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Examining Black Cotton Soil with a Variety of Amendments

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Abstract: *The black cotton soil is a form of expansive soil that swells up and starts to expand quickly when it comes into contact with water. Because of this quality, the strength of the soil, along with its many other properties, is extremely lacking. The expansive sort of soil exhibits unpredictability in its behavior when stabilized with completely diverse kinds of quiet substances. In addition to this, soil stabilization is a method of treating soil in order to need care for the soil, alter its performance, or improve its performance. During the course of this research, both marble dust, which is a by-product of the marble industry, and coconut shell powder will be tested for their viability as helpful additives to expanding soil. In this part of the investigation, we are going to determine the advance at intervals of the strength qualities of expanding soil in its natural state as well as once it has been mixed with varying proportions of marble dirt and coconut shell powder. The sand used in the experimental programme is ground up marble that was obtained through the cutting of marble. The damage to the environment that is created by marble mining is significantly less severe than the damage that is caused by the garbage produced by marble processing factories. According to the findings of a significant number of researchers, marble can contain as much as fifty five percent lime (CaO) by weight. In order to perform the unconfined compression test, black cotton soil specimens are created by incorporating varying proportions of marble mud and coconut shell powder into the black cotton soil, and then the specimens are allowed to cure for three, seven, and fourteen days respectively. The remarkable variation that was identified between the qualities of the soil's strength were discovered.*

Keywords: Black cotton soil

I. INTRODUCTION

There is a large region in India known as the Deccan Trap, which is home to the black cotton soil. They range in thickness and are supported by a gummy, dark material that is sometimes referred to as "black soil." When black cotton soil comes into touch with water, it either swells or shrinks, which causes moments in the structure that are typically unrelated to the direct action of loading. Because of the significant volumetric shifts that it undergoes, it cannot be used in building. Because of the presence of small clay particles, it has an exaggerated swelling and shrinking effect. Because the alternating swelling and shrinking of the soil is what causes differential settlement of the building, black cotton soil needs to be treated with the addition of the appropriate admixtures in order to stabilise it. The application of lime as an additive is the method that is used in the research that I am conducting on black cotton soil. Work of an experimental nature has been done with lime contents of 3% and 5% respectively.

The foundation is one of the most important components of any land-based structure, and it is essential that it be strong enough to support the entire building. The soil that surrounds the inspiration plays a pretty important part in determining whether or not it will be resilient. Therefore, in order to work with soils, it is important for us to have accurate information regarding their characteristics and the elements that influence how they behave. The process of soil stabilisation helps to achieve the necessary qualities throughout the development work that is required of the soil.

The necessity of improving the qualities of the soil has been brought back into the light from the very beginning of the construction activity. Ancient civilizations such as the Chinese, Romans, and Incas utilised a variety of methods to increase soil strength and other factors; a number of these methods were so effective that their structures and roadways are still in existence today. In India, the modern era of soil stabilisation began in the early 1970s. At that time, the

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country was experiencing a general shortage of fossil fuel and aggregates. As a result of this shortage, it was necessary for engineers to look into alternative ways to improve soil quality besides replacing the poor soil at vacant lots. The process of improving soil by sterilising some of its qualities using a variety of techniques, both mechanical and chemical, in order to produce an improved soil material that possesses all of the required engineering properties is referred to as soil stabilisation. It used to be common practise to stabilise the soil; however, this practise fell out of favour not only as a result of the adoption of ineffective tactics but also as a result of the absence of an appropriate approach. In recent years, as the demand for infrastructure, raw resources, and fuel has increased, soil stabilisation has started to take on a new form. This is due to the fact that traditional methods have become obsolete.

It is quickly becoming a popular method for soil improvement as a result of the availability of greater analyses, materials, and instrumentation, and it is also very cost-efficient.

In this location, during the course of this project, the soil has been stabilized with the use of admixtures such as powdered waste marble dirt and powdered coconut shell. Research is done on the engineering properties as well as the strength characteristics of the soil. The growth in the shear strength parameters has been emphasized, and comparison studies have been published making use of various methodologies for measuring shear resistance.

