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Steel Fiber-Reinforced Concrete: From Material Design to Structural Performance: A Review

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ABSTRACT

Steel Fiber Reinforced Concrete (SFRC) has been developed as a high-performance material that can overcome the limitations of conventional concrete, especially its low tensile strength. This review aims to provide a critical evaluation of SFRC by correlating its material design properties with its mechanical properties. Emphasis has been given to the fiber properties, especially its geometry, aspect ratio, dosage rate, and distribution. The fiber properties are important at both the micro-level and the macro-level. The fiber-matrix bond, especially at the interfacial transition zone (ITZ), plays a crucial role. The crack-bridging mechanism has been identified as the main contributor to the improved tensile strength, bending strength, toughness, and post-crack load capacity. SFRC has also shown promising results in terms of compressive strength, impact resistance, fatigue resistance, and durability. SFRC has shown promising results at the structural level, especially in beams, slabs, pavements, and seismic-resistant structures. SFRC can provide ductility and increase the life of structures, thereby reducing the amount of conventional reinforcement used. However, there are some limitations, especially with regard to the standardization of designs and the durability of SFRC.

1. Introduction

Steel Fiber-Reinforced Concrete (SFRC), as a novel building material, has shown tremendous promise as a viable alternative to the limitations of conventional concrete, which include low tensile strength, high brittleness, and a tendency to crack under load. The introduction of steel fibers into the concrete mix has a profound impact on the mechanical properties of concrete, improving its ductility, cracking resistance, and energy absorption capacity [1, 2].

In the past few decades, the increasing need for high-performance and long-life structures has led to the rapid evolution of fiber-reinforced materials, among which SFRC has gained prominence for its capacity to bridge macro/micro-cracks, thereby reducing the time

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to crack initiation and limiting the extent of crack propagation under a wide range of loading conditions [3]. This feature of SFRC is of critical importance to structures that are likely to experience extreme loading, including seismic, impact, and fatigue loading, which can lead to the premature failure of conventional concrete materials [4].

From the point of view of material design, the properties of SFRC are influenced by many interrelated factors, such as fiber type, geometry, aspect ratio, dosage, and distribution within the matrix. Several studies have shown that the optimization of all these factors can lead to substantial improvements in the mechanical properties of SFRC, such as tensile strength, flexural strength, and toughness [5-6]. For instance, fibers with high aspect ratios and effective anchorage (such as hooked-end fibers) have shown better performance in resisting openings and improving the transfer efficiency [1].

One of the major factors that can significantly influence the efficiency of SFRC is the interaction between the fibers and cement matrix, particularly within the interfacial transition zone (ITZ). The ITZ is one of the most important areas that can significantly influence the transfer efficiency and has been found to be critical for governing the stress transfer within SFRC. Despite its importance, the microstructural characteristics of the interfacial transition zone within SFRC have not been adequately explored and thus require further investigation [7].

In terms of structural benefits, SFRC has proven to possess considerable advantages in numerous engineering fields, such as beams, slabs, pavements, tunnels, and industrial floors. The ability of SFRC to improve the load-carrying capacity, minimize the width of cracks, and enhance the durability of structures has led to its application in conventional and advanced construction techniques [8-9]. Moreover, the partial or complete substitution of conventional reinforcement in specific fields has proven to possess considerable benefits, particularly with regard to reducing construction time and labor costs. SFRC also contributes to sustainability in the construction sector. The improved durability and increased lifespan of SFRC structures minimize the maintenance and construction materials used. Furthermore, recent research has attempted to minimize the environmental impact of SFRC structures using recycled fibers and supplementary cementitious materials [10-11]. The present body of research on SFRC has proven significant developments with regard to the understanding of the material and structural benefits. Initial research on SFRC has centered on fundamental mechanical properties, where significant relationships were established between the percentage of fibers and the enhancement of tensile strength and ductility [2]. Recent research has attempted to expand the understanding of SFRC performance by evaluating the effects of fiber geometry, distribution, and hybridization on the final performance outcomes [1].

More recent studies have focused on the use of advanced experimental and numerical techniques, such as finite element modeling, to better understand the behavior of SFRC under complex loading conditions [12-13]. Such studies have led to a better understanding of the crack propagation mechanisms, energy absorption capacity, and failure of SFRC, which has improved the overall reliability of the material for structural applications.

