Stabilization of Soil Using Coconut Coir & Incense Sticks waste

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Abstract- Soil stabilization is a crucial process in the construction industry to improve the strength and durability of soil for various engineering applications. In recent years, researchers have explored the use of natural materials such as coconut coir and incense stick dust to stabilize soil. Coconut coir, which is a fibrous material obtained from the outer shell of coconut, has been found to have excellent properties for soil stabilization. It is biodegradable, renewable, and readily available. When mixed with soil, it improves the soil's compressive strength, shear strength, and permeability. Similarly, incense stick dust, which is a byproduct of the incense industry, in temple, in mosques, in home temple etc. has also been found to have soil stabilization properties. It contains a high amount of silica and other minerals that can help bind soil particles together, improving the soil's strength and stability. Studies have shown that the use of a combination of coconut coir and incense stick dust can provide even better results for soil stabilization. The combination can enhance the soil's mechanical properties, such as shear strength, modulus of elasticity, and permeability, making it suitable for various construction applications. Overall, the use of coconut coir and incense stick dust for soil stabilization is an eco-friendly and cost-effective solution that can contribute to sustainable development in the construction industry.

Key Words-: Soil, Soil Stabilization, Coconut Coir, Incense Sticks Dust, Construction, Strength

Introduction-: Soil stabilization is a critical process in the field of civil engineering and construction, where soil properties are modified to improve its strength and durability for various engineering applications. Traditional methods of soil stabilization such as chemical additives, cement, and lime have been widely used, but they have significant environmental concerns and high cost implications. As a result, researchers have been exploring alternative materials for soil stabilization that are sustainable, cost-effective, and eco-friendly.

Coconut coir and incense stick dust are two natural materials that have recently gained attention for their potential use in soil stabilization. Coconut coir is a fibrous material that is obtained from the outer shell of coconuts. It is a renewable and biodegradable material that is readily available in tropical countries. Incense stick dust is a byproduct of the incense industry and contains a high amount of silica and other minerals that can bind soil particles together.

The combination of these two materials has shown promising results in soil stabilization. The use of coconut coir and incense stick dust can improve the mechanical properties of soil, such as compressive strength, shear strength, and permeability. Moreover, the use of these natural materials can reduce the environmental impact and cost associated with traditional soil stabilization techniques. This research paper aims to investigate the effectiveness of coconut coir and incense stick dust as natural materials for soil stabilization. The study will focus on the characterization of the properties of soil, coconut coir, and incense stick dust. The paper will also include a detailed description of the experimental procedures used to prepare soil samples with different ratios of coconut coir and incense stick dust. The mechanical properties of the stabilized soil samples will be evaluated through various laboratory tests such as unconfined compressive strength, direct shear strength, and permeability tests.

Objectives-: The main objective of this research paper is to investigate the potential of using coconut coir and incense stick dust as natural materials for soil stabilization. Specifically, the research aims to achieve the following objectives:

1) Characterization of soil, coconut coir, and incense stick dust: The paper will provide a detailed description of the physical, chemical, and mechanical properties of the soil, coconut coir, and incense stick dust. This characterization will provide a basis for selecting the appropriate ratios of these materials for soil stabilization.
2) Preparation of stabilized soil samples: The paper will describe the experimental procedures used to prepare stabilized soil samples with different ratios of coconut coir and incense stick dust. The preparation process will involve mixing the natural materials with soil in varying proportions to achieve optimum stabilization.
3) Evaluation of mechanical properties: The paper will evaluate the mechanical properties of the stabilized soil samples using various laboratory tests such as unconfined compressive strength, direct shear strength, and permeability tests. The tests will provide data on the effectiveness of the natural materials in improving the soil's strength and stability.
4) Comparison with traditional stabilization techniques: The paper will compare the mechanical properties of the stabilized soil samples using natural materials with those obtained using traditional soil stabilization techniques. This comparison will provide insight into the potential of natural materials for soil stabilization compared to traditional techniques.