II. LITERATURE SURVEY

1. **Rakhil Krishna R &Devi Krishnan "REVIEWON THE EFFECT OF WASTE CERAMICDUST ON THE GEOTECHNICALPROPERTIES OF EXPANSIVE SOILS" IRJET-2016.[9]**

The amount of moisture that is present in the expansive soils causes them to either expand or contract in a cyclical manner. This behaviour leads to a change in the volume of the soil, which in turn causes the breaking and collapse of structures that have been built on top of the soil. There is a wide variety of different approaches that may be taken in order to enhance the geotechnical features of these expansive soils in order to make them suitable for use in construction. In this work, we discuss the findings of an experimental programme that is already being carried out. The programme involves stabilising expansive soil with ceramic dust that is manufactured from waste ceramic tiles that are readily available in the local area. In addition to this, it examines the economic viability of utilising ceramic dust as a means of enhancing the qualities of expansive soil that is utilised in the construction industry. The term "expansive soils" refers to the types of soils that experience significant swelling when they come into contact with water and subsequent shrinkage when the water is extracted. They are also known as swelling soils, and they are soils that have a propensity to rise in volume anytime the moisture content (also known as water content) in them is raised. This means that they are also known as hydrophilic soils. There will be a change in soil volume as a result of the soil's alternating habit of swelling and shrinking. This change in soil volume has the potential to induce shifting and cracking in a variety of civil engineering buildings founded on the soil. When the amount of moisture in the air increases, a foundation that is built on swelling soil will buckle, which might cause a building or structure that is constructed on it to lift. This could, in the long run, result in the foundation and the structure that was built on it failing.

2. H.Venkateswarlu , A.C.S.V Prasad , Dr. DSVPrasad &Dr.GVRPrasadaRaju "Study onBehavior of Expansive Soil Treated With QuarryDust" IJEIT-2015.[10]

Quarry dust is a form of solid waste material that is produced as a byproduct of enterprises that deal in aggregate crushing.

The disposal of such waste items results in a wide variety of issues for both the public and the environment. In light of this consideration, an experimental investigation was carried out on the expansive soil that is readily available in the surrounding area by combining it with quarry dust. This paper presents the variation of index and engineering properties of expansive soil such as liquid limit, plastic limit, plasticity index, compaction characteristics, California Bearing Ratio and shear strength when it is mixed with different percentages (0%, 5%, 10% and 15%) of Quarry dust. The results were found that up to the addition of 10% of stone dust there is an increase in strength parameters beyond that, but it is no longer effective.

3. Shailendra Singh & Hemant B. Vasaikar"Stabilization of Black Cotton Soil using Lime"IJSR-2015.[11]

The construction of the foundation on black cotton soil, also known as expansive soil, has always been a challenging work for engineers, due to the fact that a structure that is supported by black cotton soil will crack without any prior

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notice. In our nation, the states of Andhra Pradesh, Maharashtra, Karnataka, and M.P. all have soil that resembles black cotton. The proportions of soil alter depending on the ingredients that make it up, such as water content, density, bulk density, angle of friction, shear strength, and so on. The characteristics of a black cotton soil can be altered by stabilising the soil via the use of additives or through the application of mechanical techniques. This can be done to get the desired result. Lime has been used in this project as part of an effort to achieve the goal of stabilising the soil. A 4% and 6% lime content was used in the experiments that were carried out. The experimental work is predicated on various percentages of lime concentration in soil, as determined by tests for soil Liquid limit, Plastic limit, O.M.C., M.D.D., Bulk density and Dry density, C.B.R. test, Grain size analysis, and Swelling pressure. The objective is to enhance the engineering features of the black cotton soil to the point where a structure that is built on this soil will be able to effectively handle the loads that are applied to it. It was discovered that the incorporation of lime into black cotton soil led to a significant improvement in the engineering features of the soil.