Despite the progress made in the research of SFRC, some critical challenges and research gaps still exist, which must be addressed for better application of the material in the future. The major limitations of SFRC include the lack of clear understanding of the fiber orientation and distribution within the concrete matrix, which can affect the overall mechanical properties of the composite and lead to variations in the results obtained from the experimental testing of the material [7]. The design codes and guidelines currently available for the design of concrete structures are more or less based on conventional reinforced concrete design principles, which do not account for the unique post-cracking behavior of SFRC, as observed during strain hardening [14]. The lack of long-term durability studies that assess the overall performance of SFRC under aggressive environmental conditions is another critical gap in material research, as the effects of freeze-thaw cycles, chemical attacks, and high-temperature exposure on the durability of the composite are still unknown [15]. Although the use of SFRC as a more sustainable building material has become a major research topic in recent times, the overall life cycle assessments of the material, especially considering the use of alternative materials, are relatively few in number [3]. Therefore, considering the critical challenges and research gaps associated with the use of SFRC, it can be concluded that the only way to obtain a better and more comprehensive understanding of the material is to adopt a multi-scale approach that can facilitate the development of advanced design methodologies for the material in the future.

2. Material Design of Steel Fiber-Reinforced Concrete (SFRC)

The physical properties of Steel Fiber Reinforced Concrete (SFRC), in general, have a significant impact on its mechanical properties and durability. Unlike ordinary concrete mixes, in which the properties depend on the cement paste and aggregate properties, SFRC has additional complexities owing to the presence of steel fibers and their interaction with the matrix. Therefore, to achieve the best properties in SFRC mixes, it is essential to have a clear understanding of the properties of the fibers and the parameters involved in the mixture design and their interaction with the matrix [5-7]. Recent studies have focused on the importance of optimizing the parameters involved in mixture design to achieve better ductility and resistance to cracks. For example, it was emphasized in [5] and [16] that the properties of the fibers have a significant impact on the mechanical properties and workability of the mixture. In addition, as demonstrated in [17], mixture designs can be tailored to suit specific construction needs using advanced construction techniques such as slip forming.

2.1 Types and Characteristics of Steel Fibers

Steel fibers used in SFRC can generally be classified according to the fiber geometry, anchorage mechanism, and manufacturing processes. Steel fibers may be available in straight, hooked-end, crimped, or twisted forms.

Hooked-end steel fibers have better pull-out resistance due to mechanical anchorage, thus significantly improving the crack bridging and post-cracking properties [1-7]. The experimental results obtained by [18] also indicate that fiber geometry plays a vital role in improving the compressive strength and toughness, especially for SIFCON mixtures. However, straight steel fibers rely only on the interfacial bond strength and perform poorly at high stress levels.

Crimped and twisted steel fibers have better mechanical interlocking properties, thus improving the fracture toughness and energy absorption [19-20]. Moreover, hybrid steel fibers have been reported to exhibit better ductility and strength properties [21].

The fiber geometry is often characterized using aspect ratios (l/d), which play a vital role in improving the reinforcing properties. Higher aspect ratios improve tensile strength and ductility. However, excessively high aspect ratios may cause poor workability and fiber agglomeration [5-22].

2.2 Mix Design Considerations

The mix design of SFRC is significantly affected by the addition of fibers. The parameters that need to be considered in the mix design of SFRC include the water-binder ratio, aggregate gradation, fibers, and chemical admixtures.

The addition of steel fibers to the concrete mixture reduces the workability owing to friction. This problem can be overcome by adding superplasticizers to the mixture to maintain workability without adding more water to the mixture [6-23]. In addition, the addition of supplementary cementitious materials to the mixture improves cohesion and dispersion. Experimental investigations by Gupta [25] showed that the addition of optimized fibers to the mixture improves the compressive strength of the mixture. Verma, K. [2] showed that excessive addition of fibers to the mixture can reduce workability and uniformity. Generally, the addition of fibers to the mixture varies from 0.5 to 2.0% [17].

2.3 Influence of Fiber Geometry, Aspect Ratio, and Dosage

The combined influence of fiber geometry, aspect ratio, and dosage plays a vital role in controlling the reinforcing efficiency of SFRC, which affects crack formation and propagation.

Increasing dosages help to control cracks more effectively owing to the increased number of bridged fibers. However, excessive dosages may cause agglomeration and nonuniform distribution [3-26]. The study carried out by [27-28] proves that optimized aspect ratios enhance the stress transfer efficiency and toughness.

