Influence of Terrazyme and Kenaf Fiber in Sub-grade: A Review

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***Abstract*— Road development projects are major part of a country's economic growth. It costs about 50% of a country's total cost of infrastructure. The overall performance of pavement is dependent on the subgrade soil type and its properties. Various stabilization techniques are utilized to annihilate the inadequate properties of sub-grade soils. Principally, traditional soil stabilizers like lime, cement, bitumen, etc. and combinations of these have been utilized widely to enhance the properties of poor soil. These traditional soil stabilizers are uneconomical and hence cost efficient and eco-friendly materials are suggested. From recent studies it's been found that the use of bio-enzymes and various fibers on soil shows tremendous improvement in strength properties of soil. The present study is focused on improving the geotechnical properties of cohesive soil using terrazyme ,a natural non-toxic, liquid enzyme and kenaf fiber, a plant based fiber to use it as a sub grade material. Standard proctor, Unconfined compressive strength tests and California bearing ratio tests, SEM analysis were conducted on untreated soil and soil mixed with terrazyme and its combinations with kenaf fiber. This paper is a comparative study of bio-enzyme (terrazyme) and kenaf fiber in cohesive soil subgrades.**

Keywords: Embankment, Bio-enzyme, Terrazyme, kenaf fiber, Pavement, Road development

I.INTRODUCTION

The role played by good road networks toward the economic development of nations cannot be overemphasized. However, the cost of road construction has been on the increase partly due to lack of quality construction materials, such as suitable soil for earthworks. Even when they are readily available, soils with poor engineering qualities are typically not used as the base for road pavement. Depleting natural and suitable soils, however, has made it necessary for highway design engineers to seek ways of making use of this category of soils. Stabilization of locally available soils having poor engineering properties has been an attractive option to highway design engineers.

The usefulness of traditional soil stabilizers like cement, lime, and bitumen has been extensively documented in the literature. However, they are pricey, and some have been accused of being unfriendly to the environment. This has made researchers to seek cost-effective alternative materials. Some materials whose stabilizing effects have been investigated and reported include: fly ash, blast furnace slag , steel slag , recycled basanite , marble dust , microbe-inspired cementing , corncob ash and rice husk ash , among many others. The efficiency of the traditional additives was already proven successful in both subgrade and base soil stabilization, but it could adversely alter the behavior of some soils and there by cause instability (like excessive heaving of pavement) when the soil is rich in sulfate content. The stabilizing technique helps the soil makes into more friable denser with lesser compaction energy, reduced affinity to moisture, better bonding between soil particle sand reduction of voids in the presence of additives. Traditional stabilizers like cement, fly ash, lime, bitumen, etc. are successfully stabilize the problematic fine-grained soils.

Numerous soil stabilizing items that fall under the category of "green technologies" have recently entered the market. Some of these technologies include enzymes, biopolymers , tree resins and organic-fiber reinforcement . Although many of these products promise users high soil strength after treatment, even at reduced curing times, Kestler stated that limited independent research has been conducted to test the performance of various commercial products. Some bio enzymes in the commercial market include Permazyme, Renolith, Fujibeton and Terrazyme. Even when some have been tested on some types of soils, they may not be effective for other types. The studies on stabilizing the soil using non-traditional stabilizers of bio-enzyme and nano chemicals are minimal, and the findings arrived are not conclusive. The sensitivity in reproducing the same results with the test parameters makes the technique more complicated, but still, the efficiency of an enzyme can be assured to get commendable improvement in strength when the soil contains sufficient clay content with some organic matter (Tingle et al. 2007). Hence the main objective of the present study is to introduce a new stabilization technique which could reduce the impact on the environment and the number of additives. This technique also accelerates time to obtain desired strength and to reveal the potential benefits of the same in low to high plastic clays (CLand CH).

II.LITERATURE REVIEW

G. P. Ganapathy et al (2019) studied Bio-Enzymatic Stabilization of a Soil Having Poor Engineering Properties. Type of work conducted is experimental and materials used are clayey sand and terrazyme. The test performed were Attereberg, Unconfined compressive strength, California bearing ratio. It was found that The liquid limit of the treated soil increased from 32 to 38% with increasing dosage of the bio-enzyme of 400 mL/m3.The plastic limit of the treated soil increased from 22.2 to 27.5% with increasing dosage of the bio-enzyme of 400 mL/m3.The plasticity index of the untreated soil was reduced from 9.8% to 8 %by the application of 400 mL/m3.The bio-enzyme improved the 28 days CBR value of the soil by 96 %.Applying 400 mL/m3 of the bio-enzyme to the soil increased its uncured and 7 days cured UCS by 30.3 and 30.4 %, respectively.

Strength test were performed on red soil using terrazyme by Sravan Muguda et al(2019) to study the Effect of enzymes on plasticity and strength characteristics of an earthern construction material. The test performed were Attereberg, Unconfined compressive strength. It was found that the UCS of wet cured soil specimens was found to be 60.5 kPa after 60 days of ageing for 0.065ml/kg respectively. The UCS of sealed cured soil specimens was found to be about 560 kPa after 60 days of ageing for 0.065ml/kg respectively. At the end of 60 days of ageing period, shrinkage limit has gradually increased from 21.3% to 24.3% for dosages for 0.065ml/kg respectively. Shrinkage index of the soil varies from 20.9%. to13.9% for dosages for 0.065ml/kg respectively.