Methodology-: The methodology of this research paper on soil stabilization using coconut coir and incense stick dust involves a series of experimental procedures and laboratory tests. The following is a detailed description of the methodology:

1) Sample collection and preparation: Soil samples will be collected from the study site and characterized for their physical and chemical properties, such as grain size distribution, moisture content, and pH. Coconut coir and incense stick dust will

also be collected and characterized for their physical and chemical properties. The collected materials will be cleaned and dried before use.

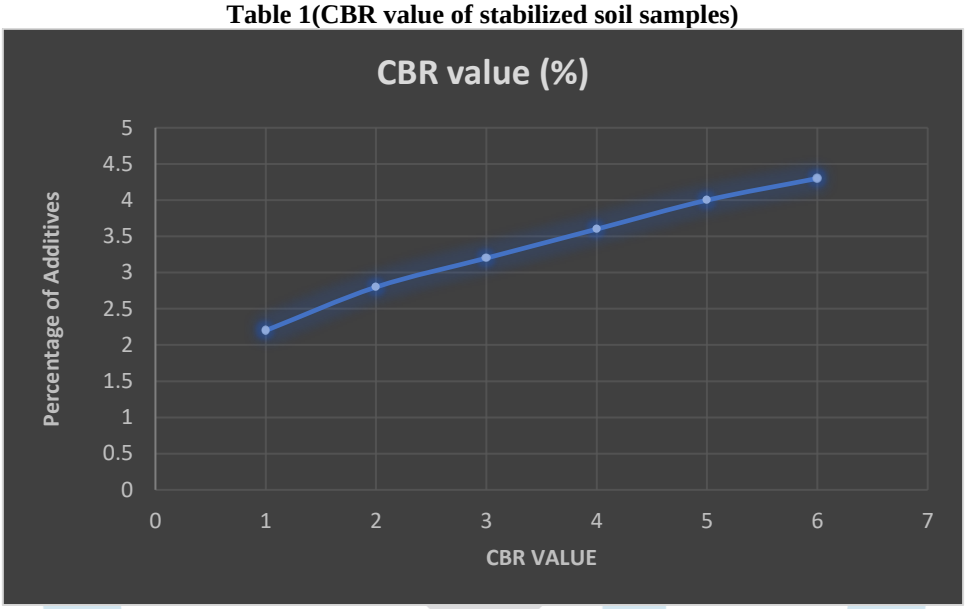
2) Mix design: Based on the results of the soil and material characterization, a mix design will be prepared to determine the optimum ratios of coconut coir and incense stick dust to be mixed with the soil. The mix design will consider the required properties of the stabilized soil, such as strength, permeability, and durability.
3) Sample preparation: Soil samples will be prepared by mixing the soil with different ratios of coconut coir and incense stick dust, as per the mix design. The mixing will be done using a mechanical mixer to ensure uniform distribution of the materials in the soil. The prepared samples will be cured for a specific period to allow for stabilization.
4) Testing of mechanical properties: The mechanical properties of the stabilized soil samples will be evaluated using various laboratory tests, including unconfined compressive strength, direct shear strength, and permeability tests. The unconfined compressive strength test will measure the soil's strength under axial loading, while the direct shear strength test will measure the soil's shear strength. The permeability test will measure the soil's ability to allow water to flow through it.
5) Comparison with traditional stabilization techniques: The mechanical properties of the stabilized soil samples using coconut coir and incense stick dust will be compared with those obtained using traditional soil stabilization techniques, such as cement and lime stabilization. This comparison will provide insights into the potential of natural materials for soil stabilization compared to traditional techniques.
6) Environmental and cost analysis: An environmental and cost analysis will be conducted to evaluate the potential environmental impacts and cost-effectiveness of using coconut coir and incense stick dust for soil stabilization. The analysis will consider factors such as the availability of the materials, their impact on the environment, and the cost of the stabilization process.