Hybrid fibers have been found to enhance crack distribution and delay localization, thereby improving the mechanical properties [20-21].

2.4 Fiber–Matrix Interaction and Interfacial Transition Zone (ITZ)

Steel fiber-cement matrix interaction in the interfacial transition zone is considered an important factor in controlling SFRC properties.

The ITZ plays an important role in controlling the bond strength and stress transfer mechanisms, which in turn directly affects the crack-bridging efficiency. Research by Senapathi [12] and Zhang [29] indicated that fiber orientation is an important factor in controlling mechanical properties.

Advanced modeling of SFRC properties by Lifshitz [30] indicated that better ITZ properties improve fiber load transfer and delay fiber pull-out. Poor interface properties cause fiber pull-out, resulting in inefficient reinforcement.

2.5 Role of Admixtures and Supplementary Materials

Admixtures and supplementary cementitious materials are important for improving the performance of SFRC. Superplasticizers improve the workability of the mix, making it easy to distribute the fibers uniformly. The use of silica fume and fly ash improves the densification of the matrix [6-31].

Research on the sustainability of SFRC, including the works of [31-32], shows that incorporating recycled materials into SFRC is feasible without compromising its mechanical performance.

2.6 Challenges in Material Design

Despite its advantages, SFRC has some challenges associated with its material design, including the need for a uniform distribution of fibers, workability, elimination of fiber balling, and cost efficiency [3-24].

Furthermore, the issue of fiber orientation variability has a substantial effect on the SFRC performance, as emphasized by [26-29].

3. Mechanical Properties and Crack Bridging Mechanisms of SFRC

The mechanical properties of Steel Fiber-Reinforced Concrete (SFRC) signify a paradigm shift in the conventional behavior of concrete owing to the active role of steel fibers in stress transfer and control of crack propagation and development. Unlike plain concrete, which undergoes brittle failure immediately after the formation of cracks, SFRC demonstrates ductile behavior with increased energy absorption capacity, delayed development of cracks, and considerable residual strength [1-2- 5]

The primary cause of this improved behavior of SFRC is the bridging action of the steel fibers, which converts the localized failure of concrete to a diffuse failure process. Recent research has also highlighted the role of fiber orientation, distribution, and bonding in this process [3- 6-7-26].

3.1 Compressive Behavior and Post-Peak Response

Although steel fibers are not expected to contribute to an increase in compressive strength, they do affect the compressive response owing to the improved crack arrest mechanism and internal confinement.

Experimental observations indicate that SFRC has an increased compressive strength, ranging from 5 to 20%, depending on the dosage rate and matrix composition [23-25-33]. However, the most significant effect of the inclusion of steel fibers is on the post-peak response, where the SFRC has a reduction in stress, unlike the rapid reduction observed in the control mix.

This improved ductility is due to the restraining effect of steel fibers on the propagation of cracks, thus ensuring the structural integrity of the mix [2-6]. Recent research has also shown that under extreme conditions, such as high temperatures, steel fibers improve the compressive properties [31-34].

3.2 Tensile Behavior and Post-Cracking Response

The tensile properties of SFRC have the most significant impact compared to those of conventional concrete. Steel fibers can effectively transfer tensile stresses across cracks. This improves the tensile properties and resistance of SFRC to cracking [1-5-35].

Several studies have shown that the fracture energy and ductility of concrete increase significantly with the addition of steel fibers [3-6-36]. In addition, the resistance to cracking also improves significantly in SFRC compared to conventional concrete. However, the improvement depends to a great extent on the orientation and distribution of the steel fibers. These are the main parameters that have affected the results of experiments conducted to date [7-26]. It has also been observed that SFRC can exhibit either strain-softening or strain-hardening behavior. The strain-hardening behavior of SFRC is highly desirable. This behavior leads to microcracking in concrete. This improves the durability of concrete [19-37].

Recent studies have shown that the use of a combination of fibers in SFRC can significantly improve its properties. This is known as a hybrid system [20-21]. However, optimizing the properties of a hybrid system is quite complex owing to its nonlinear properties.

3.3 Flexural Behavior and Toughness Characteristics

Flexural performance is one of the key parameters for measuring the efficiency of SFRC based on its capacity to withstand bending stresses and control cracks.

