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EXPERIMENTAL EVALUATION OF EXPANSIVE SOIL STABILIZED WITH TERRASIL AND RANDOMLY DISTRIBUTED COIR FIBER

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Abstract - *Differential settlements, inadequate strength, and high compressibility are challenges when building on weak or soft soils. Because they are weak, clayey soils will not adequately sustain a pavement, which will ultimately affect how well it performs and how long it lasts. To increase the load bearing capacity of soil, a number of strategies are available, including soil stabilization and supplying reinforcement. The successful use of industrial wastes as a stabilizer is made possible by soil stabilization, one of the modification techniques used to enhance the geotechnical properties of soil, which has grown to be a key practice in construction engineering. Because it is accessible and adaptable, this method is growing in popularity. The process of stabilizing waste materials allows for the creation of low-cost road building. The current article details a study that was conducted to see if adding Terrasil and Coir Fiber improved the qualities of clayey soil. To get the ideal admixture % needed for soil stabilization, unmodified soil is mixed with Terrasil and Coir Fiber in a range of percentages. For both modified and unmodified clayey soil, laboratory experiments such Atterberg's limit, Compaction test, CBR test, and UCS test were conducted as part of this comparative study. In this study Terrasil and Coir Fiber were used to stabilize Expansive soil. Using index properties tests Coir Fiber was fixed at 1.5% respectively. Terrsail was then varied (i.e. 0.3%, 06% and 0.9%).*

Key Words**:** Compaction test, CBR, UCS, Terrasil, Coir Fiber

1. INTRODUCTION

Soil stabilization has begun to take on a new form recently due to the rise in demand for infrastructure, raw resources, and fuel. It is becoming a well-liked and economically advantageous strategy for soil improvement as a result of the increase in research, supplies, and equipment. Transportation officials have been obliged to look at other methods for building roads on soft subgrade due to the high expense of repairs. The performance of the base and subgrade layers, which comprise the pavement's base, heavily influences the performance of the pavement itself. Layers beneath the base and subgrade must have sufficient stiffness modulus, moisture resistance, equilibrium, and durability.

Moisture is a major issue for roads in a country like India with abundant monsoons. Water entry during the rainy season undermines the foundation of the road. Poor shear strength soil that has excessive swelling and shrinking must be treated using the appropriate methods. Most often, soil stabilization and reinforcement are used to enhance the soil's mechanical behavior, increasing the dependability of building.

2. Literature Review

P. Sai Venkata Bharath1, K. Jyothi Raju (2016)

In this study, the soil's physical characteristics, including the California Bearing Ratio (CBR) test, are evaluated. Extensive research on the properties and behavior of expansive soil blended with various concentrations of Quarry Dust and Recron-3S fibers has been conducted through experimentation. According to the study's findings, when compared to untreated natural soil, specific soil properties that have these stabilizers applied in a specific proportion exhibit remarkably beneficial changes. The California Bearing Ratio has risen, showing more strength, as a result of the compaction parameters' increasing value.

Thomas et al. (2016)

In this study, an effort has been made to examine how stabilizing a soft soil with Terrasil improved its qualities. The soil was taken from the village of Arasnara in the Indian state of Chhattisgarh. The findings of several laboratory tests performed on samples of stabilized and unstabilized soil are compared and discussed. The effects of different Terrasil doses have been investigated. It has also been investigated how the curing process affects UCS. There has been a noticeable improvement in the soil's characteristics.

Siyyagalla Subbarayudu, S. Rozwana (2017)

Recron-3s, fly ash, and lime will all be used in this project to stabilize the soil. California's bearing ratio rating will be higher when compared to standard materials when varied amounts of soil are added. And from there, it is possible to reduce the pavement's thickness to some degree.

Rokade et al. (2017)

Recron 3-S Fibre and fly ash are added, and the black cotton soil's strength parameters are changed to measure outcome. Testing was done on BC soil combined with varied amounts of fly ash, from 10% to 40%, with 20% turning out to be the best. Then, Recron 3-S Fibre, with length/diameter aspect ratios of 20, 40, 60, and 80, and fiber contents ranging from 0.25 to 1.5 percent with a 0.25 percent interval, was employed. Of these, 0.75 percent of fiber content is deemed ideal based on MDD and the highest CBR value.