Unconfined compressive strength, California bearing ratio test were performed on Black cotton soil, red soil and silty soil using terrazyme by Aniket S Navale et al (2019) and studied the Effect of Bio-Enzyme (Terrazyme) on the Properties of Sub Grade Soil. For Black cotton soil the UCS value obtained is 0.54 to 2.4N/MM2 for 300ML/1.5M3. Silty soil has a UCS value 0.28 to 2.31N/MM2 for 300ML/M3. Red soil has a UCS value 1.05 to 2.31N/MM2 for 300ML/M3. The Black cotton soil has MDD value 1.89 to 1.897kg/cm3for 300ML/1.5M3. Silty soil has an MDD value 1.867 to 1.912kg/cm3 for 300ML/1.5M3. Red soil has a MDD value 1.629 to 1.73kg/cm3 for 300ML/1.5M3.

Varun Sushil Chaurasia et al (2018) studied Stabilization of Soil Using Terrazyme for Road Construction. This was an experimental study and the materials used are black cotton soil, red soil, Terrazyme. The test conducted was Unconfined compressive strength, California bearing ratio. It was concluded that for red soil-CBR value increases to 4.4 for 0.03ml/kg and for black cotton soil CBR value increased to 8.56 for 0.03ml/kg. Red soil-UCS value ranges from 160kpa to 305 kPa by addition of 0.03ml/kg for 30 days curing. Black cotton soil-UCS value ranges from 147kpa to 324 kPa by addition of 0.03ml/kg for 30 days curing.

S.S Kushwaha (2017) studied Stabilization of Expansive Soil Using Ekosoil Enzyme for Highway Embankment. The materials used are Ekosoil, black cotton soil. Test conducted are Unconfined compressive strength, California bearing ratio. The PI of expansive soil reduced by 65.82% by the application for 6% ES. MDD increased to1.68 gm/cc at 4% ES dose, then decreases to 1.56 gm/cc for 6% ES dose. UCC value increased to 210.32 KN/M2 at 4% ES then decreases to 195.54 KN/M2 at 6% ES dose.

S.S Kushwaha ET AL studied Stabilization of Red Mud Using Ekosoil Enzyme for Highway Embankment. The study conducted was experimental and the materials used are Ekosoil, red soil. It was concluded that the MDD value increased to 2.01 gm/cc at 4% ES and decreased to 1.96 gm/cc at 7% ESC then decreases to 242.12 KN/M2 at 7% ES dose.

Wafa Yousef et al (2019) performed Comparative Study of Subgrade Strength of Soil Using Bio-Enzyme. The study was experimental, and materials used are Clayey soil1, clayey soil2, terrazyme, earthzyme. The test performed are California Bearing Ratio Test, Standard Proctor Test. For Soil Sample1, the addition of 4ml terrazyme increased dry density from 16.1 to 17.2kN/m3.Sililarly Addition of 4ml earthzyme increased dry density from 16.1 to 16.9kN/m3. On addition of 4ml terrazyme increased CBR value to10.7%. On addition of 4ml earthzyme increased CBR value to 9.4%. In case of Soil sample 2, addition of 4ml terrazyme increased dry density from 16.8 to 17.7kN/m3. And on addition of 4ml earthzyme increased dry density from 16.8 to 17.4kN/m3.

Divya Viswanath et al (2020) performed a study on Experimental Investigations on Bio-Modified Soil. The study was bio-enzymatic stabilization on two types of soil namely, black cotton soil and lateritic soil. Laboratory tests were carried out for two different dosages (150ml/m3and 250 ml/m3) and curing periods of (7, 14, and 28 days) and the results were compared. The experimental test performed are UCS, California bearing ratio, secant modulus, and improvement factor of enzyme treated soils with respect to ageing. In black cotton soil the improvement factor increased up to 216% when compared with laterite soil. The experimental results also indicated that enzyme was more effective at lower enzyme dosage and increased curing periods. Improvement in compressive strength of treated black cotton soils are higher (up to 400%) than that of laterite soil (up to 135). Percentage improvement in bearing ratio is higher for enzyme blended black cotton soil (up to 250%) which confirms the usage of Terrazyme for durable pavement construction.

Nima Esmaeilpour Shirvani et al (2019) studied on Improvement of the engineering behavior of sand-clay mixtures using kenaf fiber reinforcement. The compaction and shear strength properties of unreinforced and reinforced sand-clay mixes have been studied in a total of 128 tests. It was observed that adding kenaf fibers reduced the initial contraction (up to 34%) and the subsequent dilation of the specimen (up to 40%), which is a benefit of kenaf fibers in terms of volume change. The shear strength parameters of KFRS (equivalent cohesion and internal friction angle) significantly improve (by 15% and 13%, respectively) as the percentage of fiber in the mixture increases due to a proper frictional surface and moisture absorption of pre-treated kenaf fibers.

III.CONCLUSION

The following conclusions are obtained from the literature study

- The bio-enzyme improved the 28 days CBR value of the soil by 96 %
- At the end of 60 days of ageing period, shrinkage limit has gradually increased from 21.3% to 24.3% and that of UCS was found to be about 560 kPa after 60 days of ageing for 0.065ml/kg respectively.
- The UCC value increased to 264.32 KN/M2 at 4% Eko soil
- Compressive strength of treated black cotton soils are higher (up to 400%) than that of laterite soil (up to 135). Percentage improvement in bearing ratio is higher for enzyme blended black cotton soil (up to 250%)
- It was observed that adding kenaf fibers reduced the initial contraction (up to 34%) and the subsequent dilation of the specimen (up to 40%).

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