International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Experimental Study on the Properties of Concrete with Alkali Resistant Glass Fiber.

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ABSTRACT:

This paper discusses the use of alkali resistant glass fiber in conventional concrete and the advantages of using AGRF concrete. Glass fibers have high tensile strength and fire-resistant properties, reducing damage during fire accidents. However, an increase in the percentage of glass fibers can reduce compressive strength and lead to a higher loss of weight. Concrete reinforced with fibers, such as steel or glass fibers, is less expensive than handtied rebar and can significantly increase the tensile strength of the concrete. The use of dual fiber (steel and glass) in concrete can enhance its ultimate load carrying capacity, stiffness, and compressive strength compared to plain concrete. The workability of concrete is only marginally affected by the addition of fibers, even with a total fiber content of 1.0 percent by volume. Glass fibers, when added to concrete, can reduce brittleness, improve plasticity characteristics, and delay crack development. However, the impact resistance of glass fiber reinforced concrete is lower than that of steel fiber reinforced concrete. The impact resistance of concrete slabs with glass fibers is influenced by the fiber content, with higher fiber content resulting in less concrete shedding and the formation of major and microcracks. The addition of glass fibers can increase the tensile strength of concrete and improve its durability. The workability of concrete is minimally affected by the addition of fibers, even at higher fiber content.

Keywords: ARGF, ARGFC, Alkali resistant glass fiber

INTRODUCTION:

This article discusses the findings of an experimental study on how structural concrete's characteristics are altered by additives added to concrete such as glass fiber. Since cement concrete is a widely used building material and is sufficiently strong in compression but weak in tension and has little ductility, it has a low resistance to cracking, which is caused by the inherent existence of micro-internal fissures. One approach is to incorporate alkali-resistant glass fiber (ARGF) to increase its post peak responsiveness and resistance to breaking. This is typically added to concrete during mixing in a specific ratio, and the finished product is known as alkali-resistant glass fiber reinforced concrete (ARGFRC). This study provides an overview of the experimental research conducted on the type of cement concrete and its aspect ratio and quantity of ARGF. The characteristics of both fresh and hardened ARGFRC are influenced by both type and amount. In this study, alkali-resistant glass fibers are employed. These fibers' effects on the workability, mechanical strength, and durability of M30 grade concrete are investigated. for 0.5 to 3% of ARGF to the weight of the cement. Compressive strength, flexural strength, and split tensile strength are the different strengths that are being investigated.

ALKALI RESISTANT GLASS FIBER:

TYPES OF AR-GLASS FIBER:

CHOPPED FIBERS:

This type of fiber is produced by slicing fiber bundles into different lengths and filament counts inside each bundle. Frequently, failure results in the fibers pulling out of the concrete matrix instead of breaking. This indicates that compared to shorter strands, longer fibers are less likely to fail. The strength and workability of the concrete mix are both influenced by the number of filaments per bundle. We think that a 19mm (3/4") 200 filament fiber bundle is the most appropriate for many artisan applications when these two factors are considered.

ROVING:

A continuous fiber strand is called a roving. During the casting process, this roving is most utilized with specialized equipment that cuts the fiber and mixes it into a concrete slurry. Additionally, roving is what creates Scrim.

SCRIM:

Scrim is roving woven into a fabric. A continuous thread of fiber through the tensile plane will provide more tensile strength than will fibers alone because fibers are more likely to pull out than to break.

ADVANTAGES:

It has higher compressive strength and tensile strength than plain concrete, especially at low fiber contents (0.5% or less).

It has improved flexural strength, toughness, and fracture energy, which means it can resist cracking and deformation better than plain concrete. It has enhanced impact resistance and energy absorption capacity, which means it can withstand dynamic loads and shocks better than plain concrete. It has good durability and resistance to harsh environments, such as high temperature, freeze-thaw cycles, and chemical attacks, because ARGF is not affected by the alkalinity of concrete.

