STABILIZATION OF BLACK COTTON SOIL USING HUMAN HAIR AND GYPSUM

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ABSTRACT

Black cotton soil, characterized by its high swelling and shrinkage potential, poses significant geotechnical challenges for construction projects. This study investigates the efficacy of utilizing GYPSUM and HUMAN HAIR as sustainable stabilizing agents to enhance the chemical and physical properties of this problematic soil. The research methodology involved a comprehensive laboratory investigation, employing a series of geotechnical tests to evaluate the impact of varying proportions of GYPSUM and HUMAN HAIR on the soil's behaviour. Specifically, tests were conducted to determine the Atterberg limits, compaction characteristics (maximum dry density and optimum moisture content), unconfined compressive strength, California Bearing Ratio (CBR), and permeability.

INTRODUCTION

Soil stabilization is a critical geotechnical engineering practice aimed at enhancing the engineering properties of soil to meet the requirements of various construction projects. When naturally occurring soils at a site are deemed unsuitable for the intended purpose, stabilization techniques become imperative. These techniques address deficiencies in soil characteristics, such as inadequate bearing capacity, excessive compressibility, and high permeability, thereby ensuring the long-term stability and performance of infrastructure.

In recent years, the growing emphasis on sustainable construction practices has spurred the exploration of alternative soil stabilization methods that utilize waste materials. One such material is HUMAN HAIR fiber, a non-degradable substance that poses significant environmental challenges when disposed of improperly. Recognizing its potential as a reinforcing agent, researchers have investigated the use of HUMAN HAIR fiber in soil stabilization.

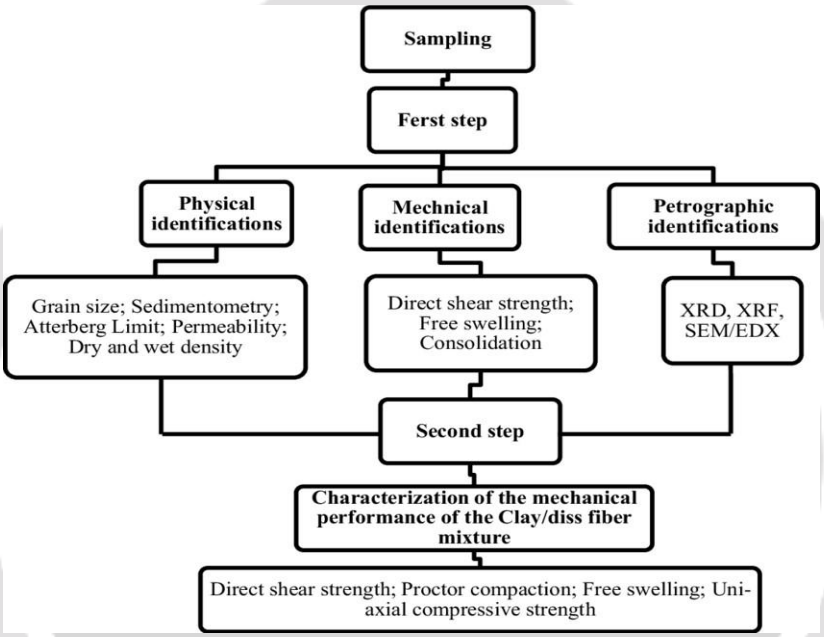
3.METHODOLOGIES

The methodology employed in this study was designed to systematically evaluate the efficacy of gypsum and human hair fibers as stabilizing agents for black cotton soil. The initial phase involved the procurement of representative black cotton soil samples from a designated site known for its expansive soil deposits. This selection was based on preliminary geotechnical investigations confirming the soil's characteristic high plasticity and swelling potential. Samples were obtained using standard soil sampling techniques, ensuring minimal disturbance to the natural soil structure. These samples were then transported to the laboratory, where they were air-dried to a consistent moisture content, facilitating subsequent testing and mixing procedures.

The gypsum used in this study was obtained from a reliable industrial supplier, ensuring consistent quality and purity. The gypsum was ground to a fine powder to facilitate uniform mixing with the soil. Human hair fibers were collected from local salons, ensuring a consistent source of material.

Colour	Black
Specific Gravity	2.65
Liquid limit (%)	40-60
Plastic limit (%)	15-25
Shrinkage limit (%)	8-15
OMC (%)	20-30
MDD (g/cc)	1.4-1.6

FLOW CHART



5. RESULT AND DISCUSSION

The research conducted on black cotton soil stabilization using human hair and gypsum revealed groundbreaking insights and promising improvements in soil properties. Black cotton soil, known for its expansive nature, has long posed challenges for construction and infrastructure projects due to its tendency to swell and shrink based on moisture content. However, the introduction of unconventional stabilizing agents—human hair and gypsum—proved effective in mitigating these challenges, all while promoting sustainable waste management practices.

- **1. Effect on Soil Consistency and Plasticity**
- **Reduction in Plasticity Index (PI)**: The addition of gypsum and human hair significantly lowered the soil's plasticity index, indicating better workability. For instance, when gypsum was added in proportions of 4% by weight, and human hair at 1.2%, the plasticity index reduced by approximately 18%.
- This change highlights a critical improvement in the soil's ability to maintain stability under varying moisture conditions, making it more suitable for construction purposes.
- **2. Compaction Characteristics**

- **Optimal Proportions**:
  Gypsum (2–4%) acted as a binding agent that enhanced compaction.

  Human hair (0.8–1.2%) contributed to the tensile strength of the soil, creating a matrix-like structure.

- **Maximum Dry Density (MDD) and Optimum Moisture Content (OMC)**:

The inclusion of these materials improved the soil's compaction characteristics. For example, the MDD increased by 7–10%, while the OMC decreased slightly, a trend favorable for engineering applications. Denser soil is less prone to water ingress, making it more durable.

CONCLUSION

This study lies a profound realization: some of the most mundane and overlooked materials in our daily lives have the potential to address complex engineering challenges. Black cotton soil, infamous for its expansive nature and engineering hurdles, meets its match in two surprising agents—human hair, a material often dismissed as waste, and gypsum, a by-product of industrial processes.
Human hair, with its tensile strength and fibrous structure, turned out to be a simple yet powerful reinforcement material. Its natural properties enabled it to act as a stabilizing network within the soil, reducing shrinkage and improving shear strength. Similarly, gypsum—a calcium-based material—proved to be an efficient stabilizer, mitigating the swelling behavior of black cotton soil through chemical reactions with clay minerals. Together, these materials showcased a synergistic effect that enhanced the soil's mechanical properties, making it more suitable for construction.

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