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# EVALUATING TENSILE STRENGTH AND LONGEVITY IN PAVEMENTS REINFORCED WITH HUMAN HAIR AND GLASS POWDER

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## ABSTRACT

This study investigates the incorporation of human hair and glass powder as reinforcing agents in pavement construction. The primary objective was to evaluate the tensile strength and lifespan improvements in both flexible and rigid pavements. Laboratory experiments, including compaction tests, California Bearing Ratio (CBR) tests, and Atterberg limits, were conducted to analyze soil stabilization properties. The findings suggest significant improvements in tensile strength, subgrade stability, and pavement durability when these materials are incorporated, demonstrating their potential as eco-friendly and cost-effective alternatives to chemical additives.

## 1. INTRODUCTION

With increasing ecological concerns and the need for sustainable construction practices, unconventional materials such as human hair and glass powder have garnered interest for use in pavement reinforcement. These materials offer unique properties: human hair provides high tensile strength, while glass powder contributes to improved load distribution. This study focuses on evaluating their combined effects on the structural performance and longevity of flexible pavements.

### 1.1 Background

Human hair, a natural biological fiber, is abundant and biodegradable, containing keratin proteins and amino acids that provide high tensile strength. Glass powder, on the other hand, is a byproduct of waste recycling and possesses excellent binding and reflective properties. Both materials have minimal ecological impact and present cost-effective solutions for improving pavement durability.

### 1.2 Objectives

- Assess the tensile strength improvements in pavements using human hair and glass powder.
- Compare the performance of reinforced pavements under soaked and unsoaked conditions.
- Evaluate the economic and ecological benefits of using these materials.

## 2. LITERATURE REVIEW

Previous research highlights the potential of using unconventional fibers in construction:

- Ganiron et al. (2013) found human hair to enhance load-bearing capacities when mixed with concrete.
- Jain and Kothari (2012) observed increased tensile and compressive strengths in hair-reinforced concrete.
- Aldea and Darling (2004) demonstrated the effectiveness of glass grids in reducing reflective cracking.

These studies underscore the potential of human hair and glass powder in improving pavement properties, paving the way for further exploration.

## 3. METHODOLOGY

### 3.1 Materials

- **Human Hair:** Sourced from barber shops and temples, cleaned, and cut to a uniform length of 25 mm.
- **Glass Powder:** Derived from recycled glass, ground to pass through a 400-micron sieve.
- **Soil:** Clayey soil collected locally, tested for physical and chemical properties.

### 3.2 Testing Procedures

1. **Atterberg Limits:** Determined liquid, plastic, and shrinkage limits to assess soil consistency.
2. **Compaction Test:** Standard Proctor tests were conducted to determine the optimum moisture content (OMC) and maximum dry density (MDD).
3. **California Bearing Ratio (CBR):** Measured soil strength under soaked and unsoaked conditions.
4. **Mix Ratios:** Hair and glass powder were added to the soil in varying proportions (2.5%, 5%, 7%, and 9%) to observe the effects on compaction and CBR values.

