A Review on Steel Fiber Reinforced Concrete

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Abstract: Concrete is most widely used construction material in construction industry. Brittleness of concrete is fails to handle tensile loading which leads to brittle failure. Fibers have the property to enhance the toughness of concrete. It is found that Steel fiber reinforced concrete have superior resistance to cracking so the intention behind the increasing usage of SFRC is to increase the toughness and to reduce the crack deformation characteristics. This paper presents a theoretical discussion on the subject of steel fiber-reinforced concrete, SFRC. It discusses commonly used terms and models of behavior that form a basis for understanding material performance without presenting mathematical details. In this research it is shown that flexural strength of steel fiber reinforced concrete is directly proportional to the steel fiber content and inversely proportional to the water□cement ratio. Different references from both early and contemporary authors are included as a means of tying the subject together along a time line. Historical review is intended to help build a background for what is currently understood about SFRC rather than as historical reporting.

Keywords: Steel Fibers, Fiber reinforced concrete, Cement, Ductility, Strength, Toughness

I. INTRODUCTION

Fibers used in cement-based composites are primarily made of steel, glass, and polymer or derived from natural materials. Fibers can control cracking more effectively due to their tendency to be more closely spaced than conventional reinforcing steel bars. Steel Fibers are used to prevent/control plastic and drying shrinkage in concrete. In this paper we are reviewing the effects of addition of Steel Fibers in concrete, and investigates the mechanical properties, and applications of steel fiber reinforced concrete (SFRC).When steel fibers are added to mortar, Portland cement concrete or refractory concrete, the flexural strength of the composite is increased from 25% to 100% - depending on the proportion of fibers added and the mix design. Steel fiber technology actually transforms a brittle material into a more ductile one. Catastrophic failure of concrete is virtually eliminated because the fibers continue supporting the load after cracking occurs. The steel fibers are manufactured either deformed or hook end, and available in lengths from 30 mm to 60 mm and aspect ratios between 20 and 100. Steel fiber reinforced concrete is a castable or sprayable composite material of hydraulic cements, fine, or fine and coarse aggregates with discrete steel fibers of rectangular cross-section randomly dispersed throughout the matrix. Steel fibers strengthen concrete by resisting tensile cracking. Fiber reinforced concrete has a higher flexural strength than that of unreinforced concrete and concrete reinforced with welded wire fabric. But unlike conventional reinforcement – which strengthens in one or possibly two directions – Steel fibers reinforce iso tropically, greatly improving the concrete's resistance to cracking, fragmentation, spalling and fatigue.

When an unreinforced concrete beam is stressed by bending, its deflection increases in proportion with the load to a point at which failure occurs and the beam breaks apart.. The load at which the first crack occurs is called the "first crack strength". The strength of first crack is generally proportional to the amount of fiber in the mix and the concrete mix design.

Two theories have been proposed to explain the strengthening mechanism. The first proposes that as the spacing between individual fibers become closer, the fibers are better able to arrest the propagation of micro cracks in the matrix. The second theory tells that the strengthening mechanism of fiber reinforcement relates to the bond between the fibers and the cement. It has been shown that micro cracking of the cement matrix occurs at very small loads. Steel fibers, then service as small reinforcing bars extending across the cracks. So till when the bond between the fibers and cement matrix remains intact the Steel fibers can carry the tensile load. The surface area of the fiber is also a factor in bond strength. Bond strength can also be enhanced with the use of deformed steel fibers, which are available in a variety of sizes.

1.1 Different Types of Fibers

In the view of modulus of elasticity, fibers can be classified into two basic categories, namely, hard intrusion; those having a higher elastic modulus than concrete mix and soft intrusion; those with lower elastic modulus than the concrete mix. Low elastic modulus fibers are Steel, carbon and glass have higher elastic modulus than cement mortar matrix, and polypropylene and vegetable fibers and they can improve the impact resistance of concrete but do not contribute much to its flexural strength whereas High elastic modulus fibers simultaneously can improve both flexural and impact resistance. According to the origin of fibers, they are classified in three categories of metallic fibers (such as steel, carbon steel, and stainless steel), mineral fibers (such as asbestos and glass fibers), and organic fibers. Organic fibers can be further divided into natural and man-madefibers.