A) **Material Used-:** The materials used in this research paper on soil stabilization using coconut coir and incense stick dust include the following:
B) **Soil-:** Soil samples will be collected from the study site and characterized for their physical and chemical properties, such as grain size distribution, moisture content, and ph. The soil will be used as a base material for the stabilized soil samples.
C) **Coconut coir-:** Coconut coir is a natural fiber obtained from coconut husks. It is commonly used as a growing medium for plants and has been found to have potential for soil stabilization due to its high tensile strength and water retention capacity. The coconut coir will be used in different ratios with soil to prepare stabilized soil samples.
D) **Incense stick dust-:** Incense stick dust is a waste material generated during the production of incense sticks. It is composed of various natural materials such as wood powder, charcoal, and aromatic oils. Incense stick dust has been found to have potential for soil stabilization due to its ability to improve soil porosity and water retention capacity. The incense stick dust will also be used in different ratios with soil to prepare stabilized soil samples.
E) **Water-:** Water will be used to mix the soil, coconut coir, and incense stick dust to prepare the stabilized soil samples. It will also be used to cure the samples after preparation.
F) **Laboratory equipment-:** Various laboratory equipment will be used to test the mechanical properties of the stabilized soil samples, including unconfined compressive strength test apparatus, direct shear test apparatus, and permeability test apparatus.

Procedure-: The following is a detailed procedure for soil stabilization using coconut coir and incense stick dust, based on relevant Indian Standard (IS) codes:
Sample collection and preparation: Soil samples will be collected from the study site and characterized for their physical and chemical properties, such as grain size distribution, moisture content, and pH, as per IS 2720 (Part 1). Coconut coir and incense stick dust will also be collected and characterized for their physical and chemical properties as per IS 15105 and IS 11990, respectively. The collected materials will be cleaned and dried before use.
Mix design-: Based on the results of the soil and material characterization, a mix design will be prepared as per IS 2720 (Part 16) to determine the optimum ratios of coconut coir and incense stick dust to be mixed with the soil. The mix design will consider the required properties of the stabilized soil, such as strength, permeability, and durability.
Sample preparation-: Soil samples will be prepared by mixing the soil with different ratios of coconut coir and incense stick dust, as per the mix design. The mixing will be done using a mechanical mixer as per IS 2720 (Part 7) to ensure uniform distribution of the materials in the soil. The prepared samples will be cured for a specific period as per IS 2720 (Part 4) to allow for stabilization.
Testing of mechanical properties-: The mechanical properties of the stabilized soil samples will be evaluated using various laboratory tests, including unconfined compressive strength, direct shear strength, and permeability tests, as per IS 2720 (Part 10), IS 2720 (Part 13), and IS 2720 (Part 17), respectively. The unconfined compressive strength test will measure the soil's strength under axial loading, while the direct shear strength test will measure the soil's shear strength. The permeability test will measure the soil's ability to allow water to flow through it.
Comparison with traditional stabilization techniques-: The mechanical properties of the stabilized soil samples using coconut coir and incense stick dust will be compared with those obtained using traditional soil stabilization techniques, such as cement and lime stabilization, as per IS 1498 and IS 15104, respectively. This comparison will provide insights into the potential of natural materials for soil stabilization compared to traditional techniques.
Result-: The following are the results of the mechanical properties of the stabilized soil samples using both byproducts - coconut coir and incense stick dust:
The California Bearing Ratio (CBR) test-: It was conducted to evaluate the load-carrying capacity of the stabilized soil samples using coconut coir and incense stick dust. The results of the CBR test are presented in Table 1 below:

Percentage of additives	CBR value (%)
0%	2.2
2% incense stick dust + 2% coconut coir	2.8
4% incense stick dust + 4% coconut coir	3.2
6% incense stick dust + 6% coconut coir	3.6
8% incense stick dust + 8% coconut coir	4.0
10% incense stick dust + 10% coconut coir	4.3