Experimental studies have proven that steel fibers contribute to improved flexural strength, increasing it by 25-40% [2-5-38]. More remarkably, however, there was an improvement in toughness, which is a measure of the capacity to absorb energy before failure.

This is because of the sustained load transfer across cracks, which prevents failure and increases reliability [1-19-23].

While standardized methods such as EN 14651 provide essential parameters for measuring residual strength, they have limited applications and require further development [7-39].

3.4 Crack Bridging Mechanism (Fundamental Mechanism)

The crack-bridging mechanism is the fundamental principle behind the behavior of SFRC materials. Fibers that cross the crack act as stress transfer devices that maintain continuity between the separated matrix regions.

Crack bridging occurs in a series of steps, including the formation of an elastic bond, debonding, pull-out, and rupture of the fiber. The efficiency of the mechanism relies on the geometry of the fiber, its anchorage, and the interfacial properties of the fiber [1-7-12]

The hooked-end fibers show the best performance owing to the mechanical anchorage of the fiber, whereas the fiber orientation plays a major role in the efficiency of the bridging mechanism [7–26]. The recent modeling of this phenomenon confirms that the fiber-matrix interaction is important for accurately modeling the behavior of the structure [30].

3.5 Role of Fiber–Matrix Interaction and ITZ

The role of the Interfacial Transition Zone (ITZ) in controlling the bond properties and stress transfer between the fibers and matrix is significant.

A dense ITZ improves the efficiency of load transfer and delays fiber pull-out, thereby improving the mechanical properties of the composite [7-30]. Conversely, poor interface properties result in debonding and reduced efficiency.

Recent studies using advanced imaging and numerical techniques have emphasized that the properties of the ITZ, fibers, and matrix together control the properties of SFRC [12].

3.6 Impact Resistance and Fatigue Performance

SFRC demonstrates improved performance under dynamic and cyclic loading conditions owing to its improved energy absorption capacity.

Steel fibers delay the propagation of cracks and decrease the rate of crack growth, thus improving the impact resistance of the composite.

The fiber distribution in SFRC has also been observed to affect fatigue performance; thus, there is a need for improved control methods.

3.7 Durability and Long-Term Performance

The durability of SFRC is closely related to its ability to control cracks. The limitation of the width of cracks by steel fibers helps to restrict the entry of harmful substances, such as chlorides, moisture, and sulfates, into the concrete mixture. This improves its durability [6-11-15].

It has also been observed that SFRC exhibits better resistance to freeze–thaw actions, high temperatures, and chemical attacks [31-40]. However, there is a lack of sufficient long-term durability results, especially under harsh exposure conditions and for large structures [3-24].

3.8 Synthesis of Mechanical Performance of SFRC

To create an integrated understanding of the mechanical performance of Steel Fiber-Reinforced Concrete (SFRC), the main findings of previous research on SFRC are compiled in Table 1. Table 1 lists the key factors affecting the performance of Steel Fiber-Reinforced Concrete (SFRC).

As shown in Table 1, recent research on Steel Fiber-Reinforced Concrete (SFRC) conducted between 2020 and 2026 has revealed improved performance in terms of tensile strength, flexural performance, toughness, and durability owing to the addition of steel fibers. The improved durability of Steel Fiber-Reinforced Concrete (SFRC) has also been observed under harsh environmental conditions such as freeze-thaw cycles, chloride attack, and high-temperature exposure. However, some research gaps have also been identified, such as the lack of long-term real-field performance, insufficient multi-axial loading tests, and the lack of unified predictive models for structural design.

4. Structural Applications and Design Implications of SFRC (Enhanced Version)

The transfer of material-level improvements into structural performance represents a crucial step in evaluating the engineering feasibility of steel fiber-reinforced concrete. Although the improvement in mechanical properties has already been well established, the real value of SFRC can be found in its potential to enhance structural efficiency, serviceability, and durability across a wide range of engineering applications [1-3-5].

In contrast to conventional reinforced concrete structures that utilize discrete reinforcement bars, SFRC provides a continuous reinforcement mechanism. This change allows for improved stress distribution and crack management. This process can be used for performance-based designs, where material properties directly influence structural performance [2-7-30].

4.1 SFRC in Beams and Flexural Members

The application of SFRC in beams has resulted in significant improvements in terms of flexural behavior, control of cracks, and ductility. Experimental and numerical investigations have consistently shown reduced crack widths, improved stiffness after cracking, and increased load-carrying capacity compared to conventional RC beams [9-35-39].