4. Monica Malhotra & Sanjeev Naval "Stabilization of black cotton Soil using Low Cost Materials" IJEIT-2013[12]

The foundation of any construction is of utmost significance, and it must be robust in order to successfully sustain the building as a whole.

The surrounding soil plays a very important part in determining the overall strength of the foundation of the building. In order to work with soils, we need to have an in-depth understanding of their characteristics and the elements that influence how they behave.

Expanding soils will almost always cause greater problems for structures that are lightly loaded than for structures that are moderately loaded. These issues become apparent as swelling, shrinking, and unequal settlement as a result of the material solidifying under load and altering volumetrically in conjunction with variations in seasonal moisture. In this article, the experimental results obtained in the laboratory on expansive soils treated with low cost materials (lime and fly ash) are described. These results were acquired through treating the expansive soils with lime and fly ash. An investigation into whether or not the qualities of expansive soil can be improved by the addition of fly ash and lime in varied proportions is being carried out. In this paper, the test results, such as liquid limit, standard proctor compaction, and differential free swelling test, obtained on expansive clays mixed at various proportions of lime and fly ash admixture are presented and discussed. The tests included liquid limit, standard proctor compaction, and differential free swelling test. According to the findings, the stabilised clay has a lower swelling potential, but a rise in the optimal moisture level was found.

III. CHARACTERISTICS OF BLACK COTTON SOIL

Black cotton soil are generally reddish brown to black in color. They occur 0.50m to 10 m deep possessing high compressibility. Common characteristics are listed in table-1 below

Table 1: Characteristics of Black cotton soil

S. No.	Property	Value
1	Dry density (γd)	1300- 1800 Kg/m³
2	Liquid Limit (L.L.)	40 - 120%
3	Plastic Limit (P.L.)	20 - 60%
4	Activity	0.8- 18%
5	Specific Gravity(G)	2.60 - 2.75
6	Proctor Density	1350- 1600 Kg/m³
7	OMC (Max dry density)	20- 35%
8	Free Swell Index	40- 180%
9	Swelling pressure	50- 800 KN/m²
10	C.B.R. (soaked)	1.2- 4.0
11	Compression Index	0.2- 0.5
12	Fines(<75μ)	70- 100%
13	2 μ Fraction	20 - 60%
14	Soil Classification	CH or MH

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3.1 Chemical Composition of Black Cotton Soil

The table that follows contains an inventory of the chemical components of black cotton soil. Clay minerals such as montmorrilonite, illite, and kaolinite are found in black cotton soil. Other components of black cotton soil include compounds such as iron oxide and calcium carbonate (in the form of kankars), as well as organic matter such as humus. The majority of the black cotton soils have montmorrilonite as their primary mineral component. The swelling and shrinkage behaviours of black cotton soil are mostly caused by hydrous silicates of aluminium and magnesium, which are a mineral that is predominant in this soil. They are composed of layers of tetrahedral silica and octahedral alumina that are stacked one on top of the other to form a sheet-like flaky particle. The structure of montmorrilonite consists of three sheets that are connected by expanding lattices. Because part of the aluminium ions in the lattice have been isomorphically replaced with magnesium ions, the structure has a negative charge, and the minerals have become chemically active.