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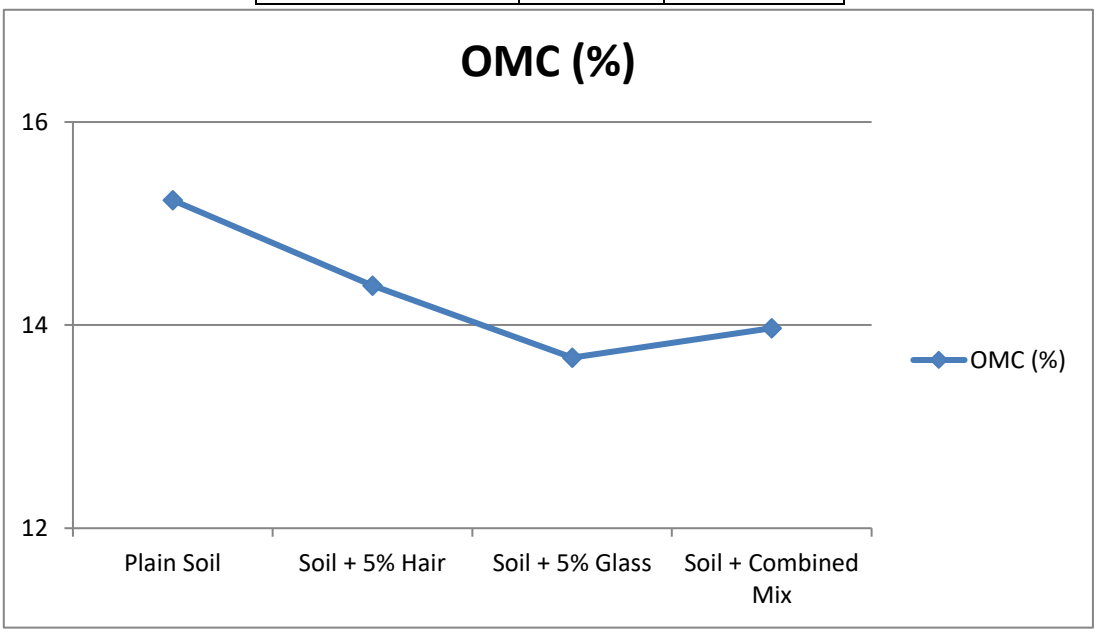
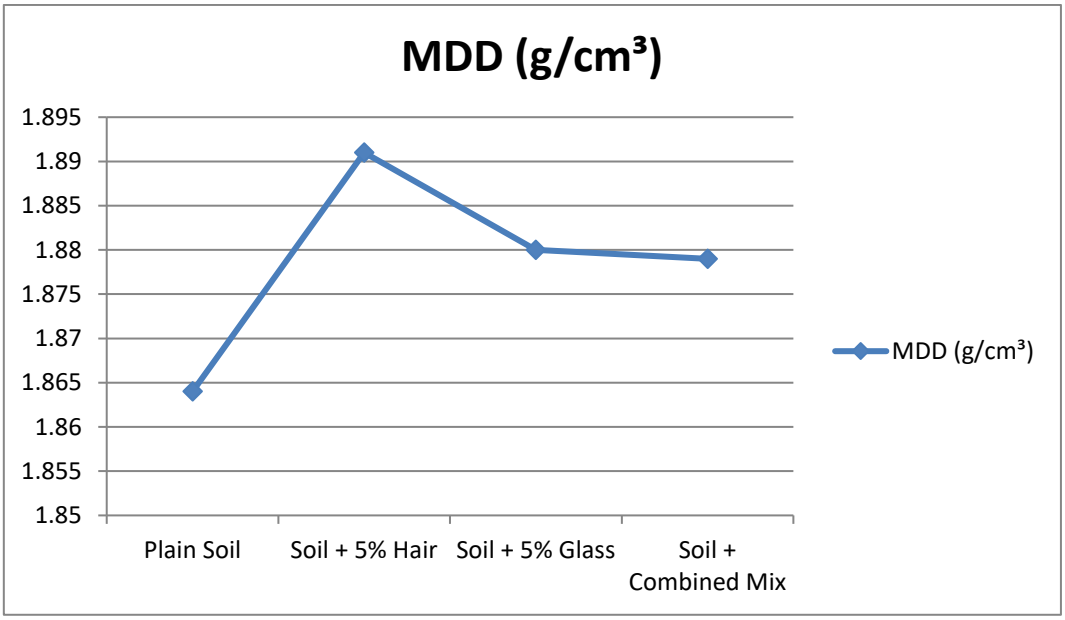
## 4. RESULTS AND DISCUSSION

**4.1 Compaction Test** The results showed an increase in MDD and a decrease in OMC with the addition of hair and glass powder up to 5%. Beyond this proportion, the benefits plateaued or slightly diminished.

| Material | OMC (%) | MDD (g/cm³) |
|---|---|---|
| Plain Soil | 15.23 | 1.864 |
| Soil + 5% Hair | 14.39 | 1.891 |
| Soil + 5% Glass | 13.68 | 1.880 |
| Soil + Combined Mix | 13.97 | 1.879 |




**4.2 California Bearing Ratio (CBR)** CBR values improved significantly with the addition of discrete fibers, especially in unsoaked conditions, indicating enhanced load-bearing capacity.

| Material | Unsoaked CBR (%) | Soaked CBR (%) |
|---|---|---|
| Plain Soil | 1.78 | 1.19 |
| Soil + 5% Hair | 3.45 | 2.36 |
| Soil + 5% Glass | 3.52 | 2.94 |
| Soil + Combined Mix | 3.45 | 2.56 |

