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A Study on Strength Analysis of Steel and Glass Fibre Geopolymer Concrete

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ABSTRACT

This study examines the strength performance of fly ash-based geopolymer concrete reinforced with steel and glass fibres. Geopolymer concrete was prepared as a sustainable replacement for conventional cement concrete by using fly ash as the main binder material. The fly ash was activated with alkaline solutions to develop a strong geopolymer matrix. In this study, glass fibre was kept constant at 0.03%, while steel fibre was varied in different proportions. The results showed that the addition of fibres reduced workability, as the slump value decreased from 125 mm in control geopolymer concrete to 86 mm in Mix 3. However, the hardened properties improved significantly with fibre addition. Mix 3, containing 0.75% steel fibre and 0.03% glass fibre, achieved the best performance under both ambient and heat curing conditions. The study concluded that hybrid fibre reinforced geopolymer concrete improves compressive strength, tensile strength, flexural strength, crack resistance, and durability.

Keywords: *Geopolymer Concrete, Fly Ash, Hybrid Fibres.*

1. INTRODUCTION

Concrete is one of the most important construction materials used in buildings, bridges, roads, and other civil engineering works because of its strength, durability, and easy availability. In conventional concrete, ordinary Portland cement is used as the main binding material. However, cement production releases a large amount of carbon dioxide, which causes environmental pollution and contributes to global warming. To reduce this problem, geopolymer concrete has been developed as a sustainable alternative. In geopolymer concrete, industrial by-products such as fly ash are activated by alkaline solutions like sodium hydroxide and sodium silicate to form a strong binder. Fly ash-based geopolymer concrete helps reduce cement use and improves sustainability. However, concrete is generally weak in tension and may crack under load. Therefore, steel and glass fibres are added to improve toughness, crack resistance, tensile strength, and flexural strength. This study focuses on the strength performance of hybrid fibre reinforced geopolymer concrete.

2. LITERATURE REVIEWS

Vijai, Kumutha, and Vishnuram had examined the performance of glass fibre reinforced geopolymer concrete composites as a possible substitute for conventional Portland cement concrete. Their study had prepared geopolymer concrete using fly ash, alkaline activator solution, ordinary Portland cement, and glass fibres. The researchers had tested important mechanical properties such as density, compressive strength, split tensile strength, and flexural strength. The results had indicated that the inclusion of glass fibres enhanced the tensile and flexural behaviour of geopolymer concrete.

Nematollahi, Sanjayan, Chai, and Lu had studied the fresh and hardened properties of fly ash-based geopolymer concrete containing glass fibres. Sodium hydroxide and sodium silicate solutions were used as alkaline activators. Glass fibres were incorporated in different volume fractions. The study had found that fibre addition reduced workability, but improved density, compressive strength, and flexural strength.

Sathanandam, Awoyera, Vijayan, and Sathishkumar had investigated low-carbon geopolymer concrete using fly ash and glass fibres. Their results had shown that oven-cured specimens achieved better strength than ambient-cured specimens. The study had also reported that glass fibre addition improved tensile strength and overall mechanical performance.

Aswathi and Shahla had studied hybrid fibre reinforced geopolymer concrete using steel and glass fibres. Their research had shown that the combined use of steel and glass fibres improved compressive strength, split tensile strength, and flexural strength. The study had concluded that hybrid fibre reinforcement enhanced crack control and strength performance.

3. METHODOLOGY AND MATERIALS

The methodology of this investigation was arranged systematically to study the strength performance of fly ash-based geopolymer concrete reinforced with steel and glass fibres. Initially, a detailed literature review was carried out to understand geopolymer concrete, alkaline activation, fibre reinforcement, and the behaviour of fly ash-based concrete. After that, the required materials were collected and tested as per relevant IS standards. Low-calcium fly ash was used as the main source material because it contained silica, alumina, and iron oxide, which are suitable for geopolymerization. River sand was used as fine aggregate, while locally available crushed stone aggregate was used as coarse aggregate. Sodium hydroxide and sodium silicate solutions were used as alkaline activators to form the geopolymer binder. Potable water and Conplast SP430 superplasticizer were used to improve mixing and workability. Steel fibres of 50 mm length and glass fibres of 12 mm length were added to improve toughness, crack resistance, and tensile behaviour. The prepared concrete mixes were tested for fresh workability using the slump cone test. Standard cubes, cylinders, and prisms were cast, compacted, cured, and tested for compressive strength, split tensile strength, and flexural strength.

4. CONCLUSION

The present review study concluded that fly ash-based geopolymer concrete reinforced with steel and glass fibres can be considered a sustainable and effective alternative to conventional cement concrete. The use of fly ash as a binder material helped in reducing cement consumption and promoted eco-friendly construction. The addition of hybrid fibres improved the hardened properties of geopolymer concrete, especially compressive strength, split tensile strength, and flexural strength.

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