1.2 Reinforcement Mechanisms in Fiber Reinforced (FRC):

In the hardened state, when fibers are properly bonded, they interact with the matrix at the level of micro-cracks and effectively bridge these cracks thereby providing stress transfer media that delays their coalescence and unstable growth. If the fiber volume fraction is sufficiently high, this may result in an increase in the tensile strength of the matrix. Indeed, for some high volume fraction fiber composite, a notable increase in the tensile flexural strength over and above the plain matrix has been reported. Once the tensile capacity of the composite is reached, and coalescence and conversion of micro-cracks to macro-cracks has occurred, fibers, depending on their length and bonding characteristics continue to restrain crack opening and crack growth by effectively bridging across macro-cracks. This post peak macro-crack bridging is the primary reinforcement mechanisms in majority of commercial fiber reinforced concrete composites

II. LITERATURE REVIEW

- **Vikrant S Vairagade (2012) et al** this paper deals with Experimental investigation for M-20 grade of concrete to study the compressive strength, and tensile strength of steel fiber reinforced concrete (SFRC) containing fibers of 0% and 0.5% volume fraction of hook end Steel fibers of 50 and 53.85 aspect ratio were used. A result data obtained has been analyzed and compared with a control specimen (0% fiber). A relationship between Compressive strength vs. days, and tensile strength vs. days represented graphically. Result data clearly shows percentage increase in7 and 28 days Compressive strength and Tensile strength for M-20 Grade of Concrete. [1]

- **A.M. Shende (2012) et al** Critical investigation for M-40 grade of concrete having mix proportion 1:1.43:3.04 with water cement ratio 0.35 to study the compressive strength, flexural strength, Split tensile strength of steel fiber reinforced concrete (SFRC) containing fibers of 0%, 1%, 2% and 3% volume fraction of hook tain. Steel fibers of 50, 60 and 67 aspect ratio were used. A result data obtained has been analyzed and compared with a control specimen (0% fiber). A relationship between aspect ratio vs. Compressive strength, aspect ratio vs. flexural strength, aspect ratio vs. Split tensile strength represented graphically. Result data clearly shows percentage increase in 28 days Compressive strength, Flexural strength and Split Tensile strength for M-40 Grade of Concrete. [2]

- **Milind V Mohod (2012) et al** in this experimental investigation for M30 grade of concrete to study the compressive strength and tensile strength of steel fibers reinforced concrete containing fibers varied by 0.25%, 0.50%, 0.75% 1% 1.5% and 2% by volume of cement cubes of size 150mmX150mmX150mm to check the compressive strength and beams of size 500mmX100mmX100mm for checking flexural strength were casted. All the specimens were cured for the period OF 3, 7 and 28 days before crushing the result of fibers reinforced concrete 3 days, 7 days, and 28 days curing with varied percentage of fiber were studied and it has been found that there is significant strength improvement in steel fiber reinforced concrete. The optimum fiber content while studying the compressive strength of cube is found to be 10% and 0.75% for flexural strength of the beam. Also it has been observed that with the increase in fiber content up to the optimum value increase the strength of concrete. [3]

- **Vasudev R, Dr. B G Vishnuram (2013) et al** this paper aims to have a comparative study between ordinary reinforced concrete and steel fiber reinforced concrete. The fibers which were used in the study were the turn fibers. They were the scraps from the lathe shops. Experimental investigations and analysis of results were conducted to study the compressive & tensile behaviour of composite concrete with varying percentage of such fibers added to it. The concrete mix adopted were M20 and M30 with varying percentage of fibers ranging from 0, 0.25, 0.5, 0.75 & 1%. On the analysis of test results the concrete with turn steel fibers had improved performance as compared to the concrete with conventional steel fibers which were readily available in market. These sustainable improvements or modifications could be easily adopted by the common man in their regular constructions. [4]