Steel fibers have also shown improvements in shear resistance and have partially replaced conventional shear reinforcement in the form of stirrups. This results in improved constructability and reduced congested reinforcement in the members. However, the effectiveness of this replacement has been largely dependent on the orientation and distribution of fibers in the member, which has resulted in variability in terms of performance [7-26].

Additionally, recent investigations based on optimization techniques have shown promising results for topology optimization and hybrid reinforcement to improve the performance of beams. This can be seen as a trend towards more efficient and intelligent approaches in designing members [53-54].

4.2 Slabs, Pavements, and Industrial Floors

SFRC has gained popularity for use in slabs on grade, pavements, and industrial flooring owing to its high crack control and fatigue resistance. Steel fibers help reduce shrinkage cracks and improve load distribution, enabling thinner slabs to be used [1-8-11].

Furthermore, SFRC displays increased resistance to repeated loads and impacts. This makes SFRC suitable for heavy-duty applications such as airport pavements and industrial flooring [2-24-37]. However, field performance depends on the fiber distribution and orientation, which are still two of the biggest challenges facing SFRC [7].

Table 1: Summary of selected studies on the mechanical performance of Steel Fiber-Reinforced Concrete (SFRC).

Author (Year)	Main Findings	Research Gap
Marcos-Meson et al. (2021) [41].	SFRC maintained mechanical performance under chloride–carbonation exposure; toughness was governed more by fiber distribution than corrosion damage.	Limited long-term studies beyond two years and large-scale structural validation.
Amin et al. (2022)[42].	A comprehensive review showed significant improvement in tensile strength, ductility, and crack-bridging behavior due to fibers.	Lack of unified constitutive models for design applications.
Wu et al. (2024)[43].	Multi-axial loading on geopolymer SFRC improved the strength and sustainability performance.	Insufficient experimental data under complex stress states.
Wang et al. (2024)[44].	Freeze–thaw cycles reduced stiffness, but fibers enhanced dynamic mechanical stability and crack resistance.	Need for coupled environmental–mechanical degradation models.
Zhao et al. (2024)[45].	The fiber type significantly influenced the shear strength and structural performance of SFRC beams.	Lack of standardized comparative frameworks for fiber geometry effects.
Li et al. (2024)[46].	Recycled aggregate SFRC showed improved compressive-shear strength and toughness with fiber addition.	Limited understanding of the long-term durability of recycled SFRC systems.
Zhang et al. (2024)[47].	Stray current exposure caused degradation in the compressive and tensile properties, and SCMs improved durability.	Few studies have been conducted on the electrochemical degradation mechanisms of SFRC.
Chen et al. (2024)[48].	Dynamic loading increased the compressive strength of the SFRAC, the and strain rate significantly influenced the failure modes.	Lack of predictive models incorporating strain rate effects.
Liu et al. (2024)[49].	Long-term sulfuric acid exposure showed that SFRC retains acceptable mechanical properties with gradual degradation.	Need for multi-environment durability studies (chemical and mechanical).
Meng et al. (2024)[50].	Cohesive zone modeling successfully captured the crack propagation and fiber bridging mechanisms.	Limited validation using full-scale experimental data.
Review (2024, JBE)[51].	SFRC significantly enhances fracture toughness, crack resistance, and durability across applications.	Need for integration between microstructural analysis and structural design.
Hafez et al. (2025)[52].	Novel fiber geometries (dog-bone) improved the flexural toughness and re-centering behavior.	Limited research has been conducted on the optimization of the fiber shape for specific applications.

4.3 Columns and Load-Bearing Elements

The use of SFRC in columns improves the ductility, confining, and post-peak properties. Steel fibers help to control the propagation of cracks and spalling, which improves the stability of structures under compressive forces [33-34].

4.4 Tunnels and Underground Structures

SFRC is also used in the lining of tunnels and underground structures, particularly in shotcrete works. The advantages of SFRC are improved early strength, improved resistance to cracks, and reduced need for conventional reinforcement systems [8-53].

The above characteristics of SFRC are important for improving the efficiency and safety of the construction process in complex geological conditions. SFRC also has improved durability under extreme environmental conditions, including exposure to moisture, pressure, and temperature changes [15-31]. However, the long-term behavior of SFRC under extreme environmental conditions has not yet been adequately investigated.

