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An Evaluation Paper on PVA Fiber Experimental Research in Reinforced Concrete

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Abstract

The purpose of this article is to determine the bonding performance between rebar and PVA fiber-reinforced concrete, as well as between superposed members of ordinary concrete and PVA fiber-reinforced concrete. In order to achieve this, specimens of six distinct contact surfaces between PVA-reinforced concrete and regular concrete underwent tensile testing. The findings demonstrate that PVA fiber-reinforced concrete performs significantly better at bonding than regular concrete, and this performance rises with the contact surface's roughness. Additionally, two distinct rebar diameters of PVA fiber-reinforced concrete were created for pull-out testing. The bonding ability of the rebar and concrete was compared to that of regular concrete and rebar. This allowed the author to ascertain the mechanism of failure of the bonding between rebar and PVA fiber-reinforced concrete, and to deduce. This experimental investigation that quantifies the impact of polymer fiber on concrete's mechanical characteristics. Regarded as one of the best polymeric fibers for use as concrete reinforcement is polyvinyl alcohol (PVA) fiber. The experimental methods and results for the compressive strength of cubes after 3, 7, 28, 56, and 90 days are presented in this work. The concrete's split tensile and flexural strengths were assessed after 28 days of cure. The concrete known as fiber-reinforced concrete (FRC).

Keywords: PVA Fibers; Fiber-Reinforced Concrete (FRC); Durability; Compressive Strength

Abbreviations: PVA: Polyvinyl Alcohol; FRC: Fiber-Reinforced Concrete; HPFRCCs: High Performance Fiber Reinforced Cement Composites; SF: Silica Fume.

Introduction

Concrete made with plain cement had very little resistance to breaking, negligible ductility, and very poor tensile strength. Internal microcracks are a natural feature of concrete, and as a result of these microcracks spreading, the material finally fractures brittlely and loses its tensile strength. Fiber reinforced concrete is a composite material made of cement mortar or concrete mixtures with discontinuous discrete evenly scattered fibers. Fiber is a type of reinforcing material that resembles hair and has specific qualities. They may be flat or round. The convenient aspect ratio characteristic primarily describes the fiber. The ratio of the fiber's length to diameter is known as its aspect ratio. Aspect ratio values often fall between 30 and 150.

Polyvinyl Alcohol Fibers

PVA fiber is a good choice for cementitious composites because of its reinforcing properties. An excellent environmentally friendly cement-reinforced material is polyvinyl alcohol fiber. It because of its distinct molecular structure, has weather and alkali resistance, therefore it Boost concrete's resistance to frost forming a strong bond with cement, effectively stopping the onset and propagation of cracks, increasing the concrete's bending, impact, and fracture strengths as well as its permeability, impact resistance, and seismic resistance Boost toughness by making concrete less brittle and more impact- and bending-resistant Strong bonding with cement matrix is one of PVA fiber's unique qualities.

Literature Review

Sadaqat Ullah Khan a, Tehmina Ayub (2016)

A thorough assessment of the literature on the behavior of concrete specimens under direct tension is given in the paper "High performance fiber reinforced concrete under direct tension." It talks about the strain-hardening response linked to high performance fiber reinforced composites and how their lower modulus of elasticity, higher binder content, and structural application limits limit their use. The impact of fibers and interface characteristics on fiber bridging, the application of superplasticizer to enhance workability, and the effect of specimen form on direct tension testing are all covered in the publication. It also examines the strain capacity in strain or slip-hardening reaction and the interaction of PVA fibers with the concrete matrix, as well as comparing the compressive strength and related strain results of concrete containing PVA fibers [1,2].

Peng Zhang, Xu Han, Shaowei Hu, Juan Wang, Tingya Wang (2022)

The paper's literature review covers the properties of a geopolymer based on fly ash with naSiO2 added, as well as the effects of phosphorus slag content and fineness on the fractal dimension, permeability, pore structure, and cement hydration of concrete. It also discusses the influence of various fly ash classes on geopolymers following exposure to increased temperatures, as well as the distribution of bubble chord length in PVA fiber reinforced geopolymer mortar. The paper also covers the bonding behavior of steel fly ashbased geopolymer past after exposure to increased temperatures, as well as the earlyage reaction process of alkali-activated slag [3].