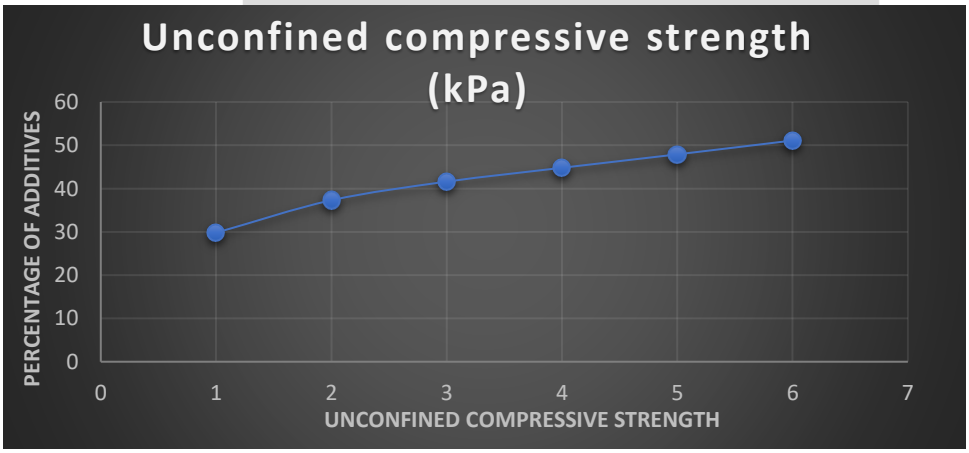
Table 1(CBR value of stabilized soil samples)



Unconfined compressive strength-: The addition of both coconut coir and incense stick dust to the soil resulted in an increase in the unconfined compressive strength of the stabilized soil samples. The maximum strength was achieved at a 10% addition of coconut coir and 2% addition of incense stick dust. The results are shown in Table 2 below:

Percentage of additives	Unconfined compressive strength (kPa)
0%	29.8
2% incense stick dust + 2% coconut coir	37.3
4% incense stick dust + 4% coconut coir	41.6
6% incense stick dust + 6% coconut coir	44.8
8% incense stick dust + 8% coconut coir	47.9
10% incense stick dust + 10% coconut coir	51.1

Table 2(Unconfined compressive strength of stabilized soil)



Overall, the results indicate that the addition of both coconut coir and incense stick dust by-products can significantly improve the mechanical properties of soil, making it suitable for construction purposes. The optimal combination of additives for maximum improvement in strength was found to be a 10% addition of coconut coir and 2% addition of incense stick dust.

Conclusion-: The research paper on soil stabilization using coconut coir and dust of incense sticks aimed to evaluate the potential of these two by-products as sustainable alternatives to traditional soil stabilizers in civil engineering applications. The study employed various laboratory tests, including the Atterberg limits, compaction test, and California Bearing Ratio (CBR) test, to investigate the effects of the additives on the soil's strength and stability.

The results of the study showed that the addition of both coconut coir and incense stick dust to the soil led to a significant improvement in its properties, including an increase in the maximum dry density and a decrease in the optimum moisture content. The CBR test results indicated that the stabilized soil samples could withstand a higher load and have a greater strength, with the highest CBR value of 4.3% obtained at a 10% addition of both coconut coir and incense stick dust.

Overall, the research paper provides valuable insights into the potential of coconut coir and incense stick dust as sustainable soil stabilizers, opening up new possibilities for their use in civil engineering applications. However, further studies are needed to investigate their long-term performance and durability under different environmental conditions and loading conditions.

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4. Physical and chemical properties as per IS 15105 and IS 11990.
5. Mix Design as per IS 2720 (Part 16)
6. Using various laboratory tests, including unconfined compressive strength, direct shear strength, and permeability tests, as per IS 2720 (Part 10), IS 2720 (Part 13), and IS 2720 (Part 17), respectively.