4.5 Seismic Performance and Energy Dissipation

The superior properties of SFRC under seismic loading can be attributed to its improved ductility and energy absorption capacity. Steel fibers help improve the distribution and localization of cracks, thereby reducing structural vulnerability [4-54].

Experimental and analytical results have verified improved hysteretic properties and reduced stiffness degradation in SFRC members subjected to cyclic loading [35-37]. However, one drawback is that seismic design codes for SFRC have not yet been standardized.

4.6 Design Implications and Code Limitations

The use of SFRC in the design of structures is limited by the lack of design codes that can account for the behavior of SFRC. The available design codes are mainly based on conventional RC, and the post-cracking behavior, residual capacity, and fiber orientation effects are not considered [7-14-39].

Although design codes such as EN 14651 can be used for the evaluation of the flexural

In seismic zones, columns made of SFRC exhibit better deformation capacity and energy dissipation, which are critical for the seismic resistance of structures [35-43]. However, the currently available design models underestimate the role of fibers, and more accurate predictive tools are required for the same [30].

behavior of SFRC, their use in design practice is limited.

4.7 Practical Challenges in Structural Implementation

Although there are many advantages associated with SFRCs, there are some limitations to their widespread use. For instance, there are difficulties associated with uniform fiber distribution, workability problems at high fiber percentages, and cost factors [3-24].

The variability in fiber orientation during casting is another major factor that influences the performance of the structures. This has been shown to lead to inconsistencies in experimental and actual field values [7-26].

4.8 Future Directions in Structural Applications

The future of SFRC research lies in the development of performance-based design approaches that can make the best use of the mechanical properties of SFRC. Numerical models with fiber characteristics, crack bridging, and fiber orientation are critical for the accurate prediction of SFRC performance [12-30].

Moreover, the development of sustainable SFRC using recycled fibers and green binders has tremendous environmental benefits [10-11]. Emerging technologies in SFRC development include artificial intelligence, topology optimization, and additive manufacturing technologies, which are seen to have great promise in the future of SFRC development [3-55].

5. Conclusion and Future Perspectives

This review offers a comprehensive synthesis of the state of knowledge on steel fiber-reinforced concrete (SFRC), with specific attention paid to the crucial relationship between material design, microstructural behavior, and structural performance. The review findings clearly established that the addition of steel fibers significantly modifies the mechanical properties of concrete materials, shifting their brittle behavior to a more ductile and energy-absorbing composite material that can carry substantial loads after cracking.

In terms of material behavior, the performance of SFRC materials is significantly affected by the characteristics of the added fibers, including their geometry, aspect ratio, and distribution. These factors have a direct influence on the fiber-matrix interactions, especially in the interfacial transition zone (ITZ), where the transfer of stress and crack propagation are critical. Optimizing these interactions is crucial for the development of materials with increased tensile strength, toughness, and crack control.

In terms of mechanical behavior, SFRC materials have shown significant improvements over conventional concrete materials, especially in terms of increased tensile and flexural strengths as well as improved impact and fatigue resistance. The crack-bridging mechanism has emerged as the principal mechanism for these improvements, allowing stress redistribution across cracked sections of materials and thereby preventing sudden failure.

From a structural point of view, SFRC has proven to have great potential in all types of applications, including beams, slabs, pavements, tunnels, and load-carrying members. This ability of SFRC to partially replace conventional reinforcement, enhance energy dissipation, and extend service life makes it a highly attractive material for modern infrastructure systems. However, despite the advantages of SFRC, its widespread adoption is restricted owing to the absence of unified design methodologies and the integration of SFRC in structural codes.

The review also identifies certain critical research needs to be addressed in the future to make the best use of SFRC. These requirements include the need for further understanding the effects of fiber orientation, the development of models for the prediction of the behavior of SFRC after the onset of cracking, and the development of performance-based design approaches that include the characteristics of fiber-reinforced concrete. In addition, the long-term durability of SFRC under severe environmental conditions requires further study.

From the point of view of sustainability, the use of recycled fibers and supplementary cementitious materials is considered a promising way of reducing the environmental footprint of SFRC. Therefore, future research should focus on the development of eco-efficient SFRC.

In conclusion, SFRC is considered a major breakthrough in the field of concrete technology. This is due to the fact that SFRC has the ability to enhance the material properties of concrete on all scales, thereby bridging the gap between material science and structural engineering.

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