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AN EXPERIMENTAL STUDY OF HUMAN HAIR IN CONCRETE AS FIBRE REINFORCEMENT

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Abstract
Concrete is one of the most widely used construction materials, but its brittle nature and low tensile strength pose significant challenges. In this study, human hair fibre (HHF), a non-degradable waste material, is investigated as a potential fibre reinforcement in M25 and M35 grade concretes. Mixes were prepared with varying percentages of hair fibres (0%, 0.5%, 1%, 1.5%, and 2% by weight of cement) and tested for workability, compressive strength, split tensile strength, flexural strength, rebound hammer test, and ultrasonic pulse velocity (UPV). The results demonstrate that hair fibre improves the mechanical properties of concrete up to an optimum content (1.5%), after which strength reduces due to fibre balling and poor workability. The study concludes that HHF can be a sustainable, low-cost fibre reinforcement material for concrete, reducing waste disposal issues and contributing to eco-friendly construction practices.

Keywords
Human Hair Fibre, Fibre Reinforced Concrete, M25, M35, Compressive Strength, Flexural Strength, Sustainability

1. Introduction

Concrete is the backbone of modern construction, but its brittle behavior and low tensile strength often necessitate the addition of fibres to enhance ductility and strength. Fibre reinforced concrete (FRC) has gained significant attention in recent years, with fibres such as steel, polypropylene, glass, and natural fibres being used. Human hair, a non-degradable waste material, is often disposed of improperly, leading to environmental concerns. Using hair as a fibre reinforcement in concrete not only improves its mechanical properties but also addresses the problem of waste management. This study investigates the effect of human hair fibres on the mechanical performance of concrete of grades M25 and M35.

2. Materials and Methodology

The experimental work involved the preparation of concrete mixes with varying proportions of human hair fibre (0%, 0.5%, 1%, 1.5%, and 2% by weight of cement). The materials used included OPC cement (53 grade), natural river sand as fine aggregate, crushed stone as coarse aggregate, potable water, and human hair collected from salons. The hair was washed, dried, and cut into lengths of 20–30 mm. Standard cube, cylinder, and beam specimens were cast and cured for 7, 14, and 28 days. Tests conducted included slump test, compressive strength, split tensile strength, flexural strength, rebound hammer, and ultrasonic pulse velocity (UPV).

3. Experimental Program

Concrete mixes were designed for M25 and M35 grades as per IS 10262:2019. Hair fibres were added at 0%, 0.5%, 1%, 1.5%, and 2% by weight of cement. Workability was measured using the slump cone test. For each mix, cube (150 mm), cylinder (150 mm × 300 mm), and beam (100 mm × 100 mm × 500 mm) specimens were cast. The compressive, tensile, and flexural strengths were tested at 7, 14, and 28 days. Rebound hammer and UPV tests were conducted on 28-day specimens to evaluate surface hardness and internal quality of concrete.

4. Results and Discussion

The results indicate that the addition of human hair fibres significantly influenced the mechanical properties of concrete. Workability decreased as fibre content increased. Compressive strength improved with fibre addition up to 1.5%, after which it declined due to poor workability and fibre clustering. Similar trends were observed in split tensile and flexural strength tests. Rebound hammer and UPV tests showed improved surface hardness and internal quality up to the optimum fibre content. Detailed test results are presented in the following tables and figures.

Table 1: Compressive Strength of M25 and M35 Concrete with Varying Hair Fiber Content

HHF (%)	M25 Compressive Strength (MPa)	M35 Compressive Strength (MPa)
0.0	28	37

HHF (%)	M25 Compressive Strength (MPa)	M35 Compressive Strength (MPa)
0.5	31	40
1.0	33	42
1.5	30	39
2.0	27	36