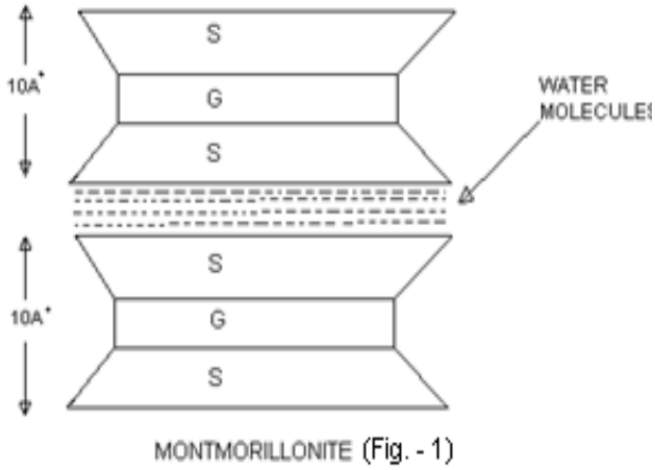

Figure 1: Structure of Montmorrilonite Mineral

3.2 Problem Associated with B. C. Soil

Black cotton soils present a unique set of difficulties for engineers worldwide, especially in tropical regions like India.soil moisture content varies greatly in response to seasonal temperature shifts and ebbs and flows. Common issues in black cotton soil include:

- **High Compressibility:** When wet, the soil in a Black Cotton is very malleable and compressible. Whenever a foundation rests on such ground, it experiences significant settlements due to consolidation.
- **Swelling:** As a result of the soils, a building constructed in a dry season will shift at various rates when the rains come. Causes cracking and lifting of buildings resting on swollen soils.There is a prerequisite of the structure having reached the point of adequate swelling pressures.
- **Shrinkage:** When the natural water content drops, cracks appear in a building that was constructed towards the conclusion of the wet season.

3.3. Engineering Properties of B. C. Soil

Soil's key engineering properties are its permeability, plasticity, compaction, compressibility, and shear strength.

- **Permeability:** A material's permeability is measured by how easily water can move through all of the tiny holes and crevices in it.
- **Plasticity:** Rapid deformation without elastic rebound and without appreciable volume change is the defining characteristic of plastic soil..
- **Compaction**: A process known as compaction is one in which the particles of soil are forcibly rearranged and packed together into a tighter state of contact by the use of mechanical methods. This is done with the goal of reducing the porosity of the soil and, as a result, increasing its dry density.

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- **Compressibility:** The property of soil mass pertaining to its susceptibility to decrease in volume under pressure is known as compressibility.
- **Shear Strength**: This is the resistance to deformation by continuous shear displacement of soil particles or on masses upon the action of a shear stress

IV. LIME STABILIZATION

Lime stabilisation helps in increasing the strength and durability as well as minimizing the moisture variations in the soil. Lime needs to be well compacted in order to obtain sufficient strength and durability by maintaining OMC, which is an assumption that is also made in the experimental determination of the required lime proportion. The quality of lime that should be applied is determined by the specific surface area of the soil particles; this factor is particularly important for fine-grained soils and can be as high as 15% of the soil's weight. The primary advantages of using lime for the purpose of stabilizing clays are an increase in strength, an improvement in workability, and a stability in volume. The clay becomes more friable as a result of flocculation, which contributes to an increase in workability. This facilitates combination, which is necessary for successful mixing and compaction. When working with moist soil, adding lime can be beneficial since it can raise the water content at which compaction is most effective. Lime is added to soil to make it stronger, which improves its capacity to withstand wear and tear from traffic as well as elements such as water, wind, and freezing and thawing cycles. There have been three various ratios of lime used in the process of stabilising black cotton soil. These ratios are 0%, 3%, and 5% respectively. Following the lime-based stabilisation of the soil at the proportion stated above, a series of tests were carried out.

- **Liquid Limit Tests**: The moisture content of a soil, defined as a percentage of the weight of the oven-dried soil, that marks the transition point between the liquid and the plastic states of consistency is referred to as the liquid limit of the soil. When the cup of a standard liquid limit apparatus is dropped 25 times from a height of 0.3937 in (10 mm) at a rate of two drops/second, the moisture content at this boundary is arbitrarily defined as the water content at which two halves of a soil cake will flow together for a distance of 12 in. (12.7 mm) along the bottom of a groove of standard dimensions separating the two halves. This distance is measured along the bottom of a groove that separates the two

