Structural Performance of Polyvinyl Alcohol Fibre in Reinforced Concrete

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Abstract – This project investigates the structural performance of polyvinyl alcohol (PVA) fiber as a reinforcing material in concrete. PVA fibers are known for their high tensile strength, excellent bonding with cement matrices, and resistance to alkali environments, making them a promising alternative to traditional reinforcement methods. The study evaluates the effects of PVA fiber content and distribution on concrete's mechanical properties, including compressive strength, and crack resistance. Experimental tests were conducted to assess the durability, load-bearing capacity, and failure modes of PVA-reinforced concrete under various loading conditions. The results demonstrate that the incorporation of PVA fibers significantly enhances the ductility and toughness of concrete, improves crack control, and delays crack propagation.

This project explores the structural performance of polyvinyl alcohol (PVA) fibre as an innovative reinforcement material in concrete. PVA fibres, recognized for their high tensile strength, excellent durability, and resistance to cracking, offer unique advantages over conventional steel reinforcement, particularly in reducing crack propagation and improving the overall resilience of concrete structures. The study involved preparing and testing PVA fibre-Reinforced concrete samples with varying fibre contents to analyze their impact on concrete's mechanical property, like compressive strength.

Key words: *PVA fibre, compressive strength test, workability.*

INTRODUCTION

This project focuses on Polyvinyl Alcohol Fibre Reinforced Concrete (PVA-FRC), a composite material that integrates polyvinyl alcohol (PVA) fibres into the concrete matrix. PVA fibres are known for their excellent tensile strength, flexibility, and resistance to environmental degradation. When mixed with concrete, these fibres help to improve its structural performance by enhancing its tensile properties, reducing crack propagation, and increasing overall durability.

Polyvinyl Alcohol Fibers are high-performance reinforcement fibres for concrete and mortar. PVA fibres are well-suited for a wide variety of applications because of their superior crack-fighting properties, high modulus of elasticity, excellent tensile and molecular bond strength, and high resistance to alkali, UV, chemicals, fatigue and abrasion. PVA fibres are unique in their ability to create a molecular bond with mortar and concrete that is 300% greater than other fibres.

Addressing the Challenges of Crack Formation and Durability in Concrete Structures: Evaluating the Effectiveness of PVA Fiber Reinforcement in Enhancing Structural performance in the Construction Industry. concrete, while strong in compression, has limitations in its tensile properties, making it susceptible to cracking and shrinkage under stress. These issues can lead to a reduction in structural durability and increased maintenance costs over time. Although steel reinforcement provides support, it may not fully prevent micro-cracking or offer the post-cracking ductility needed for certain applications.

PLANNING:

• Selection of Materials: This is the initial stage in research process. It involves selection of materials required to design the desirable grade of concrete. Based upon the various research papers we selected the following materials for the project work.
• We selected the OPC-53 grade of cement, 20% fly ash, 20mm coarse aggregate, fine aggregates, water and admixtures, and the polyvinyl alcohol fibre is selected in the design of concrete
• Design of Mix Proportion:
This provides information on the composition of concrete mix, significance of mix design. M50 grade concrete is considered.

TESTING PROCEDURE:

• Casting of Specimen: The experimental process involves casting of concrete specimens. The casting of specimen involves the process of creating concrete cubes and cylinders for the testing of compressive and split tensile strength respectively. The optimum volume fraction percentage of PVA fibre is used in casting of specimen. The casting involves making the concrete mixture and pouring into the mould of cube and cylinder. Completion of the casting phase marks the initiation of the experimental stage, where the newly cast specimens will undergo testing and analysis.

• Curing: This process involves the curing for the specimens after the casting. Curing is done for specimens in various time periods like 7, 14, and 28 days. Specimens are fully immersed in water.

• Testing: This involves application of external loads to the specimen to simulate the forces, it may experience in practical scenarios. This helps determine the factors such as compressive strength, split tensile strength under the different loading conditions. This information is crucial for understanding the behavior of the specimen under stress.