Table 2: Split Tensile Strength Results

HHF (%)	Split Tensile Strength (MPa)
0.0	2.5
0.5	2.8
1.0	3.0
1.5	2.6
2.0	2.4

Table 3: Flexural Strength Results

HHF (%)	Flexural Strength (MPa)
0.0	4.5
0.5	4.8
1.0	5.1
1.5	4.6
2.0	4.3

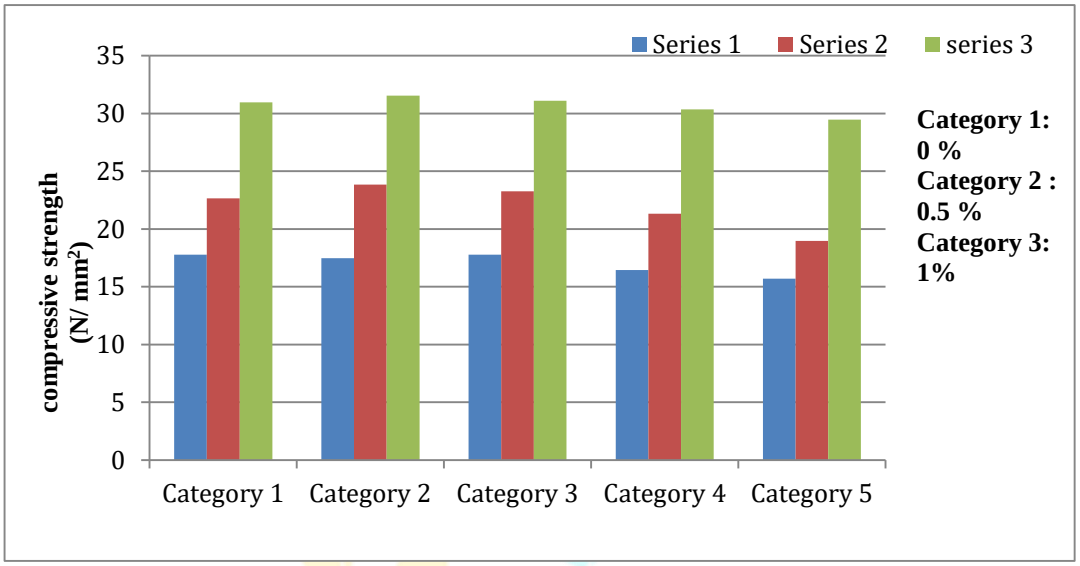

Figure 1: Compressive Strength Variation Graph

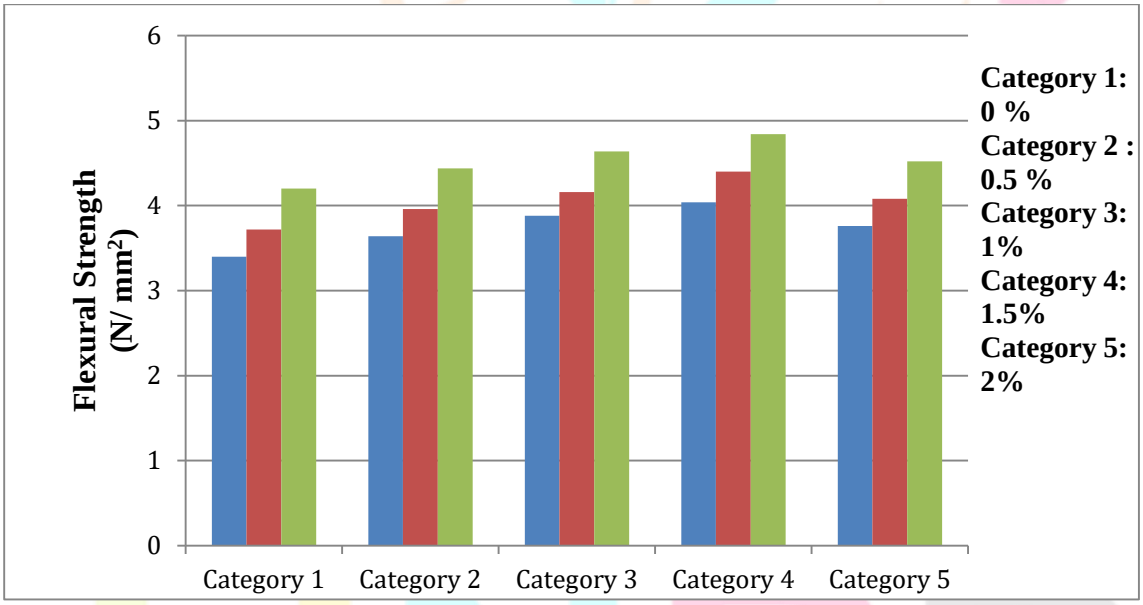

Figure 2: Tensile Strength Variation Graph

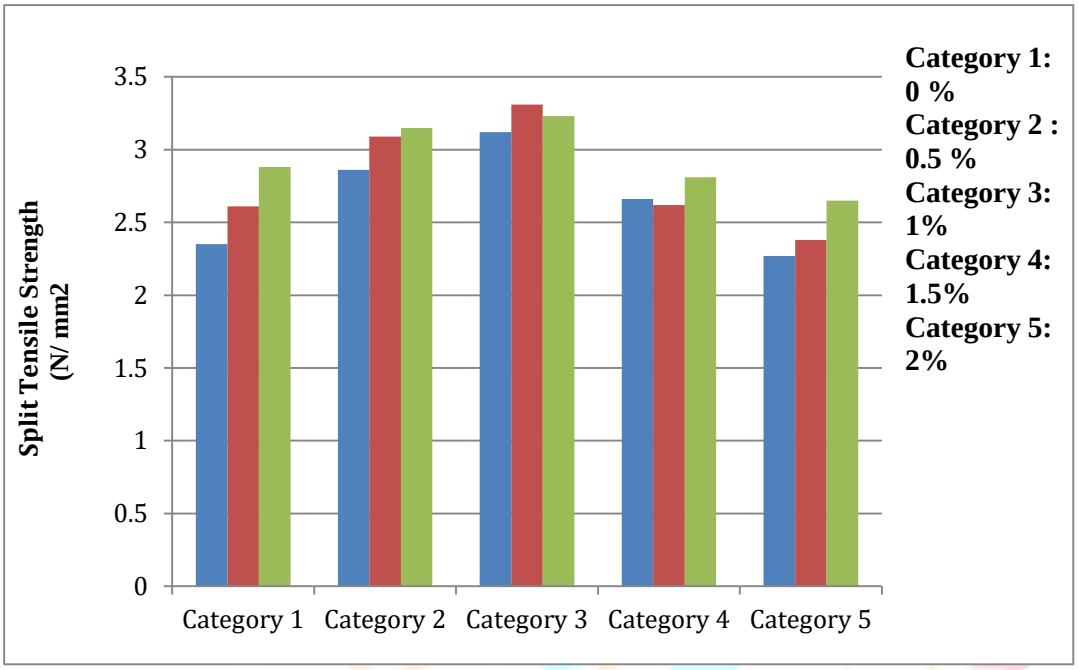

Figure 3: Flexural Strength Variation Graph

5. Conclusions

From the experimental study, the following conclusions were drawn:
1. Human hair fibre can be effectively used as a fibre reinforcement in concrete.
2. The optimum percentage of hair fibre is 1.5% by weight of cement for both M25 and M35 grades.
3. Beyond 1.5%, strength reduces due to fibre balling and poor workability.
4. HHF improves compressive, tensile, and flexural strengths up to the optimum dosage.
5. Rebound hammer and UPV tests confirm improved durability and quality of HHF reinforced concrete.
6. The use of HHF promotes sustainable construction by utilizing waste materials.

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