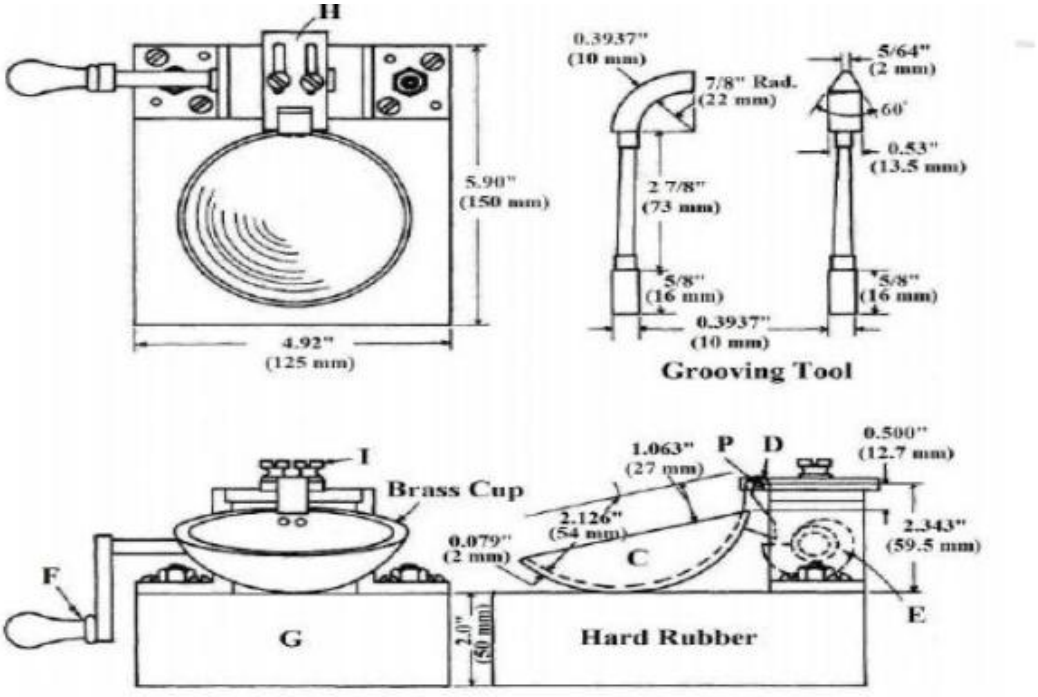

Figure 2: Mechanical Liquid Limit Device

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- **Plastic Limit Tests:** The moisture content of a soil, stated as a percentage of the weight of the soil after it has been dried in an oven, is considered to be its plastic limit. This moisture content marks the transition point between the plastic and semisolid states of consistency. When rolled into a thread with a diameter of 1/8 inch (3 mm) using a ground glass plate or another appropriate surface, it is the moisture content at which a soil will barely begin to crumble.

