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IMPACT OF STEEL FIBERS ON THE STRUCTURAL PERFORMANCE OF CONCRETE CORNER JOINTS

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ABSTRACT

The addition of steel fibers to concrete corner joints greatly improves their structural performance, notably in terms of strength, durability, and crack resistance. According to research, steel fibers increase the mechanical properties of self-compacting concrete, making it more resistant to stress and deformation. Experimental studies reveal that concrete corners reinforced with steel fibers perform better under load, lowering the risk of failure at crucial stress locations. Furthermore, the use of steel fibers in beam-column junctions increases shear strength and ductility, resulting in a more resilient structural framework. The use of steel fibers also helps to prevent crack growth, improving the longevity and service life of concrete structures. Overall, the integration of steel fibers into concrete corner joints represents a viable strategy for improving structural integrity and performance, offering substantial benefits in terms of load-bearing capacity and durability.

Keywords: - Steel, Fiber Reinforced Concrete, cyclic loading,

INTRODUCTION

The study of corner joints in simple structural elements like beams and columns is limited, as corner strength significantly impacts joint behavior. Reinforcement details should be straightforward, and structural members meet basic strength requirements. Steel fiber reinforced concrete (SFRC) is an ordinary concrete that contains discontinuities.Discontinuous fibers with short lengths and small diameters. SFRC is a hydraulic cement-based concrete with fine and coarse aggregates and discontinuous discrete fibers. According to ACI committee 544, composites have a wide range of uses, particularly in structural parts. Its current fields of application include highways and airports. Concrete's attractive characteristics enable inventive designs. Concrete has strong compressive strength, stiffness, and low thermal and electrical conductivity, but it is brittle and weak under compression. The creation of fiber reinforced concrete composites has addressed these two shortcomings. Concrete slabs' low strength and strain capacity can be enhanced by adding fibres like glass, steel, synthetic, and natural fibres. The material behavior of fibre reinforced concrete depends on dosage and fiber characteristics. Steel fibres are a widely researched and practical fiber used in steel fibre reinforced concrete. This type of concrete contains randomly oriented discrete steel fibres, aiming to control crack widening and propagation after the concrete matrix has cracked. This control significantly improves the mechanical properties of the composite material. Steel fibres, typically carbon steel or stainless steel, are used in structures for corrosion-resistant properties. They have tensile strengths ranging from 200-2600 MPa and ultimate elongations between 0.5% and 5%. However, strong fibres can negatively impact reinforcing efficiency, as pull-out experiments show that high tensile strength steel fibres cause more severe matrix spalling around the fibre exit point in low-strength matrices.

Steel Properties

Steel possesses several properties that make it an ideal material for reinforcing concrete. These properties include:

1. **High Tensile Strength**: Steel's high tensile strength enhances the load-bearing capacity of concrete structures, preventing sudden failure under stress.
2. **Ductility**: The ability of steel to undergo significant deformation before failure contributes to the overall flexibility and resilience of reinforced concrete.
3. **Corrosion Resistance**: Modern steel alloys are often treated or combined with other elements to improve their resistance to corrosion, thus extending the lifespan of the structures they reinforce.

4. **Thermal Conductivity**: Steel's thermal properties ensure that it can withstand varying temperatures without significant degradation.
5. **Bonding with Concrete**: Steel fibers bond effectively with the concrete matrix, ensuring a uniform distribution of stress across the structure.

Materials

To achieve the objectives of the present investigation, following materials were used

1. Cement
2. Fine Aggregate
3. Coarse Aggregate
4. Steel Fibers
5. Steel Bars
6. Water
7. Superplasticizer

Table .1 Properties of Steel Fiber

S. No	Property	Test Value
1	Material	Galvanized Mild Steel
2	Diameter	0.9mm,1.2mm,1.5mm,2mm
3	Length of fiber	36mm,48mm,60mm,80mm
4	Aspect Ratio	40
5	Youngs Modulus	2 x10^5Mpa

Table 2 properties of Steel

Diameter (mm)	Young's Modulus of Elasticity (N/mm^2)	Yield Stress N/mm^2	Ultimate Stress N/mm^2
12	2.35 x10^6	650	720

The study tested specimens C1, C2, and C3 with fibers. Results showed a decrease in deflection for C2 with 1.0% fibers compared to C1 with 0.5% fibers. This decrease was 14.94% at 1KN load, 22.84% at 2.0KN load, and 7.42% at 3KN load. C3 with 1.5% fibers also experienced a decrease in deflection by 18.81% at 1KN load, 13.91% at 2KN, and 6.43% at 3KN load.

