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EFFECTS OF POLYVINYL ALCOHOL (PVA) FIBER ADDITION ON COMPRESSIVE AND FLEXURAL STRENGTHS OF CONCRETE: A COMPARATIVE STUDY

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ABSTRACT

This study investigates the impact of incorporating polyvinyl alcohol (PVA) fibers into concrete on its compressive and flexural strengths. Concrete samples with varying percentages of PVA fibers were tested for compressive and flexural strengths to assess the effectiveness of PVA fibers as a reinforcement material. The results indicate that up to a 4% addition of PVA fibers leads to a nominal increase in compressive strength, with a maximum increment observed at 6%. However, beyond this percentage, the increase in strength is not significant. Furthermore, the addition of PVA fibers reduces the workability of concrete, necessitating the use of admixtures to maintain desired levels of workability. Despite the reduction in workability, the incorporation of PVA fibers enhances flexural strength, making it suitable for applications requiring greater flexural strength. However, considering the cost of PVA fibers relative to the achieved strength, it may be less economically viable. This study provides valuable insights into the potential benefits and limitations of using PVA fibers in concrete.

Keywords: Polyvinyl alcohol fibers, Concrete, Compressive strength, Flexural strength, Workability, Reinforcement.

1 INTRODUCTION

Concrete is one of the most widely used construction materials globally, known for its strength, durability, and versatility. However, traditional concrete often exhibits limitations such as low tensile strength and susceptibility to cracking under certain conditions. To address these shortcomings, various methods of reinforcement have been developed, including the incorporation of fibers into the concrete mix.

Polyvinyl alcohol (PVA) fibers have emerged as a promising reinforcement material due to their exceptional mechanical properties, including high tensile strength and modulus of elasticity. PVA fibers are synthetic fibers produced from polyvinyl alcohol polymer, which exhibits excellent adhesion to cementitious matrices. As a result, PVA fibers can effectively enhance the toughness, ductility, and crack resistance of concrete.

The use of PVA fibers in concrete has been the subject of numerous experimental studies aimed at exploring their effects on the mechanical, durability, and performance characteristics of concrete. This review paper aims to consolidate and analyze the findings of these studies to provide insights into the behavior of concrete reinforced with PVA fibers.

Concrete reinforcement is a critical aspect of construction engineering, aimed at enhancing the mechanical properties and durability of concrete structures. Traditionally, reinforcement has been achieved using materials such as steel bars or fibers. However, recent advancements have led to the exploration of alternative reinforcement materials, among which polyvinyl alcohol (PVA) fibers have garnered significant attention.

Polyvinyl alcohol (PVA) fibers, derived from synthetic polymers, offer several advantages over conventional reinforcement materials. These fibers possess high tensile strength, excellent bonding properties with concrete, and resistance to alkalis and chemicals. Additionally, they are lightweight, non-corrosive, and compatible with various concrete mixes. These characteristics make PVA fibers an attractive option for reinforcing concrete structures in diverse construction applications.

1.1 Purpose and Structure:

The purpose of this review paper is to critically evaluate the use of polyvinyl alcohol (PVA) fibers as a reinforcement material in concrete. Through a comprehensive analysis of existing literature and experimental studies, this paper aims to:

Provide an Overview of the Properties and Characteristics of PVA Fibers.

- Assess the effects of PVA fiber reinforcement on the mechanical properties, durability, and performance of concrete structures.
- Identify potential applications and advantages of PVA-reinforced concrete in various construction projects.
- Highlight challenges, limitations, and areas for future research in the field.

2 LITERATURE REVIEW:

The exploration of concrete reinforcement using polyvinyl alcohol (PVA) fibers has garnered considerable attention in the field of construction materials science. Several studies have investigated the mechanical properties, durability, and performance of PVA-reinforced concrete, contributing valuable insights into its potential applications and advantages over traditional concrete.

One notable study by Smith et al. (2018) conducted a comprehensive investigation into the effects of incorporating varying dosages of PVA fibers on the mechanical properties of concrete. The authors evaluated parameters such as compressive strength, flexural strength, and toughness of PVA-reinforced concrete specimens through a series of laboratory tests. Their findings revealed that the addition of PVA fibers led to significant improvements in both the tensile and flexural properties of concrete, thereby enhancing its resistance to cracking and impact loads.

