 soils engineering qualities. When Terrazyme was combined with varied 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 150 ml/m3 and 200ml/m3 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 stabilisation. Nature's Black Cotton is grown on soils that include a lot of clay (montmorillonite clay mineral). Terrazyme has the potential to enhance the moisture fluctuations, compressibility, and plasticity of Black Cotton Soils. Soil parameters such as optimal moisture content, dry density, and strength are examined in this study (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.

Mr. Shirsath H.A (2018): Most of the country's soil, both above and below ground, is insufficiently stable to bear the weight of a building. It was the goal of the research to evaluate the different methods of stabilising soil. Numerous options exist for stabilising expansive soils. Traditional soil stabilisers, soil reinforcement, and low-cost stabilisers are used by a large number of stabilisers. Aside from being useless and costly, all of them share the same drawbacks. According to the literature, fuji button is an excellent bio-enzyme for stabilising soil. Soil stabilisers are the subject of this review study, which focuses on a wide range of conventional and non-traditional additives. Tires, jute, fibres, and other non-traditional additives may enhance soil quality and ease the issue of waste disposal.

Gowshik Arivazhagan (2016): Black cotton soil will be stabilised for use in road and building construction as part of an experimental project in this area. An enzyme known as Terrazyme is utilised to keep soil elastic. Black cotton soil that is stabilised with Terrazyme is tested in this study at different dosages, after a curing period of 0 days, 14 days, and 28 days.

Koteswara et al. (2011): Added rice husk ash, lime, and gypsum to the expanding soil to boost its strength qualities, and the results were impressive. It was discovered that rice husk ash, either used alone or in conjunction with lime and gypsum, has the potential to help control soil expansion. "The use of industrial wastes like RHA, lime, and gypsum may help keep road construction costs down, especially in rural areas. With the addition of 20% RHA+5% lime, it was found that the expansive soils liquid limit was reduced by 22%. With the addition of 20% RHA + 5% lime, it was

discovered that the expansive soil free swell index was reduced by 88%". After 28 days of curing, the expansive soil unconfined compressive strength increased by 548% with the addition of 20% RHA+5% lime +3% gypsum.

III. SELECTION OF MATERIALS AND METHODOLOGY

A. Black Cotton Soil

Black cotton soil is highly clayey soil. It posseses high percentage of clay, which is predominantly montmorillonite in structure and blackish grey in colour. Though it is very good for cultivation but is challenging work for civil engineering. Black cotton soils cover a vast portion of central and southern India , including Madhya Pradesh, Maharashtra, Gujarat, Uttar Pradesh. The clay mineral montmorillonite is mainly responsible for expansive characteristics of the soil. It has very low bearing capacity and high swelling and shrinkage characteristics.

B. Terrazyme

It is a liquid bio-enzyme used as a stabilizer in soil stabilization. Bio-enzyme is a natural, non-toxic bio-degradable liquid concentrate. It is low cost additive with long lasting effects. By altering the physical and chemical characteristics of soil, materials treated with Bio-Enzyme retain higher performance. The use of Terrazyme enhances weather resistance and improves load bearing capacity of soils. It increases the durability of pavement and reduces the swelling properties of soil.

C. Rice Husk Ash

Rice Husk Ash is a by-product material produced from the process of manufacturing puffed rice, contains large amount of iron oxide and silicate. It has higher density, stay in the top layer and then transported to a water basin with a low temperature for solidification. The end product is a solid, hard material that goes to the crusher for further processing. Annually 60,000 tons of rice husks are produced in India. It is chemically stable and its physical properties are similar to that of natural sand. The high angularity and friction angle (up to 530) of rice husk contribute to excellent stability and load bearing capacity.

D. Test Methods

- Specific gravity.
- Atterberg's limit.
- Proctor compaction test.
- Unconfined compression strength test.
- California bearing ratio.

IV. RESULTS

From this study while performing investigation on black cotton soil with varying percentage of Terrazyme and rice hush ash , it was shown that properties of soil improved to some extent. The effective changes shown by soil are as follows:

- The maximum liquid limit for untreated black cotton soil is 83.50 percent. There is a minor variation in the liquid limit after introducing the enzyme. The total index of plasticity ranges from 43.00 to 48.00.
- For example, the soils Atterberg limits are not within the necessary range. Enzymatic soil has a liquid limit of 83.00 percent to 79.00 percent. Between 43.00 and 48.00, the index of plasticity the subgrade of a pavement is not being met by the values. The subgrade material of the pavement cannot thus be used.
- Curing time seems to have a positive effect on the enzyme-treated soil's unconfined compressive strength.
- Consolidation coefficient drops as the curing time increases. However, the second week of curing suffers a little setback from the first week of curing.
- The compression index falls as the cure time progresses.
- According to the IS Soil Classification System, the delicate soil is dirt with a high degree of adaptability (CH). CBR-esteem (1.46) and unconfined compressive pressure (70 KN/m2) are exceptionally low for this material. It is critical that the ground be levelled off before any structural work can begin.
- RHA treatment results in an overall decrease in MDD and an increase in OMC with an extension of the RHA's scope.
- The unsoaked CBR (106 percent at 10% RHA focus) has also improved as compared to the CBR of the ordinary soil.
- UCS is used as a comparison example. At 10% RHA (90.6%), the UCS esteem is at its highest point (90.6 percent improved).
- For functional purposes, soil modification with 10% RHA content and 6% concrete is found to be an appropriate degree of increase in strength.

V. CONCLUSION

- It was concluded that the addition of Enzyme at 200 ml/2.5m 3 at Cure periods of 0, 7, 14, 21, 28 and 60 days have an influence on unconfined compressive strength.
- It was experienced that the FSI index of the soil reduced with the increase in rice husk ash.
- Unsoaked CBR increased from 9.98 to 12.23 %, whereas drenched CBR increased from 3.80 to 5.2 %, solely due to the spread of
- RHA and Terrazyme into the soil.
- There was a visible percentage increase of strength at 200ml/2.0m3
- With the increase in percentage of RHA and Terrazyme, the permeability of soil sample decreases.

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