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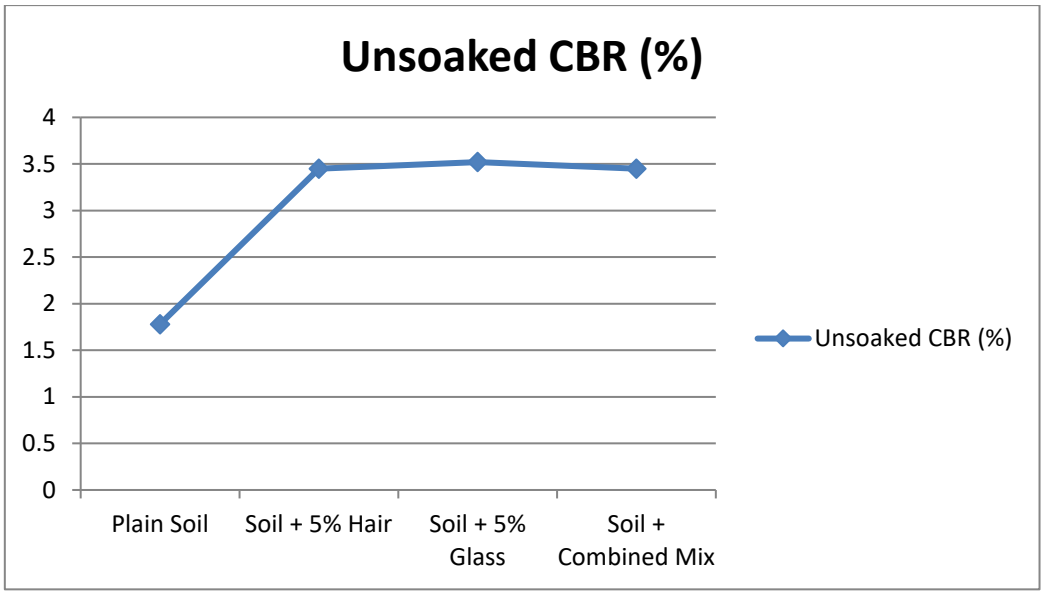


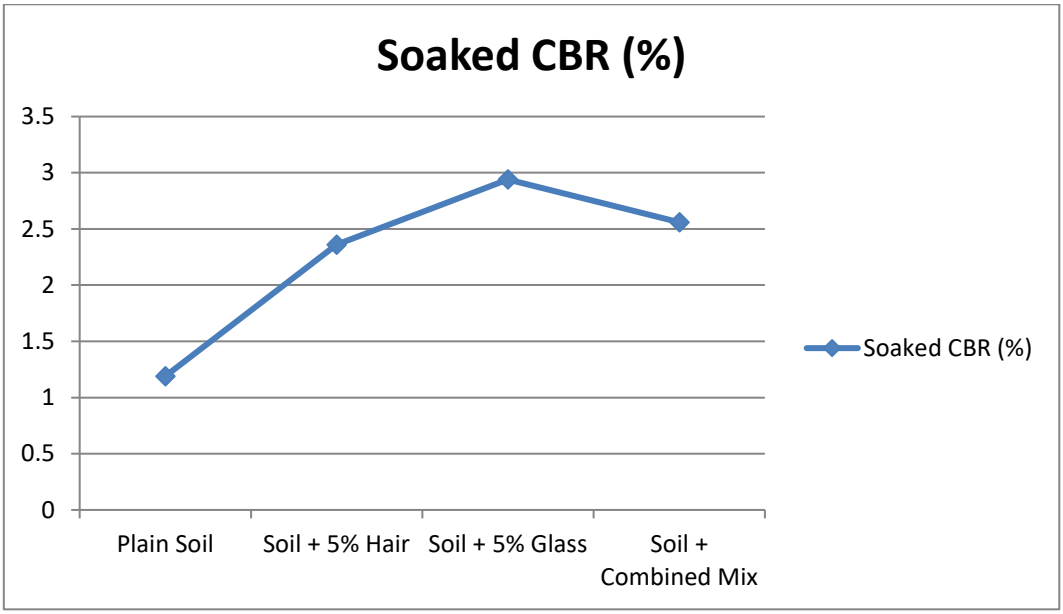


**4.3 Discussion** The enhanced CBR values suggest that human hair and glass powder improve soil strength by increasing cohesion and reducing permeability. The findings align with those of Ganiron et al. (2013) and Aldea and Darling (2004), affirming the efficacy of these materials in pavement applications.

## 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Conclusions

- Incorporating human hair and glass powder enhances the tensile strength and durability of pavements.
- Flexible pavements showed an extended lifespan from 8-10 years to an estimated 12-15 years.
- The materials offer a sustainable and cost-effective alternative to chemical additives.

### 5.2 Recommendations

- Further large-scale field trials are recommended to validate laboratory findings.
- Develop standardized guidelines for mixing ratios to optimize performance.
- Promote the use of recycled glass and human hair in other construction applications to reduce environmental waste.

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