Dan Meng, Ting Huang, Y Zhang, and C Lee (2017)

High performance fiber reinforced cement composites (HPFRCCs) and its exceptional mechanical qualities are first discussed by the writers. They draw attention to ECC as a particular kind of HPFRCC that exhibits repeated microcracking and enhanced tensile strain hardening behavior. In contrast to other forms of ECC reinforced with various fibers, PVA-ECC has demonstrated greater toughness and flexural strength The writers talk about how local sand is a better option than micro silica sand for cutting expenses and addressing social and environmental problems related to building material production. They point out that while locally available sand with larger particle sizes may have a marginally reduced tensile strain capacity, it still falls within the ideal range for use in reinforced concrete structures. The materials employed, specimen preparation, and testing methods for four-point bending, uniaxial compression, and uniaxial tension are all covered in the experimental section of the study. The stress-strain correlations, compressive strength, ultimate tensile strength, and flexural behavior of the PVA-ECC are among the test results that are shown and discussed. To ascertain the 95% confidence intervals of the population, mean for the mechanical properties, statistical data analysis is also carried out [4].

Exira Du, Yujie Yana, Jiao Guoa (2017)

A study of the literature on the mechanical property test of reinforced concrete using polyvinyl alcohol (PVA) fibers is included in this document. It cites multiple research that investigated the mechanical properties of cementitious composites, such as the self-healing capacity, crack resistance, and PVA fiber length and surface features. The review focuses on how fiber concrete is superior to regular concrete in terms of tensile strength, impact resistance, fracture resistance, and bending strength. However, fiber concrete's expensive cost prevents it from being used widely [5]. The traditional PVA-ECC mix proportion's enhancement to satisfy structure usage regulations and reduce construction costs is also included in the document. The review focuses on how the mechanical performance of PVA-ECC material is affected by the fiber content, water-binder ratio, and maximum sand size. The application of fiber concrete in projects is based on an analysis of the mechanical property test results, which include load-deformation curves, compressive strength, and rupture strength.

Exira Du, Shuang long Donga, Mianheng Sunb (2018)

It cites other research that looked into the bonding qualities between concrete and rebar as well as the bonding between concrete substrates and various kinds of toppings. The review emphasizes the potential advantages of employing PVA fiber-reinforced concrete as well as the significance of bonding strength in reinforced concrete buildings. It also discusses how the high cost of imported fibers has limited the use of PVA fiber-reinforced concrete in China. The mechanical characteristics of PVA fibers and the test procedures used to gauge the bonding strength are covered in the document. The paper's research, which focuses on the bonding performance of PVA fiber-reinforced concrete in various circumstances, is generally built up by the literature review.

Vinodh Kumar Balaji, Chinnakotti Sasidhar (2017)

The study's objective is to assess how PVA fibers affect concrete's compressive strength. The concrete examples included a variety of PVA fiber combinations at varying volume fractions (0.6%, 0.8%, 1.0%, 1.2%, 1.5%, and 2.0%). The physical characteristics of the PVA fibers, cement, fine and coarse aggregate, and other materials utilized in the studies Compressive strength tests were performed on the specimens at various curing times (3 days, 7 days, 28 days, 56 days, and 90 days). Comparing the specimens with 1.5% PVA fibers to those with various variants of PVA fibers, the results indicated a considerable increase in compressive strength. The study includes comments and graphs showing the compressive strength results for various PVA fiber mix amounts [6].

Yan Tan, Ziling Xu, Zeli Liu and Jiuhong Jiang (2022)

This study looks into the freeze-thaw resilience of silica fume (SF) and polyvinyl alcohol (PVA) fibers found in high-performance fiber-reinforced concrete (HPFRC). The authors assessed the mechanical characteristics and damage progression of the concrete by performing freeze-thaw cycle tests on several HPFRC combinations. They obtained the damage evolution equation for the concrete by analyzing the damage evolution using the Weibull distribution. The outcomes demonstrated that the HPFRC's ability to withstand freeze-thaw was enhanced by the addition of SF and PVA fibers. The study sheds light on how long-lasting HPFRC is in freeze-thaw environments.