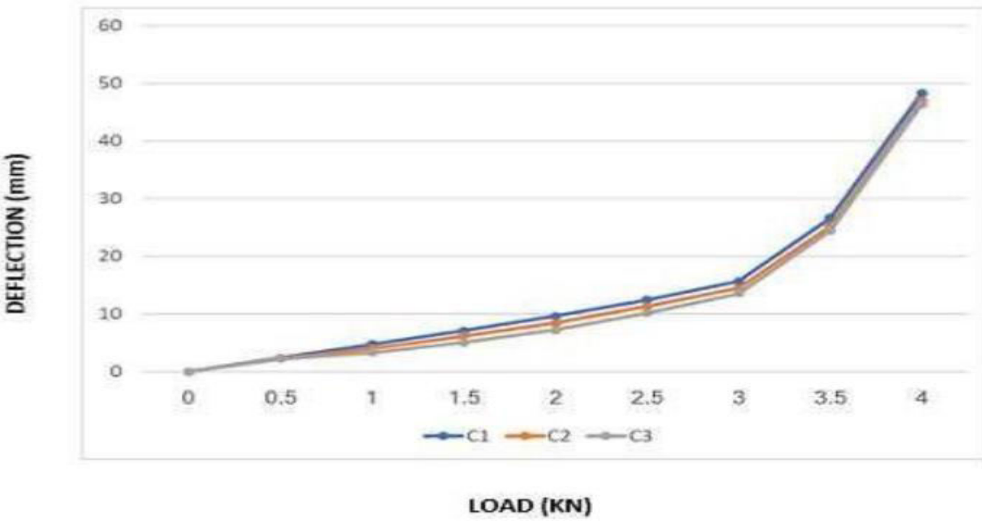

Figure 1. Combined graph for deflection at different %ages of fibers (C1, C2, & C3)

Reinforced Concrete and Its Impact

Reinforced concrete, which combines the compressive strength of concrete with the tensile strength of steel, has become a staple in construction. The addition of steel fibers to concrete, known as Steel Fiber Reinforced Concrete (SFRC), enhances its mechanical properties and structural performance. This section delves into the specific impacts of steel fibers on concrete corner joints.

Improved Structural Performance

1. **Increased Strength**: The incorporation of steel fibers significantly increases the compressive, tensile, and flexural strength of concrete. Studies have shown that steel fibers improve the post-cracking behavior of concrete, leading to higher load-bearing capacities [2].
2. **Enhanced Ductility**: Steel fibers impart ductility to concrete, allowing it to absorb and dissipate energy more efficiently during load application. This property is particularly beneficial in seismic regions where structures are subjected to dynamic loads.
3. **Crack Control**: One of the most significant benefits of steel fibers is their ability to control crack propagation. The fibers bridge cracks as they form, preventing them from widening and thus maintaining the structural integrity of the concrete [3].

Experimental Studies and Results

1. **Load-Displacement Behavior**: Experimental studies have shown that steel fiber-reinforced concrete exhibits superior load-displacement behavior compared to conventional concrete. This behavior is indicative of improved energy absorption and resistance to dynamic loads [4].
2. **Shear Strength**: The inclusion of steel fibers enhances the shear strength of concrete corner joints. This improvement is crucial in regions where joints are subjected to high shear forces, such as in beam-column connections [5].

3. **Durability**: Steel fibers contribute to the long-term durability of concrete structures by reducing permeability and improving resistance to environmental degradation. This results in a longer service life for reinforced structures [6].

PRACTICAL APPLICATIONS

1. **Seismic Design**: The enhanced ductility and crack control provided by steel fibers make SFRC an excellent choice for structures in seismic regions. The ability to absorb and dissipate energy during an earthquake reduces the likelihood of catastrophic failure.
2. **Industrial Floors**: Steel fibers are commonly used in the construction of industrial floors due to their ability to withstand heavy loads and reduce the formation of cracks.
3. **Bridges and Tunnels**: The durability and strength of SFRC make it ideal for infrastructure projects such as bridges and tunnels, where long-term performance is critical.

CONCLUSION

Steel fiber reinforced concrete (SFRC) is an ordinary concrete including discontinuities. Discrete fibers with short lengths and small diameters. SFRC is a hydraulic cement-based concrete that contains fine and coarse aggregate as well as discontinuous discrete fibers. According to ACI committee 544, the composite has the potential for a wide range of applications, particularly in structural parts. Its current fields of application include highway and airfield.Concrete's attractive characteristics make it suitable for various unique designs. Concrete techniques have great compressive strength and stiffness, as well as low thermal and electrical conductivity, but they are brittle and weak in tension. Fiber reinforced concrete composites have addressed these two problems.

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