MECHANICAL PROPERTIES:

Alkali resistant glass fibers (ARGF) are a type of synthetic fiber that can resist the corrosive effects of alkali substances, such as cement, concrete, and mortar. They are often used to reinforce concrete structures and improve their mechanical properties, such as strength, toughness, and impact resistance. Tensile strength: The maximum stress that a fiber can withstand before breaking. ARGF has high tensile strength, ranging from 1700 to 2400 MPa12.

ELASTIC MODULUS: The ratio of stress to strain in a fiber. ARGF has a high elastic modulus, ranging from 72 to 86 GPa12.

ALKALI RESISTANCE: The ability of a fiber to resist degradation by alkali substances. ARGF have high alkali resistance, due to their low content of alkali-soluble oxides, such as Na2O and K2O13.

THERMAL INSULATION: The ability of a fiber to reduce heat transfer. ARGF have good thermal insulation, due to their low thermal conductivity, ranging from 0.035 to 0.045 W/mK14.

FIRE RESISTANCE: The ability of a fiber to withstand high temperatures and flames. ARGF have good fire resistance, due to their high melting point, ranging from 1200 to 1400°C.

LITERATURE REVIEW:

Chao Wu et.al (2022) The impacts of fibre content on the mechanical qualities and microstructural features of alkali-resistant glass fibre reinforced concrete (ARGFRC) are examined experimentally in this work.In order to examine the mechanical characteristics and microstructure of ARGFRC, the study used tests including compression, flexural, impact resistance, scanning electron microscopy, and energy dispersive spectroscopy. The outcomes demonstrated that raising the fibre content of ARGFRC enhanced its resistance to brittle failure, ductility, and flexural toughness index. It was discovered that 1.3% was the ideal fibre content for impact resistance. The results of the scanning electron microscope investigation showed that the impact of the concrete grout on fibre packing reduced with increasing fibre content. According to the energy dispersive spectroscopy observation, the concrete hydration reaction was unaffected by the addition of a certain fibre content.

Zhifu Dong et.al (2012) This study examines the impact resistance of reinforced concrete slabs using high zirconium alkali-resistant glass fibre in comparison to macro-polypropylene and steel fibre. It also analyses the impact resistance of different fibre types and volume fractions. according to the study, the impact resistance of the slabs is enhanced by increasing the fibre volume fractions. At a volume fraction of 0.75%, macro-polypropylene fibre reinforced concrete exhibits superior impact resistance than glass fibre. Nonetheless, glass fibre that is resistant to alkali offers benefits when it comes to corrosion.

J Sahaya Ruban et.al (2016) The purpose of the study is to determine how adding steel and treated coir fibres affects concrete's mechanical qualities, particularly its flexural, splitting, and compressive strengths. The inclusion of three steel fibres considerably increases the splitting tensile strength and flexural strength of concrete, while the addition of silica fume and copper slag improves the mechanical qualities of the material. A combination including three treated coir fibres and three steel fibres produced the greatest results. In comparison to non-fibrous concrete, the inclusion of glass fibre not only improves the concrete's compressive and tensile strengths but also raises its coefficient of sorptivity and water absorption. It is discovered that ARGF can improve the composite concrete's toughness, weight bearing ability, and stiffness when combined with silica fume.

Adeyemi Adesina (2022) The study offers a thorough analysis of the microstructural characteristics and longevity of alkali-activated materials (AAMs) produced using recycled glass as a precursor, emphasizing the materials' potential as sustainable substitutes for Portland cement. The study covers the microstructural characteristics of glass powder-based AAMs and concentrates on the little literature on the durability features of AAMs created using waste glass, such as permeability properties, shrinkage, alkali-silica reaction, and resilience to harsh conditions.

Yuwaraj M. Ghugal et.al (2006) The paper titled "Performance of Alkali-resistant Glass Fiber Reinforced Concrete" by Yuwaraj M. Ghugal and Santosh B. Deshmukh provides an experimental investigation on the effects of alkali-resistant glass fibers on the properties of structural concrete. The study examines the impact of fiber content on workability, density, and various strengths of M20 grade concrete, including compressive strength, flexural strength, split tensile strength, and bond strength. The research shows that the inclusion of glass fibers in the concrete leads to a significant improvement in various strengths. The paper proposes new expressions for various strengths and presents results of elastic constants obtained by different methods. The study concludes that the optimum fiber content depends on the desired strength of the concrete.