Olaniyan et al. (2017)

A significant component of road building is laterite. However, it is expensive and extensively documented to stabilize weak laterite with cement or lime. Information on the stabilization of weak laterite with nanochemicals is scarce. In this work, the geotechnical properties of weak laterites stabilized utilizing nanochemicals (Terrasil and Zycobond) are investigated. The lateral soil samples were taken from two different burrow trenches (Sample A, latitude 80008′N, longitude Sample B, latitude 8025′N, longitude 40.3′E, altitude 306′ and 40015′E

Raghavendra et al. (2018)

In this investigation, several weights of terrasil and zycobond were used: 0.6 kg/m3, 0.8 kg/m3, 1 kg/m3, and 1.2 kg/m3, respectively. Cement is employed in this study in a constant quantity of 3% of the soil. Unconfined compressive strength testing is done after 7, 21, and 28 days of cure. For the Terrasil and Zycobond ratios of 0.6kg/m3, 0.8kg/m3, 1kg/m3, and 1.2kg/m3, a free swell index test is conducted.

Padmavathi et al. (2019)

By fusing the soil's particles together to provide a long-lasting effect, soil stabilization techniques aim to raise the base soil's strength and stability to meet the demands of a particular application. They also aim to boost resistance to softening when soaked or immersed. In this study, nanomaterials such Terrasil, Zycobond, and cement are combined with c-/ soil (SC) to boost its strength capabilities in both OMC and SMC circumstances. When Zycobond and Terrasil are used both alone as additives and in conjunction with cement, the product's strength characteristics are significantly improved. A product that was watertight was created by adding Terrasil to the basic soil.

Tripathi et al. (2020)

In this study, soil engineering qualities are improved by using stabilizers such as Recron 3-S fiber, Terrasil, and silica fume. Our primary focus has been on increasing the soil's CBR because doing so contributes to reducing the pavement's thickness and has positive economic benefits.

Datta et al. (2023)

Terrasil and coir fiber were utilized in this investigation in quantities of 0.5%, 0.5%, 1.0%, 1.5%, and 2.0%, respectively. According to analyses or test results, clay subgrade soil that has been stabilized with 0.5% Terrasil and 1.5% coir fiber displays specific strength and CBR value augmentation values. The number of layers required for the subgrade is reduced as a result of the treated soil's normally higher CBR estimated value, which is 90% more than the untreated soil.

3. Materials

3.1 SOIL

Source of soil

The soil has low compressibility clayey soil, according to has classification. The table below lists the soil characteristics:

Table no. 1 Properties of soil used in the study

S.NO.	PROPERTIES	RESULTS
1.	Liquid Limit	36 %
2.	Plastic Limit	21.5 %
3.	Plasticity Index	14.5 %
4.	Optimum Moisture	13.1 %
5.	Maximum Dry	15.46 kN/m³
6.	Specific Gravity	2.58
7.	CBR (%) (soaked)	3.2 %
8.	CBR (%)	4.4 %
	U.C.S	140.2 kN/m²
10.	Indian Soil	CI

3.2 Coir Fiber

These fibers are environmentally friendly and biodegradable. Among all natural fibers, it possesses the highest tearing strength and maintains this quality when wet. Coconut fiber was chosen as the study's reinforcement material as a result. The 30 mm strip of coir utilized for the investigation was cut.

Table 2 Properties of Coir Fiber

S.No	Property	value
1	Density (g=cm^3)	1.2
2	Modulus (GPa)	4-6
3	Tensile Strength (MPa)	175
4	Elongation of Failure (%)	30
5	Water Absorption (%)	130-180

3.3 TERRASIL:

Terrasil is a soil-modifying additive that is made entirely of organosilanes, is water-soluble, and is resistant to heat and ultraviolet light. Therefore, its primary function is to waterproof soils and subsoils.

It contains silanol groups, which interact with the soil's silicates to change the surface and give it long-lasting hydrophobic qualities.

By doing this, the soil will reject water molecules, making it waterproof and preventing the issues that arise from its presence.

