Soil Stabilization Using Waste Fibre Materials

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**ABSTRACT**

stabilization techniques play a crucial role in geotechnical engineering to enhance the engineering properties of soils for various construction applications. This study focuses on investigating the effectiveness of waste fibre materials for soil stabilization. The waste fibre materials selected for this research include discarded textiles, jute fibres, and coir fibres, which are readily available at low cost and considered as environmental pollutants. Laboratory tests are part of the experimental program to assess the mechanical qualities of soil-fibre mixtures made at various fibre content percentages. Shear strength, compaction qualities, and permeability are some of the important engineering properties investigated. The results indicate that the addition of waste fibre materials significantly improves the shear strength and bearing capacity of the stabilized soil. Moreover, the fibre incorporation enhances the compaction characteristics by reducing the maximum dry density and increasing the optimum moisture content. The fibre reinforcement is also seen to cause a decrease in the permeability of the stabilized soil. Overall, the findings demonstrate the potential of waste fibre materials as an effective and sustainable solution for soil stabilization in geotechnical engineering applications, contributing to waste management and eco-friendly construction practices.

**Keywords—** Waste fibre materials, soil stabilization, geotechnical engineering, mechanical properties, shear strength, compaction characteristics, permeability, sustainable solution, waste management, eco-friendly construction.

# INTRODUCTION

A growing portion of plastic materials that were only utilized briefly before being disposed can be found in municipal solid trash as a result of the increased use of plastics in everyday consumer applications. Plastic bag consumption is a linear process that involves single use followed by disposal, which has created environmental problems like marine and urban trash and a shortage of landfill space. Therefore, there is a rising need to identify alternate uses for reclaimed plastic bag waste in order to extend the useful life of the plastic and prevent the environment from further degradation. The idea of using plastic cover strips to reinforce soil masses may be a recent innovation. Contrarily, although it is sparingly documented, the use of random elements as soil reinforcement is probably not older than written history. This research is motivated by the pursuit of enhanced soil structure and its affordability in building and slope stabilization. In this study, the potential for using recycled plastic from plastic covers as tensile inclusions to reinforce soil for ground-improvement plans was investigated. These applications included embankments, slope stabilization, foundation slabs, dams, sea walls, bridge abutments, and retaining walls. The unique quality of soil reinforcement is its flexibility, which makes it possible to build quickly and affordably even on subpar foundation soil. Any procedure that enhances the engineering qualities of soil, such as raising its shear strength or bearing capacity, is referred to as soil stabilization. In soil mechanics, the term "shear strength" is used to define the amount of shear stress that a soil can withstand. The friction and interlocking of soil particles, as well as any possible cementation or bonding at particle contacts, all contribute to the soil's shear resistance. Geotechnically speaking, bearing strength is the ability of the earth to hold the loads placed on it without failing. The greatest average contact pressure between the foundation and the soil, which should not cause shear failure in the soil, is hence the bearing capacity of the soil.

**Soil stabilization techniques can broadly be classified into three types namely:**

1. **Mechanical**

Mechanical methods of stabilizing soil are the most traditional. It entails physically altering the soil's characteristics. One of the main methods of soil stabilization is called "dynamic compaction," which involves periodically dropping a large weight into the ground at regular intervals to essentially "pound out" irregularities and guarantee a consistently packed surface. Another method that utilizes related concepts is called vibration compaction, which accomplishes its objectives by using vibration rather than kinetic force to cause deformation.

1. **Chemical**

Chemical methods rely on introducing a new substance into the soil that will interact with it physically and alter its characteristics.

Many various methods of soil stabilization depend on chemical additives of some kind; widely used substances include the use of cement, lime, fly ash, or kiln dust. Depending on the kind of soil, the majority of the reactions are either cementitious or pozzolanic in nature.

1. **Polymer/Alternative**

The majority of the more recent findings and methods created so far are polymer-based in nature and use waste materials like polythene bags, plastic bottles, or recovered plastic pins. These novel materials and polymers have a number of important benefits; they are generally less expensive and more efficient than mechanical solutions and far less hazardous to the environment than many chemical ones.

In this project, stability is accomplished utilizing plastic coverings and the polymer technique. Because they account for 35% of all plastic waste, the plastic covers were selected as the stabilizing material. Utilizing it for soil stabilization therefore helps conserve natural resources and lessen trash generation. Additionally, plastic strips are inert and biodegradable, so they persist a long time in the soil.

**SCOPE AND OBJECTIVE**

A growing portion of plastic materials that were only utilized briefly before being disposed can be found in municipal solid trash as a result of the increased use of plastics in everyday consumer applications. Therefore, there is a rising need to identify alternate uses for reclaimed plastic bag waste in order to extend the useful life of the plastic and prevent the environment from further degradation. The idea of using plastic cover strips to reinforce soil masses may be a recent innovation. Contrarily, although it is very poorly documented, the use of random elements as soil reinforcement is probably not older than written history. The objective of this project is to analyse the effect of inclusion of plastic fibres in soil on the stability of soil in a cost effective manner. The four different replacement percentages of plastic fibres (0.25%,0.5%, 1%, 1.5%) will be tested.