Junsuo Yao et.al (2018) The paper investigates the impact resistance of high zirconium alkali-resistant glass fiber reinforced concrete slabs through drop hammer tests and compares it with macro-polypropylene and steel fiber reinforced concrete slabs. The study examines the effects of fiber type and volume fractions on the impact resistance of concrete slabs. It is found that an increase in fiber volume fractions improves the impact resistance of specimens, with slabs exhibiting secondary strengthening properties and experiencing an elastic-plastic phase. The impact resistance of macro-polypropylene fiber reinforced concrete slabs is better than that of glass fiber reinforced concrete slabs at a volume fraction of 0.75%. However, at a volume fraction of 0.45%, the first impact resistance of both types of fibers is similar. The comprehensive analysis suggests that high zirconium alkali-resistant glass fiber reinforced concrete has advantages in the use of the corrosion environment. The study provides insights into the impact behavior of glass fiber reinforced concrete slabs and highlights the superior performance of steel fiber reinforced concrete slabs in terms of cracking characteristics, energy absorption, and integrity upon impact.

Er. Lakshit Guptal et.al (2018) The papers discuss the combined effect of steel and glass fibers on the compressive strength, flexural strength, and durability of concrete, as well as their comparison with conventional concrete. Addition of steel fibers at 0.5% by volume of concrete reduces cracks under different loading conditions and improves the brittleness of concrete. Steel fibers also increase the tensile strength of concrete. Workability of concrete is affected by the addition of fibers, with steel fibers reducing workability compared to other fibers. Glass fibers in split tensile tests reduce crack width with increasing fiber dose. The addition of steel fibers at 0.5% by volume of concrete reduces cracks under different loading conditions. Glass fiber concrete mixes show a percentage increase in compressive strength of 10 to 20% compared to 28 days compressive strength. The use of dual fibers (steel and glass) in concrete increases its ultimate load carrying capacity and stiffness compared to conventional concrete. The compressive strength of dual fiber concrete is maximum at 1.0% total fiber content of steel at 28 days. Steel fiber reinforced concrete exhibits better impact resistance and cracking characteristics compared to glass fiber reinforced concrete.

Ajmal Paktiawal et.al (2021) The study looks at how alkali-resistant glass fibre performs in high-strength concrete, with particular attention to workability, tensile and compressive strengths, % voids, NDT, and sorptivity after 7 and 28 days of curing. In comparison to non-fibrous concrete, the inclusion of glass fibre not only improves the concrete's compressive and tensile strengths but also raises its coefficient of sorptivity and water absorption.

Ajmal Paktiawal et.al (2020) The use of alkali-resistant glass fibre (ARGF) in cement concrete is reviewed experimentally in this work, with particular attention paid to the effects of fibre type and amount on the characteristics of both fresh and cured ARGFRC. It is discovered that ARGF can improve the composite concrete's toughness, weight bearing ability, and stiffness when combined with silica fume.

SUMMARY:

The paragraph discusses experimental examinations on the impacts of fiber content, specifically alkali-resistant glass fibers, on the mechanical qualities and microstructural features of reinforced concrete. Various tests, including compression, flexural, and impact resistance, were conducted. Results indicate that increasing fiber content enhances resistance to brittle failure, ductility, and flexural toughness. Optimal impact resistance is achieved at 1.3% fiber content. The study compares different fiber types and volumes, highlighting the advantages of alkali-resistant glass fibers in corrosion environments. Additionally, it explores the combined effects of steel and glass fibers on concrete properties, emphasizing improvements in compressive strength, flexural strength, and durability. The paper concludes by proposing expressions for various strengths and presenting insights into the impact behavior of glass fiber reinforced concrete slabs.

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