4. EXPERIMENTAL RESULTS

4.1 STANDARD PROCTOR TEST

CLAYEY SOIL- COIR FIBER AND TERRASIL MIXES

Table no. 3: Results of OMC and MDD for mix proportions of Coir Fiber and Terrasil

SOIL:TL:CF	MDD (kN/m³)	OMC (%)
100:0:0	15.46	13.10
98.2:0.3:1.5	16.71	15.80
97.9:0.6:1.5	17.62	14.95
97.6:0.9:1.5	18.96	14.12

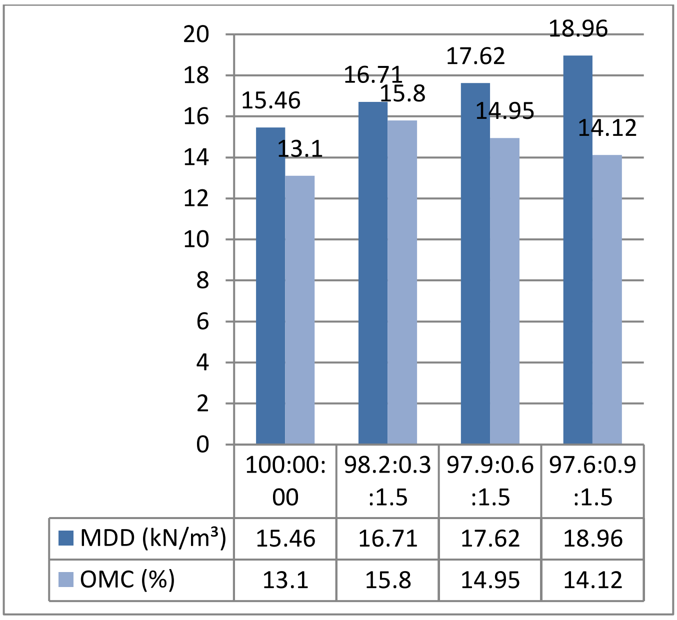

Fig:-1 Differences b/w MDD and OMC of Coir fiber and Terrasil in various ratios

Table 4: Results of UCS of Coir Fiber and Terrasil

Clayey Soil:TL:CF	Curing Period (Days)	UCS (kN/m²)
100:0:0	7	140.20
98.2:0.3:1.5	7	215.41
97.9:0.6:1.5	7	260.37
97.6:0.9:1.5	7	317.11

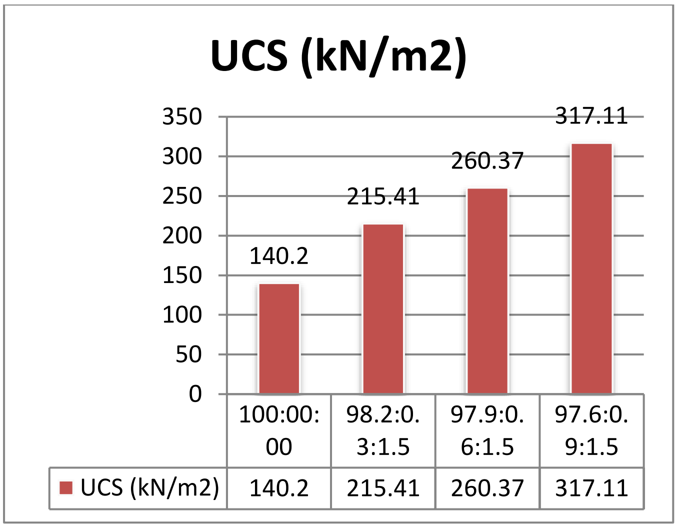

Fig:-2 various ratios of Coir fiber and Terrasil are shown in the UCS graph.

Table 5: Results of CBR for Terrasil and Coir Fiber

Mix Proportions (CS:TL:CF)	CBR (%) (Soaked)	CBR (%) (Unsoaked)
100:00:00	3.20	4.41
98.2:0.3:1.5	5.31	7.27
97.9:0.6:1.5	5.92	8.28
97.6:0.9:1.5	6.54	9.15