**METHODOLOGY**

1. Soil.
2. Plastic Fibre.
3. **SOIL**

The study's clayey soil came from Kalathipadi in the Kottayam area. A significant soil group in India is composed of clayey soils, which are inorganic clays with medium to high compressibility. They have significant swelling and shrinking characteristics. The clayey soils have presented a challenge to the civil engineering community due to their significant swelling and shrinkage properties. engineers. When dry, clayey soil is incredibly tough; but, when wet, it completely loses its toughness. According to mineralogical investigation, clayey soil has a significant amount of montmorillonite. High degree of expansiveness is produced by a high montmorillonite content. This characteristic causes dirt to break suddenly. These fissures occasionally may reach quite severe limits. Therefore, a structure built on this soil may sustain significant damage as a result of changing climatic conditions.

1. **PLASTIC FIBRE**

Waste plastic covers (milk and curd packets) were used to make plastic fibres. The plastic covers were properly cleaned and allowed to dry outside before being shredded into fibres with an average thickness of 2mm. Typically, these plastic covers are thought of as trash.

**RESULTS**

1. **Soil Characteristics**

Test was conducted to find various characteristics of the soil sample. The results obtained are tabulated in Table 1

**Table – 1**

**Results of Classification tests.**

|  |  |  |
| --- | --- | --- |
| 1. | Natural Moisture Content | 52.5% |
| 2. | Specific Gravity | 1.825 |
| 3. | Hydrometer Analysis | Silty clay |
| 4. | Optimum Moisture Content | 32.43% |
| 5. | Maximum Dry Density | 1.295 |
| 6. | Compressive Strength | 0.068 N/mm2 |

1. **Engineering Property Tests**

Tests were performed on samples that had not been treated as well as samples where 0.25, 0.50, 1.25, and 1.5% of the soil had been replaced with plastic fibres. The tests were performed according to the procedures provided in IS 2720 part VII- 1980.A standard proctor test as well as unconfined compressive tests were conducted. These two tests' outcomes are listed below.

**Table – 2**

**Results from Proctor Test Conducted**

|  |  |  |  |
| --- | --- | --- | --- |
| S. No | Soil sample | OMC (%) | MDD (g/ cm3 ) |
| 1. | Untreated soil | 32.43 | 1.295 |
| 2. | 99.75%soil + 0.25% plastic | 25.3 | 1.33 |
| 3. | 99.5%soil + 0.5% plastic | 29.35 | 1.38 |
| 4. | 99%soil + 1% plastic | 24.08 | 1.34 |
| 5. | 98.5%soil + 1.5% plastic | 33.12 | 1.32 |

**Fig. 1: Proctor Results**

The variance in Maximum Dry Density values between untreated and treated soil samples with 0.5, 1, and 1.5% plastic substitution is shown in Fig. 1. It can be noticed that the soil sample with 0.5% plastic replacement improved the Maximum Dry Density from 1.29 for the untreated soil sample to 1.383. But after that, the value falls. The reduction in voids brought on by the addition of plastic is what causes the increase in maximum dry density. By improving compaction, the OMC will be decreased and the Maximum dry Density will be raised.

**Table – 3**

**Results from UCC Tests Conducted**

|  |  |  |
| --- | --- | --- |
| S.No | Soil Sample | Compressive strength (N/mm2 ) |
| 1 | Untreated soil | 0.0255 |
| 2 | 99.75%soil + 0.25% Plastic | 0.0383 |
| 3 | 99.5% soil + .5% Plastic | 0.050 |
| 4 | 99% soil + 1% Plastic | 0.042 |
| 5 | 98.5% soil + 1.5% Plastic | 0.0152 |

**Fig. 2: UCC RESULTS**

The Unconfined Compressive Strength values of the untreated and soil samples treated with 0.5, 1, and 1.5% plastic vary, as shown in Fig. 2. When soil is treated with 0.5% plastic, the unconfined compressive strength increases from 0.0255 N/mm2 for untreated soil to 0.050 N/mm2 for treated soil. As more plastic is added, the sample's strength gradually declines. The ideal plastic content, or 0.5% plastic content, results in the highest value in strength. Increased cohesiveness of the soil results in increased unconfined compressive strength of the soil when plastic is added to the soil sample. However, a further increase in the plastic content causes the cohesiveness to decline, which in turn causes the strength to decline. The shear strength of the soil, which is directly connected to cohesion, also follows a similar trend, peaking at 0.5% plastic replacement before falling off.

**CONCLUSION**

1. The performance of plastic fibre as a soil stabilization material is the main objective of this project. According to the study, plastic fibre can be an excellent soil stabilizing technology when properly mixed and applied. The following outcomes were attained as a result of this initiative.
2. The expanding clayey soil's OMC was decreased and the maximum dry density was increased by the replacement of 0.5% plastic fibres.
3. It was discovered that the soil's unconfined compressive strength had improved by 0.5%.
4. It was shown that the MDD and UCC were more than untreated soil with 1% replacement but less than 0.5% replacement.
5. The MDD and the unconfined compressive strength of the soil decreased as the plastic replacement was increased further.
6. The ideal plastic content is suggested to be 0.5% based on the non-problematic soil criterion, which will enhance the silty clay's engineering properties.
7. With the addition of plastic, there are less voids in the soil, which effectively compacts it and also increases cohesion, causing the soil's Maximum Dry Density to rise.
8. The primary benefit of employing plastic fibre has been demonstrated to be affordable because it is a cost- and non-existent waste product. Additionally, it solves the issue of how to dispose of plastic garbage. The use of plastic material for soil stabilization may become clearer with more research in this area.

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