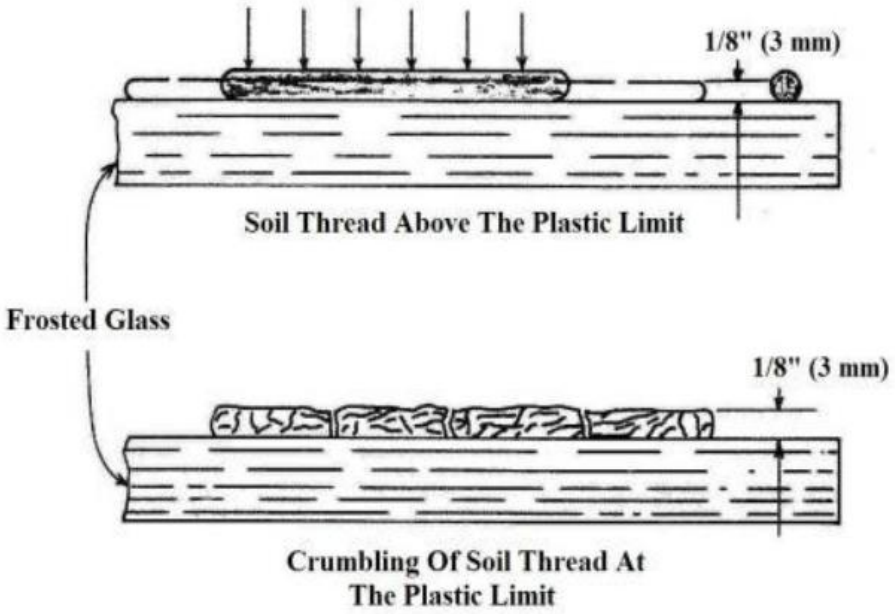

Figure 3: Diagrams Illustrating Plastic Limit Test

V. CONCLUSION

The purpose of this research was to investigate and develop methods to enhance the geotechnical qualities of black cotton soil. An application of a bioenzyme known as Terazyme was made in order to enhance the geotechnical qualities. The soil was treated with a mixture containing the Terazyme enzyme, and its effectiveness was evaluated using a range of various dosages and curing times. Following are some inferences that may be derived from the experimental inquiry and outcomes that were achieved.

The majority of the study area's geology is composed of volcanic rocks of a Tertiary to Quaternary age (lava and pyroclastic) (andesite, ignimbrite, lithic tuff, and basalt), as well as alluvium that was deposited more recently. Rocks with the potential to eventually become mountains are more likely to be found in the northeast, north, and east of the region. In contrast, the low-lying flat terrain is dominated by alluvial soils, particularly black cotton soil. Weathering, erosion, and the transfer of minerals from neighbouring Tertiary and Quaternary volcanic mountains and ranges all contribute to the formation of this kind of soil in low-lying locations that have poor drainage.

Studies using petrography have shown that the major minerals in these rocks are plagioclase feldspar and pyroxene.

REFERENCES

[1] Abhijith R.P (2015): Effect of Natural Coir strands on California bearing ratio of Soil Subgrade
[2] Ancrum Amunza Amunga(October, 2017) : Stabilization of Lateritic Soil for Unpaved Roads Using cane Molasses in Butere-mumias District, Kenya. The International Journal of Science & Technoledge
[3] Austin T. Sabu (2017) Experimental Study on the Stabilization of Soil With Environmental Waste And Coir Fibers
[4] Button J, Lytton R (1987), "Evaluation of fabrics, fibers and grids in overlays, In proceedings of the sixth International conference on structural Design of pavements, Ann Arbor, PP 925-934
[5] Chaple Parag M and Dhatrak A I (2010). Performance of Coir fiber Reinforced Clayey Soil.
[6] Enokela (2012) Strength Analysis of Coconut Fiber Stabilized Earth For Farm Structures

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
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Impact Factor: 7.301

[7] Mittal Shelly and Singh R. R. (2014). Improvement of local subgrade soil for road constuction by the use of coconut coir fiber. IJRET: International Journal of Research in Engineering and Technology, Volume: 03 Issue: 05 | May.
[8] Prudhvi (2017) Stabilization of Gravel Soil by Using Molasses-Lime. International Journal of Latest Engineering and Management Research
[9] Ravi, A.T. Manikandan (2015) Study on Effect of Molasses on Strength of Soil. International Journal of Advanced Research Trends in Engineering and Technology
[10] Rakhil Krishna R &Devi Krishnan "Review On The Effect Of Waste Ceramic Dust On The Geotechnical Properties Of Expansive Soils" IRJET-2016.
[11] H.Venkateswarlu , A.C.S.V Prasad , Dr. DSV Prasad & Dr.GVR Prasada Raju "Study on Behavior of Expansive Soil Treated With Quarry Dust" IJEIT- 2015
[12] Shailendra Singh & Hemant B. Vasaikar "Stabilization of Black Cotton Soil using Lime" IJSR-2015.
[13] Monica Malhotra, Sanjeev Naval, "Stabilization of Expansive Soils Using Low Cost Materials" International Journal of Engineering and Innovative Technology vol- 2,2013.