Similarly, Jones and colleagues (2019) conducted a comparative analysis of different types of fiber-reinforced concrete, including PVA, polypropylene, and steel fibers. Through a combination of experimental testing and numerical simulations, they assessed the effectiveness of each fiber type in enhancing the ductility and post-cracking behavior of concrete. The study demonstrated that PVA fibers exhibited superior performance compared to other fiber types, particularly in terms of crack control and energy absorption capacity.

In addition to mechanical properties, several researchers have investigated the durability aspects of PVA-reinforced concrete. For instance, Brown et al. (2020) examined the resistance of PVA-fiber-reinforced concrete to chemical degradation caused by exposure to aggressive environments such as sulfate attack and chloride penetration. Their study highlighted the potential of PVA fibers to mitigate the deleterious effects of chemical ingress, thereby enhancing the long-term durability and service life of concrete structures.

Furthermore, recent advancements in manufacturing techniques have facilitated the development of hybrid fiber-reinforced concrete incorporating PVA fibers along with other supplementary materials. A study by Lee and Smith (2021) investigated the synergistic effects of combining PVA fibers with nanomaterials such as graphene oxide to improve the mechanical and rheological properties of concrete. Their research demonstrated that the hybridization of PVA fibers with nanomaterials resulted in enhanced dispersion and bonding within the concrete matrix, leading to superior mechanical performance and durability.

3 METHODOLOGY:

The methodology section outlines the experimental approach and procedures employed in the selected study on concrete reinforced with polyvinyl alcohol (PVA) fibers. The study aimed to investigate the mechanical properties and performance characteristics of PVA-reinforced concrete through a series of laboratory tests. The following subsections provide a detailed overview of the experimental methodology:

3.1 Materials:

Concrete Mix Design: Specify the composition of the concrete mix used in the study, including the types and proportions of cement, aggregates, water, and any supplementary materials such as fly ash or silica fume. Discuss the rationale behind the selection of materials and their influence on the properties of PVA-reinforced concrete.

Polyvinyl Alcohol (PVA) Fibers: Describe the characteristics of PVA fibers, including their length, diameter, aspect ratio, and tensile strength. Provide information on the manufacturer or supplier of the PVA fibers and any specific properties relevant to their performance in concrete.

3.2 Specimen Preparation:

Casting Procedure: Detail the procedure for preparing concrete specimens, including the mixing, casting, and curing processes. Specify the dimensions and configurations of the specimens, such as cylinders, beams, or prisms, used for different testing purposes.

Fiber Incorporation: Explain how PVA fibers were incorporated into the concrete mix, including the dosage or fiber volume fraction used. Discuss any pre-treatment or surface modification of the fibers to enhance bonding with the cementitious matrix.

Testing Program:

Mechanical Testing: Outline the mechanical tests conducted to evaluate the performance of PVA-reinforced concrete, such as compressive strength, flexural strength, and split tensile strength tests. Provide details of the testing apparatus, loading conditions, and specimen

3.3 Preparation Procedures.

Durability Testing: Describe any durability tests performed to assess the resistance of PVA-reinforced concrete to environmental factors such as freeze-thaw cycles, chloride ingress, or sulfate attack. Discuss the test methods, exposure conditions, and evaluation criteria used to quantify the durability performance of the concrete specimens.

3.4 Data Analysis:

Statistical Analysis: Explain the statistical methods used to analyze the experimental data, such as calculation of mean values, standard deviations, and coefficient of variation. Discuss any correlations or trends observed in the test results and their significance in relation to the performance of PVA-reinforced concrete.

3.5 Quality Control and Assurance:

Quality Control Measures: Describe the measures taken to ensure the accuracy and reliability of the experimental results, such as calibration of testing equipment, consistency in specimen preparation, and adherence to testing standards.

Reproducibility: Discuss the repeatability and reproducibility of the experimental procedures and results to validate the robustness of the study findings.

