A Comparative Analysis of Conventional Concrete with Steel Fiber Concrete

Prof. Tejaswini S. Junghare[1]

Mr. Shailesh Lade[2] , Mr. Raj Sahare[2] , Mr. Dravid Shende[2], Mr. Mahesh Rathod[2]

Mr. Mayur Suryawanshi[2] , Mr. Sahil Rodge[2], Mr. Shrikant Gaikwad[2]

[1]Assistant Professor, Department of Civil Engineering, J D College of Engineering and Management, Nagpur

[2]4th Year B.Tech, Department of Civil Engineering, J D College of Engineering andManagement, Nagpur

Abstract : **The most frequently utilized structure material worldwide is concrete. Concrete that has been strengthened with short, irregular fiber is known as fiber reinforced concrete(FRC). The fiber used in FRC can be made of a variety of accoutrements , including glass, aramid, asbestos, polypropylene, jute, steel ,G.I., carbon, and others. The compressive strength, tensile strength, flexural strength, and impact strength of concrete can all be significantly bettered by including this fiber into the concrete mass. FRC has multitudinous uses in the world of civil engineering. steel fiber reinforced concrete(SFRC) cell and cylinder samples with fiber of 0 and 0.50 volume bit of hook end have been constructed grounded on the laboratory trial on fiber reinforce concrete(FRC). Without amalgamation,53.8550 steel fiber comprising 0 and 0.25 percent by weight of cement with a 12 mm cut length were employed. This composition proved the salutary effect of colorful fibers with chance increase in contraction and splitting enhancement of instance at 7 by comparing the results of FRC with plain M30 grade concrete. The perceptivity of adding fibers to concrete with different strengths was examined after 7 and 28 days.**

Keywords: *Compressive Strength, Fiber Reinforced Concrete, Flexural strength, Split Tensile Strength, Steel Fibers.*

Introduction

Brittle failure, or the almost complete loss of loading capability, is what cement concrete is known for. This property, which restricts the material's use, can be remedied by the addition of a small quantity of short, randomly distributed fibers (made of steel, glass, synthetic, and natural materials), which can also be used to treat other concrete flaws like low growth resistance, high shrinkage cracking, low durability, etc.

Concrete's strength and durability can be altered by appropriately altering its constituent parts, such as cementations material, aggregate, and water, as well as by adding some unique chemicals. As a result, concrete is excellently suited for a variety of uses. However, concrete has certain drawbacks, including low impact strength, low tensile strength, low post-cracking capacity, brittleness and low ductility, and a short fatigue life.

The inherent fragility of plain concrete is caused by the existence of micro cracks at the mortar-aggregate contact. By adding fibers to the mixture, the weakness can be eliminated. To boost the concrete's toughness or capacity to resist fracture growth different kinds of fibers, such as those found in conventional composite materials, have been added to the mix. At the internal micro fractures, the fibers aid in load transfer. Fiber-reinforced concrete is the name given to such a concrete (FRC). Fiber-reinforced concrete, then, is a composite material that primarily consists of Regular concrete or mortar that has been reinforced with fine fibers.

The fibres can be thought of as an aggregate that deviates greatly from the spherical, smooth aggregate in terms of shape. The mix becomes more cohesive and less likely to segregate but the workability is significantly reduced by the fibers' interlocking and entanglement with the aggregate particles. During the mixing process, the fibres are spread and distributed randomly throughout the concrete, improving its qualities everywhere. Fibers aid in eliminating temperature and shrinkage cracks while enhancing pre-crack tensile strength, fatigue strength, and impact strength

In essence, fiber serve as a "crack arrester," preventing cracks from forming and converting a naturally brittle matrix, such as cement concrete, with low tensile and impact resistances, into a strong composite with superior crack resistance, improved ductility, and distinctive post- cracking behavior prior to failure.

This study investigates the viability of using metallic and synthetic fibers, with the goal of performing parametric studies on compressive strength, tensile strength, flexural strength, etc. for a certain grade of concrete, aspect ratio, and different fiber percentages.

1. Literature Survey

Presently, several lab tests on the mechanical characteristics of SFRC have been conducted. In their research, Shah Surrender and Rang an] tested fiber reinforced concrete specimens under uniaxial compression. According to the findings, the strength increased by 6 to 17 percent for compressive strength, 18 to 47 percent for split tensile strength, 22 to 63 percent for flexural strength, and 8 to 25 percent for elastic modulus. Hwan Steel fibers with hooked ends and steel fibers with mill cuts are used to reinforce them. By using various factors, such as direct tensile strength, split cylinder strength, and cube strength, Dwaraknath and Nagaraj estimated the flexural strength of steel fiber concrete. The minimal fiber volume dose rates for steel, glass, and polypropylene fibers in the concrete matrix were calculated to be, respectively, 0.31 percent, 0.40 percent, and 0.75 percent, according to James and Beaudoin. Patton and Whittaker looked studied the relationship between changes in the modulus of elasticity and damage caused by load in steel fiber concrete. Rossi et al. found that the impacts of steel fiber on cracking were interdependent at both the local (behavior of steel fibers) and global (behavior of the fiber/cement composite) levels.

