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# STEEL FIBER REINFORCED CONCRETE A REVIEW

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## ABSTRACT

Extensively used material in construction industry is concrete this is because of good workability and ability to be moulded to any shape. 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.

**KEYWORDS**: Steel Fiber Concrete, Cement, Steel Fibers, Strength

## INTRODUCTION

In this era of world concrete is most used material for compressive strength for building construction. Tensile load carrying capacity is very low of concrete. This results in brittle failure of concrete components. To increase the performance of concrete under tensile loading or dynamic loading different types of the fibers are added to concrete. Concrete is characterized by brittle failure which tends for the complete loss of loading capacity, once failure is initiated. the application of the material can be overused by the inclusion of a small amount of short randomly distributed fibers (steel, glass, synthetic and natural) and can be practiced among others that remedy weaknesses of concrete, such as low growth resistance, high shrinkage cracking, low durability, etc. mainly Steel fiber reinforced concrete （SFRC） has the ability of excellent tensile strength, flexural strength, shock resistance, fatigue resistance, ductility and crack arrest. Therefore, it has been applied abroad in various professional fields of construction, irrigation works and architecture. Mostly steel fibers are seen to be performing well as compared to the other random fibers.

**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.

**Effect on workability of steel fiber:** Slump tests were carried out to determine the workability and consistency of fresh concrete. The efficiency of all fiber reinforcement is dependent upon achievement of a uniform

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distribution of the fibers in the concrete, their interaction with the cement matrix, and the ability of the concrete to be successfully cast or sprayed. Essentially, each individual fiber needs to be coated with cement paste to provide any benefit in the concrete. Regular users of fiber reinforcement concrete will fully appreciate that adding more fibers into the concrete, particularly of a very small diameter, results in a greater negative effect on workability and the necessity for mix design changes. The slump changed due to the different type of fiber content and form. The reason of lower slump is that adding steel fibers can form a network structure in concrete, which restrain mixture from segregation and flow. Due to the high content and large surface area of fibers, fibers are sure to absorb more cement paste to wrap around and the increase of the viscosity of mixture makes the slump loss.

**Effect of steel fiber on compressive, splitting tensile and modulous of rupture of concrete:** Presently, a number of laboratory experiments on mechanical properties of SFRC have been done. Investigations conducted uni-axial compression test on fiber reinforced concrete specimens. The results shown the increase in strength of 6% to 17% compressive strength, 18% to 47% split tensile strength, 22% to 63% flexural strength and 8% to 25% modulus of elasticity respectively. The mechanical properties of concrete have been studied, these results shown the increase in strength of 6% to 17% compressive strength, 14% to 49% split tensile strength, 25% to 55% flexural strength and 13% to 27% modulus of elasticity respectively. The strength of 15 steel fibers reinforced and plain concrete ground slabs. The slabs were 2x2x0.12m, reinforced with hooked end steel fibers and mill cut steel fibers.

**Effect of steel fiber on impact capacity and toughness of concrete:** Toughness is a measure of the ability of the material to absorb energy during deformation. This property is estimated using the area under the stress-strain curves conducted test on the mechanical properties and resistance against impact on steel fiber reinforced high-performance concrete. Five different geometry of fibers included steel-sheet-cut fibers and steel ingot milled fibers with four fiber volume fractions (4%, 6%, 8% and 10%) were applied in to the mix. studied and conducted test for fiber content dosage Vf ranged from 0.0 to 2.0 percent. Steel and Polyolefin fibers were combined in different proportions and their impact on strength and toughness studied. Addition of 2.0 percent by volume of hooked-end steel fibers increases the toughness by about 19.27%, when compared to the plain concrete. When the fibers were used in a hybrid form, the increase in above study parameters was about 31.42%, when compared to the plain concrete.

The study on the introduction of effect of steel fibers is not still promising as steel fiber reinforced concrete has to be used for sustainable and long-lasting concrete structures. Thought its study is not yet completed Steel fibers are widely used as a fiber reinforced concrete all over the world as it ensures less cracking than normal concrete. Lot of research work had been done on steel fiber reinforced concrete for basically enhancing the flexure capacity of the concrete material. This review study tried to focus on the most significant effects of addition of steel fibers to the concrete mixes. The steel fibers are mostly used fiber for fiber reinforced concrete out of available fibers in market. According to many researchers, the addition of steel fiber into concrete creates low workable or inadequate workability to the concrete, therefore to solve this problem of super plasticizer without affecting other properties of concrete may introduce.

## RELATED WORK

**Ali Amin and Stephen J. Foster [2016],** Despite the increased awareness of Steel Fibre Reinforced Concrete (SFRC) in practice and research, SFRC is yet to find common application in load bearing or shear critical building structural elements. Although the far majority of studies on SFRC have focused on members containing fibres only, in most practical applications of SFRC construction, structural members made of SFRC are also reinforced with conventional reinforcing steel for shear ligatures. In this paper, results are presented on shear tests which have been conducted on ten 5 m long by 0.3 m wide by 0.7 m high rectangular simply supported beams with varying transverse and steel fibre reinforcement ratios. The tests have been analysed along with complete material characterisation which quantify the post-cracking behaviour of the SFRC.