Jiaqing Wang, Qingli Dai, Ruizhe Si, Shuaicheng Guo (2018)

An investigation on the mechanical characteristics, durability, and viability of recycling tire rubber into concrete by reinforcing it with PVA fiber. The study reports on the concrete samples' compressive strength, electrical resistivity, post-cracking behavior, and durability performance. The findings suggest that the mechanical characteristics and durability performance of rubberized concrete are enhanced by the addition of PVA-fiber. According to the study, rubber concrete reinforced with PVA fibers will have good freeze-thaw performance and long-term durability. Researchers and industry experts working in the construction and building materials sectors would find the study to be very informative.

Margareth Silva Magalhães, Romildo Dias Toledo Filho, Eduardo Moraes Rego Fairbairn (2013)

The study's objective is to comprehend the PVA fibers' remaining mechanical and physical characteristics following their exposure to temperatures between 90°C and 250°C.The density, elastic modulus, tensile strength, and elongation at failure are among the mechanical and physical characteristics. Through thermal and microscopic examination, the study also seeks to determine the mechanism by which PVA fibers deteriorate under thermal loads. The experimental program measures the degree of fluctuation in yarn strength at various temperature settings using Weibull statistics and PVA fibers with brand nameREC15 [7].

A. Noushini1, B. Samali, and K. Vessalas (2013)

In this paper investigates the changes in concrete's characteristics caused by the addition of PVA fibers. The mix ratios, mixing schedule, and placement of various sets of mixed concrete are provided in the paper. Additionally, test findings supporting the idea that adding more than 0.5% of fiber volume fraction resulted in non-cohesive concrete. The findings show that, regardless of the amount of HWR, adding PVA fiber reduces the slump or workability of the concrete. Adding fibers to the mix also reduces the mass per unit volume of concrete, most likely because the fibers' lower density results in a lower volume density. This impact was observed for varying amounts and lengths of fiber [8,9].

Zhen Gao, Peng Zhang, Jinjun Guo, Kexun Wang (2021)

The study investigates how many parameters, including PVA fiber and NS contents, the kind of alkali-activated mortar, the strength grade of the concrete, and interfacial roughness, affect the bonding strength of the samples. PVA fibers have the potential to greatly increase the bonding strength between the concrete matrix and alkali-activated mortar. In actuality, the bond strength is at its strongest at 0.8% PVA fiber concentration. In the meantime, adding NS particles can increase the samples' bond strength and bond toughness; however, their reinforcement effect on bonding behavior is negligible in comparison to that of PVA fiber.

Ming Kun Yew, Hilmi Bin Mahmud, Bee Chin Ang and Ming Chian Yew (2014)

It is well known that fibers are what give ordinary concrete its excellent workability and smooth flowing qualities. An increase in the volume percentage of PVA fibers causes a decrease in the slump of fresh oil palm shell concrete. Throughout the entire investigation, the amounts of water and slump are maintained constant for every mix. It also reported that the addition of monofilament PVA fibers into the mixtures from 0 to 0.5% will reduce the density of OPS at about 20% on various curing conditions up to 28 days. The addition of fibers into the mixtures from 0 to 0.125, 0.25, 0.375, and 0.50 decreases the workability by 5.0, 7.5, 22.5, and 40.0%, respectively. When wet curing continuously within the range of 43-49MPa [10].

Fang Liu, Baomin Wang, Yunqing Xing, Kunkun Zhang and Wei Jiang

One of the primary constituents or components of concrete, the most common building material, is Portland cement. This study's analysis takes into account how polyvinyl alcohol (PVA) fiber affects the characteristics of Portland mortar. To obtain the highest concrete quality possible, the study takes into account their effects on tensile, compressive, and impact strengths reducing the proportion of PVA fibers in weight minimum proportional weight of PVA fiber, a polymer, along with concrete mixtures are examined to determine their flexural strengths and other physical characteristics, such as resistance to propagation of cracks.

Summary

- The Polyvinyl Alcohol Fiber summary may be added to the concrete mixture at a concentration of 0.5% to 1.5% per unit weight of cement.
- Polyvinyl Alcohol Fiber increases the split tensile, flexural, and compressive strengths of concrete.
- There will be less need for cracking and maintenance.
- PVA fibers improved the geopolymer mortar's strengths at 200°C and 25°C. The mortar containing 0.8% PVA fiber demonstrated a 35.6% and 50.5% improvement in cubic compressive strength at 25°C and 200 ∘C when compared to the geopolymer mortar without fibers.
- Thermal study indicates that the glass transition temperature of a PVA fiber is about 66ºC, and its initial melting point is about 200°C.

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