- **Abdul Ghaffar (2014) et al** this research is based on the investigation of the use of steel fibers in structural concrete to enhance the mechanical properties of concrete. The objective of the study was to determine and compare the differences in properties of concrete containing without fibers and concrete with fibers. This investigation was carried out using several tests, compressive test and flexural test. A total of eleven mix batches of concrete containing 0% to 5% with an interval of 0.5% by wt. of cement. 'Hooked' steel fibers were tested to determine the enhancement of mechanical properties of concrete. The workability of concrete significantly reduced as the fiber dosage rate increases. [5]

- **ErGulzar Ahmad, ErkshipraKapoor (2016) et al** Fthis research carried out test on steel fiber reinforced concrete to check the influence of fibers on strength of concrete. According to various research papers, it has been found that steel fibers give the maximum strength in comparison to glass and polypropylene fibers. Now a days there exists many reinforcement techniques for improving the strength of those materials which lacks load carrying and less durable capacity. Use of steel fiber to enhance the strength and reduce maintenance is an effective technology established in recent times. Fiber reinforced concrete has been successfully used in slabs on grade, shotcrete, architectural panels, precast products, offshore structures, structures in seismic regions, thin and thick repairs, crash barriers, footings, hydraulic structures and many other applications. The usefulness of fiber reinforced concrete in various Civil Engineering applications is thus indisputable. This review study is a trial of giving some highlights for inclusion of steel fibers especially in terms of using them with new types of concrete. [6]

- **PramodKawde (2017) et al,** in this research it is shown thart ordinary cement concrete possesses very low tensile strength, limited ductility and less resistance to cracking. The concrete shows the brittle behaviour and fails to handle tensile loading hence leads to internal micro cracks which are mainly responsible for brittle failure of concrete. In this era, RCC constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been proved that different type of fibers added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. As compared to other fibers it is now established that one of the important properties of Steel Fiber Reinforced Concrete (SFRC) is its superior resistance to cracking and crack propagation. In this paper Past studies based on the Steel fiber concrete is studied in detail. [7]

- **Prasad Karunakaran.R. (2017) et al** This paper deals with experimental study on behaviour of steel fiber reinforced concrete for M25 grade having mix proportion of 1:1:2 with 0.44 water cement ratio to study the Compressive strength, Split tensile strength, Flexural strength of steel fiber reinforced concrete (SFRC) containing fibers of 0.5% volume fraction of hook end Steel fibers of 50 aspect ratio were used. A result data obtained has been analyzed and relationship between Compressive strength, Split tensile strength, Flexural strength vs. days represented graphically. [8]

- **Dr.K.Vidhya (2017) et al** in this experimental it is shown that concrete is a relatively brittle material, when subjected to normal stresses and impact loads. As a result for these characteristics, plain concrete members could not support loads and tensile stresses that occurred, on concrete beams and slabs. Concrete members are reinforced with continuous reinforcing bars to withstand tensile stresses and compensate for the lack of ductility and strength. The addition of steel reinforcement significantly increases the strength of concrete, and results in concrete with homogenous tensile properties; however the development of micro cracks in concrete structures must be checked. The introduction of fibers is generally taken as a solution to develop concrete in view of enhancing its flexural and tensile strength. M40 grade of concrete are arrived with the following ingredients such as Cement, Fine aggregate, Coarse aggregate, Water, Steel fiber, Fly ash, Silica fumes and Superplasticizers. Then variables in this study include the steel fiber (Hooked end and crimpled) percentage in addition to the weight of cement. The Compressive strength, tensile strength and flexural behavior of steel fiber reinforced concrete beam with the varying percentage of fiber of M40 grade of concrete. [9]

III. CONCLUSIONS

On the study of Review paper, following conclusion are obtained:

- Steel fibers reinforced concrete results in durable concrete with a high flexural and fatigue flexural strength, improved abrasion, and impact resistance.
- Addition of steel fibers in concrete increases the ductility.
- It is observed that the addition of steel fibers in concrete increases the toughness as compared to plain concrete.
- Steel fibers reinforced concrete is a far more economical design alternative in present time

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