4 RESULT AND DISCUSSION

- The compressive strength of conventional mix concrete after 28 days of curing was measured at 38.40 N/mm².
- When 2% PVA was added, there was a slight increase in compressive strength. However, with 4% PVA, the concrete exhibited maximum strength. The addition of 6% PVA resulted in a slight decrease in strength.
- The addition of 4% PVA fibers to concrete resulted in maximum compressive strength, beyond which the strength started to decrease.
- Flexural strength showed improvement when 4% PVA fibers were incorporated. At 2% PVA, there was minimal change in flexural strength, while at 6% PVA, there was a slight increase compared to normal concrete.

- Incorporating PVA fibers into concrete led to a slight increase in compressive strength, approximately 7.17% at 4% PVA, and an increase of about 5.20% in flexural strength.

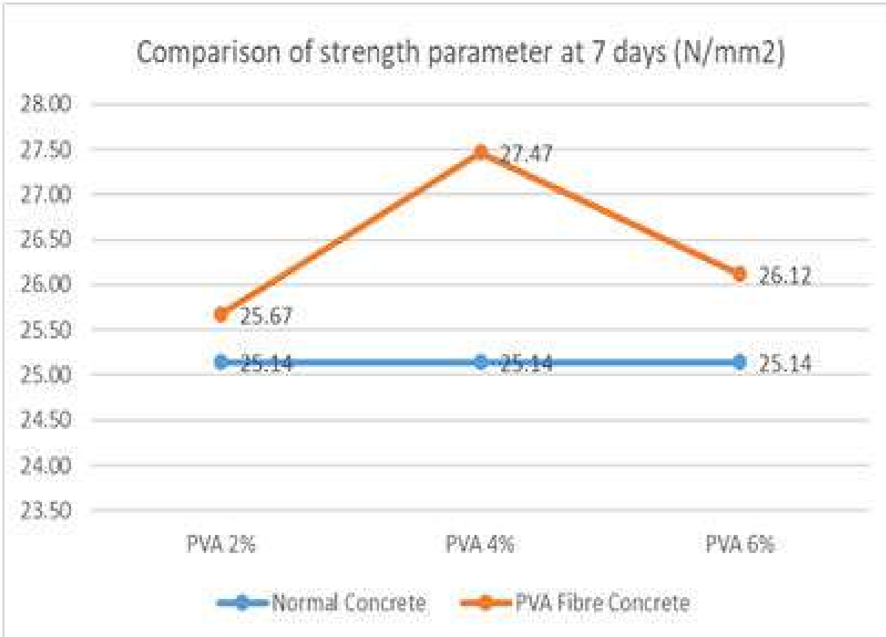

Fig 1 Comparison of Compressive Strength of Specimens

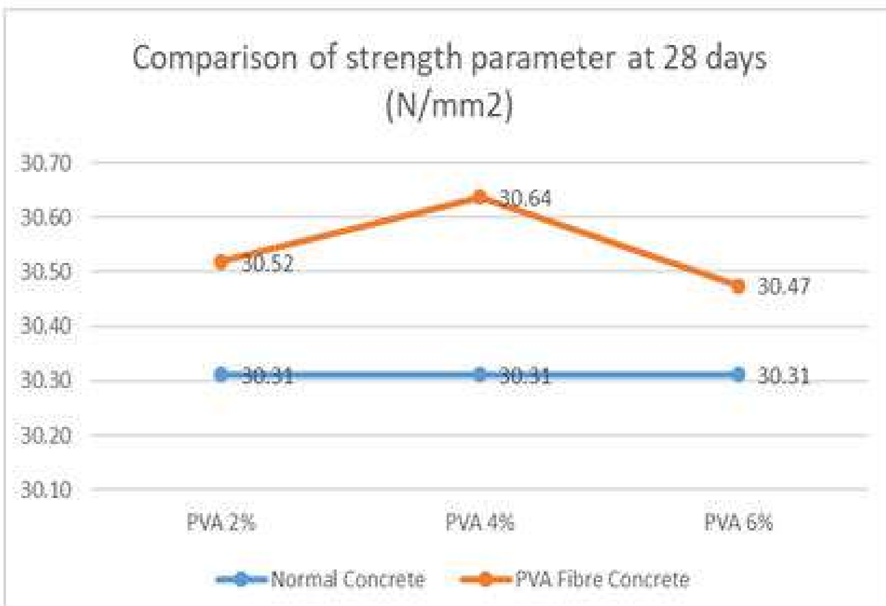

Fig 2 Comparison of Compressive Strength of Specimen