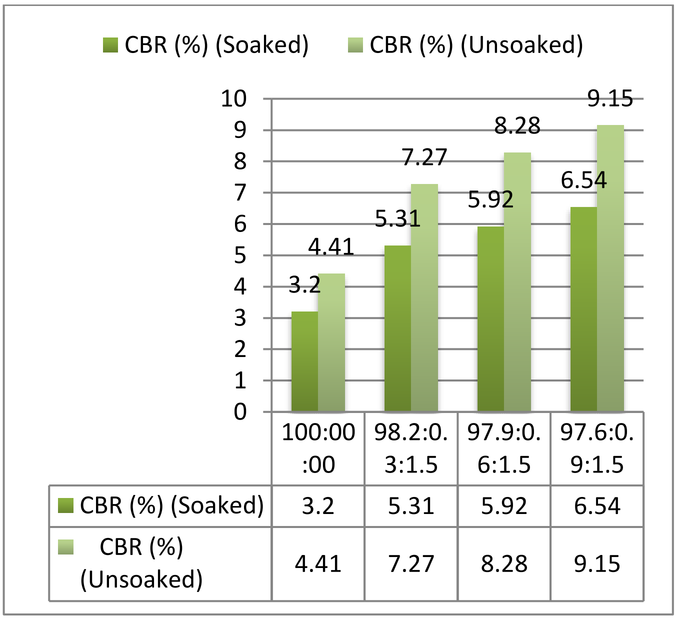

Fig:-3 CBR Graph of Coir Fiber and Terrasil with various ratios

5 DISCUSSIONS

5.1 STANDARD PROCTOR TEST:

- As shown in Figure 3 and summarized in Table 4.3, the findings reveal how maximum Optimum moisture content and dry density varies with the amount of Terrasil and coir fiber.
- The MDD value increases from 16.71 kN/m3 to 18.96 kN/m3 and the OMC value decreases from 15.80% to 14.12% as a result of a fixed quantity of 1.5% coir fiber and an increase in Terrasil from 0.3% to 0.9% because adding two lightweight elements to the soil will vary its fraction of denser soil and reduce its water content. As a result, the soil's OMC decreased from 15.80% to 14.12%.

5.2 CBR TEST

- The CBR values are shown in the tables for both wet and dry values. The CBR values improve when the amount of coir fiber content goes up to 1.5%. Soil that has been soaked increases its CBR value from 3.20 to 6.54%, or 2.04 times more than untreated soil.
- The CBR value for unsoaked soil increased 2.07 times, from 9.15% to 4.41%, a difference of 2.07 times. Coir fiber and Terrasil agglomeration enhanced the soil's shear resistance, enabling it to withstand the stress imposed on by penetration.

5.3 UCS TEST:

- The results show that the UCS for reinforced soil is 2.26 times greater than the UCS for unreinforced soil when soil + 0.9% Terrasil + 1.5% coir fiber are combined.
- The capacity of Terrasil to fill the soil's pores and function as a water-resistive agent caused the UCS value to rise from 140.20kN/m2 to 317.11kN/m2. Since the coir fiber that replaced the soil is tensile in nature, the earth is altering its behavior to that of spring.
- It gets more challenging to create a strong bond between soil, Terrasil, and the fibers as the fiber concentration rises because the soil matrix's capacity to trap the fibers decreases.

CHAPTER 6

CONCLUSIONS

In order to get observable stabilizing outcomes, the quantity of coir fiber and Terrasil required for this study relies on the soil's characteristics. As a consequence of the research, the following conclusions were drawn:

1. It was demonstrated that increasing the amount of Terrasil and coir fiber to 0.9%+1.5% resulted in a decrease in OMC and an increase in MDD. Intergranular packing disturbance and/or using lighter soil substitutes may have contributed to this.
2. It was later discovered that the treated soil's UCS increased to 0.9% Terrasil+1.5% coir fiber content. Because of the soil's propensity to rebound, the tensile properties of the coir fiber, and the replacement of old coir, it adapts to springing action. The UCS values for treated and untreated soil varied by 2.26.
3. Both in soaked and unsoaked conditions, the addition of 1.5% coir fiber and 0.9% terrasil increases the CBR value up to 2.04 to 2.07 times compared to the untreated soil because the soil's shear resistance increased due to the agglomeration phenomenon, which results in resisting the loading caused by the penetration.

At these levels, the CBR value increased as a result of the Terrasil dosage and coir fiber content.

4. Chemical ingredient Terrasil has not caused any unfavorable or adverse impacts on the soil. We can infer that the cohesiveness of the clay soil was greatly enhanced by the addition of Terrasil.

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