ANALYSIS:

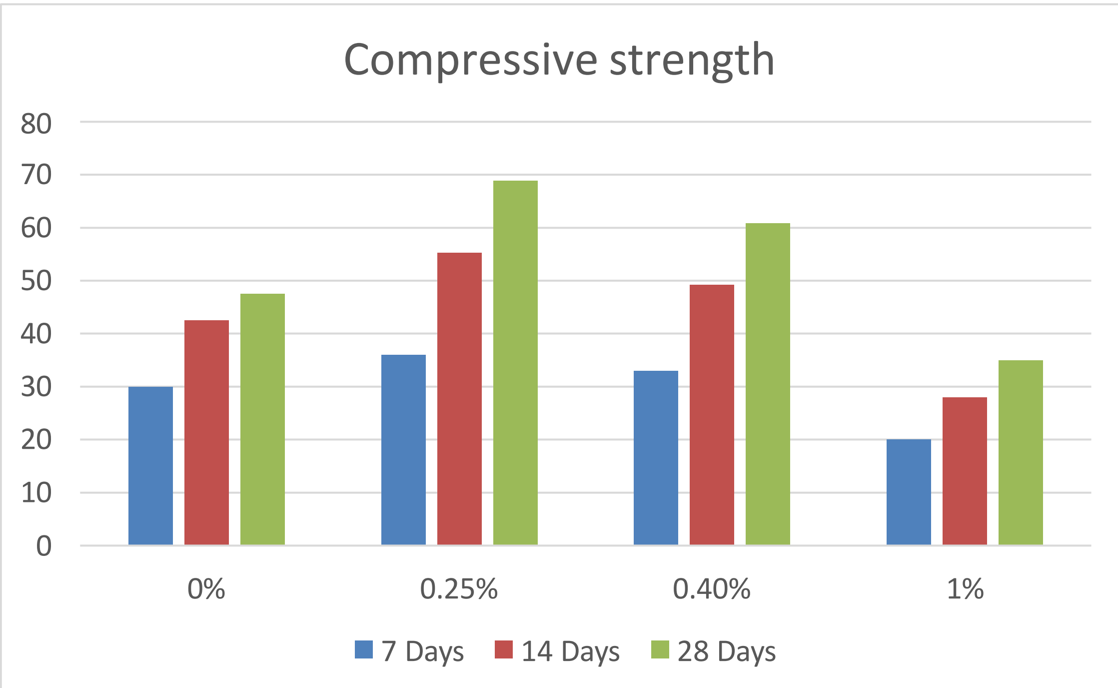
RESULTS: after the experimental test, the testing results will be discussed.

CONCLUSION: summarizing the key findings and achievement of PVA specimen as compared to conventional concrete.

Table 1: Results for compressive strength

SPECIMEN DETAILS (% PVA)	7 days (Mpa)	14 days (Mpa)	28 days (Mpa)
0% (conventional concrete)	30	42.5	47.5
0.25%	36	55.25	68.87
0.4%	33	49.3	60.8
1%	20	28	35

Tabular representation for compressive strength results



CONCLUSION:

1. Investigation of Compressive Strength with Varying Fibre Content

- An experimental study was conducted on concrete mixes with varying PVA fibre contents: 0%, 0.25%, 0.4%, and 1%, to evaluate their compressive strength.
- The control mix (0%) exhibited compressive strength as expected for M50 grade concrete and served as a baseline for comparison.
- The results showed that the inclusion of PVA fibres up to a certain level improves the compressive strength of concrete due to better crack-bridging and internal cohesion.
- However, beyond 0.25% fibre content, the compressive strength declined, primarily due to reduced workability, fibre balling, and inadequate compaction.
- This confirms that PVA fibres significantly influence the mechanical behavior of concrete, and dosage levels must be optimized to achieve beneficial effects.

2. Determination of Optimum Volume Fraction

- Among all the tested mixes, the concrete with 0.25% PVA fibre achieved the maximum compressive strength.
- This indicates that 0.25% is the optimum fibre dosage, providing an ideal balance between improved strength and acceptable workability.
- Mixes with higher fibre volumes (0.4% and 1%) experienced a drop in strength due to handling difficulties and improper compaction.

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