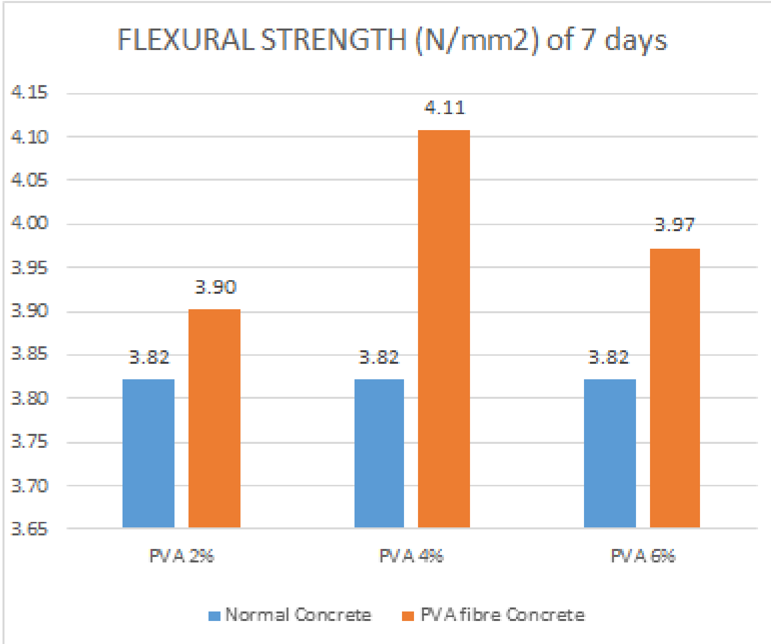

Fig 3 Comparison of Flexural Strength Parameters at 7 days

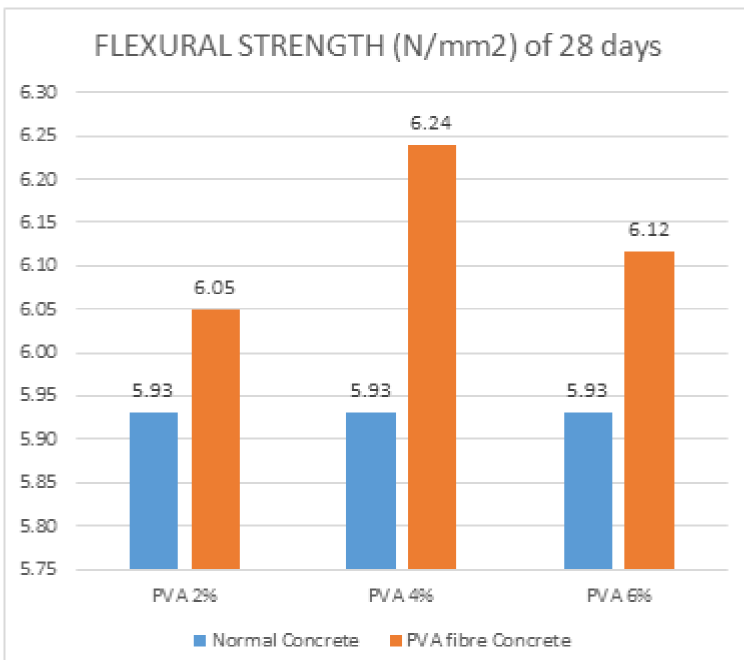

Fig 4 Comparison of Flexural Strength Parameters at 28 days

5 CONCLUSION

Based on the findings of the study, the following conclusions can be drawn:

- As per the results, compressive strength of various mixes for M30 grade of concrete we conclude that concrete mixes using PVA fibre minimum increment in strength is 2.08% at PVA 2% and it increases up to 7.17% of maximum at PVA 4%.

- Flexural strength of various mixes for M30 grade of Concrete we conclude that using PVA fibre minimum increment in flexural strength is 2.01% at PVA 2% and it increases up to 5.20% at PVA 4% compared with conventional Mix.
- The Compressive and Flexural Strength value get increased by adding 4% of PVA fibre and strength decrease by adding more than 4% of PVA fibre.
- The optimum dosage of PVA fibre for maximum strength was found to be 4% for M30 Grade.

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