**Rubén Serrano et al; [2016],** The decrease in concrete resistance and the expansion generated in reinforced concrete structures by direct exposure to fire at 400 C maximum temperatures serves as the basis for the present research. The aim is to improve these problems by the addition of steel fibers or of polypropylene fibers in concrete. From the results analysis of compression fracture tests on cylindrical concrete specimens, it can be concluded that concrete with addition of polypropylene fibers or steel fibers are a good alternative to traditional concrete, because both its strength, and its behavior in case of fire are improved, delaying the appearance of fissures and explosive concrete spalling.

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**Abdul Ghaffar, Amit S. Chavhan, Dr.R.S.Tatwawadi [2014],** The purpose of this research is based on the investigation of the use of steel fibres 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 fibres and concrete with fibres. 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 fibres were tested to determine the enhancement of mechanical properties of concrete. The workability of concrete significantly reduced as the fibre dosage rate increases.

**G. Murali, A. S. Santhi and G. Mohan Ganesh[2014],** It is well known that concrete is characterized by its high compressive strength, yet its brittle mode of failure is considered as a drawback of high strength concrete when it is subjected to impact and dynamic loads. This study aims to investigate the impact resistance of fibre reinforced concrete (FRC), incorporated with steel fibres at various dosages. For this, a drop weight test was performed on the 28 days cured plain and fibre reinforced concrete samples as per the testing procedure recommended by ACI committee 544. Crimped and hooked end steel fibre of length 50 mm and an aspect ratio equal to 50 was added to concrete in different proportions i.e. 0%, 0.5%, 1.0% and 1.5% with water cement ratio of 0.42. From the test results, it was proved that the (FRC) was effective under the impact loads thus improving the impact resistance. Also, the reduction of strength under impact load in each specimen for every three blows was determined by ultrasonic pulse velocity (UPV) test. Further, a statistical correlation between (UPV) and number of blows under impact load was developed using regression analysis. The developed regression model predicts the reduction in strength of concrete under impact load accurately.

**Patil Shweta and Rupali Kavilkar, [2014],** Concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Various types of fibre reinforced concrete are being used against plain concrete due to their higher flexural strength, better tensile strength, modulus of rupture and crack resistance. In the present investigation properties of steel fiber reinforced concrete like flexure and compressive strength are studied. Tests were conducted to study the flexural and compressive strength of steel fibre reinforced concrete with varying aspect and varying percentage of fibre. In the experiments conducted four aspect ratio were selected i.e. 40,50,60,70 and percentage of steel in each case varied from 0.5% to 2.5% at interval of 0.5%. The various strength parameters studied are compressive strength and flexural strength as per the relevant IS standards. The experimental results indicate that the addition of steel fibre into concrete significantly increases the flexural strength. It also indicates that at constant percentage of fibre, that is 1.5% by increasing the aspect ratio of fibre from 40 to 70, flexural strength increased from 36.7% to 58.65%. The research paper proposes that due to these properties of steel fibre reinforced concrete, it can be used for the design of curvilinear forms.

**Amit Rana [2013],** Fibres are generally used as resistance of cracking and strengthening of concrete. In this project, I am going to carry out test on steel fibre reinforced concrete to check the influence of fibres on flexural strength of concrete. According to various research papers, it has been found that steel fibres give the maximum strength in comparison to glass and polypropylene fibres. Hence, in this project I was interested in finding out the optimum quantity of steel fibres required to achieve the maximum flexural strength for M25 grade concrete. From the exhaustive and extensive experimental work it was found that with increase in steel fibre content in concrete there was a tremendous increase in Flexural strength. Even at 1 % steel fibre content flexural strength of 6.46 N/mm2 was observed against flexural strength 5.36 N/mm2 at 0% hence increase of 1.1% flexural strength was obtained.

**A.M. Shende et al; [2012],** 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 fibre 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.

**Milind V. Mohod [2012]** Cement concrete is the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be moulded to any shape. Ordinary cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks, leading to brittle failure of concrete. In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this

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purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibers added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. 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 effect of fibers on the strength of concrete for M 30 grade have been studied by varying the percentage of fibers in concrete. Fiber content were 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 results of fiber reinforced concrete for 3days, 7days and 28days 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 1% 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 increases the strength of concrete. Slump cone test was adopted to measure the workability of concrete. The Slump cone test results revealed that workability gets reduced with the increase in fiber content.

## CONCLUSION

Steel Fiber reinforced concrete (SFRC) is defined as concrete made with hydraulic cement containing Fine and coarse aggregate and discontinuous discrete fiber. In SFRC, thousands of small fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties. SFRC is being increasingly used to improve static and dynamic tensile strength, energy absorbing capacity and better fatigue. They concluded that the addition of steel fiber increases the ultimate strength and ductility. The plain structure cracks into two pieces when the structure is subjected to the peak tensile load and cannot withstand further load or deformation.

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