The size effect of the 18 concrete beams under four-point loads was calibrated by Sener et al. Using steel fiber, Swami and Saad conducted research on the deformation and ultimate strength of flexural in reinforced concrete beams under four point loading. The study involved 15 beams (130x203x2500mm) with the same steel reinforcement (2Y-10 top bar and 2Y-12 bottom bar) and variables of fibervolume fraction (0 percent , 0.5 percent and 1.0 percent). Tan et al[9] .'s inquiry into the shear behavior of steel fiber reinforced concrete came to a conclusion. Six simply supported beams were put to the test using hooked steel fiber that were 30mm long and 0.5mm in diameter, with the fiber volume fraction increasing by 0.25 percent units every time from 0% to 1.0%.Similar fracture behavior research had been conducted by Vandewalle using five full-scale steel- fiber-reinforced concrete beams (350x200x3600mm) (volume fraction of 0.38 percent and 0.56 percent). In his study, the fracture width theoretical prediction and experimental outcomes were compared.

2. Experimental Program

A. Material Used

Used materials were cement, sand, coarse aggregate, water, steel fiber.

Cement: The cement used had a specific gravity of 3.15 and was classified as Ordinary Portland cement (53 Grade). The cement took 20 minutes to harden initially and 227 minutes to set completely. According to I.S.-8112- 1989, Ordinary Portland Cement of grade 53 was utilized.

Sand: A fine aggregate was employed, which was river sandof high grade. Sand that is readily available in the area and conforms to I.S. - 383-1970 with specific gravity of 2.45, water absorption of 2%, and fineness modulus of 3.18 is zone II-certified.

Coarse aggregate: Crushed granite stones with a maximum size of 20 mm and specific gravities of 2.67 and 7.10, in accordance with IS 383-1970.

Water: The experimentation was conducted using potable water.

Fibers: The effects on concrete strength with two hook end steel fiber at low volume fraction were examined in this work.

Mild Steel Wire shape with hook ends that are 35 mm and 50 mm in length, a density of 7.85 g/cm3, and a minimum tensile strength of 345 MPa when filled with concrete gathered from used was Stewols Pvt. Ltd. from Nagpur, Maharashtra, India. Aspect ratios of 53.85 and 50 were used, and the fiber diameters used were 0.93 mm and 0.7 mm, respectively. Table 1 displays the physical characteristics of the employed fibres.

Table 1: Description of Different Fibers

Fiber Designation	Length (mm)	Description	Dosage ofFibers	Aspect Ratio (L/D)
S1 (Steel)	50	Hook End	0.5% by vol	53.85
S2 (Steel)	35	Hook End	0.5% by vol	50

B. Concrete Mix Proportions

The proportioning of the combination was carried out in accordance with IS 456-2000 [19] and the Indian Standard Recommended Method IS 10262- 2009 [20]. The OPC control mixture's goal mean strength was 26 MPa, with a total binder content of 383 kg/m3, fine aggregate collected at a rate of 672 kg/m3, and coarse aggregate taken at a rate of 1100 kg/m3. The proportion of water to binder was maintained at 0.5. The samples were mixed for a total of 5 minutes, cast, and then left for 24 hours before being demolded . Cement, sand, and coarse aggregate were then properly mixed in the proportions of 1:1.75:2.87 by weight before water was added, and the mixture was properly finished to produce homogeneous material. They were then put in the curing tank until the day of testing. Moisture content and water absorption capability were taken into account. For casting, cylinder and cube moulds were employed. For each of the three layers, 25 strokes of a 16 mm rod were used to compact the concrete. Before the specimens were demolded and put in the curing tank, the concrete was left in the mould and allowed to set for 24 hours. The specimens were cured in the tank for 7 and 28 days, respectively, with and without fiber.

According to I.S. 10262:2009, concrete was made for M30 grade.

Table 2: Details of Quantity of Materials

Material	*Quantity*	*Proportion*
Cement	383 Kg/ m3	1
Sand	672 Kg/ m3	1.75
Coarse Aggregates (20 mm)	1100 Kg/ m3	2.87
Water	192 Kg/ m3	0.45

The mechanical characteristics of a concrete mix containing steel fiber, 0.25 percent by weight of cement, and at a ratio of 0 percent by volume and 0.5 percent by volume have been studied.

C. Compressive Strength Test

When concrete is 7 and 28 days old, the crushing strength of 150mm x 150mm x 150mm is typically used to define and determine the material's strength. Due to its simplicity and the fact that the majority of concrete's desirable characteristic qualities are qualitatively correlated with its compressive strength, it is the most often performed test on hardened concrete. Steel mound made of cast iron, 150mm x 150mm x 150mm, used for casting concrete cubes packed with conventional concrete, 0 percent and
0.25 percent by weight of cement, and steel fibers, 0 percent and 0.5% by volume of concrete. In order to prevent leaks during manufacturing, the mound and its base were tightly drained. In the casting. Before casting, the base plates and mold's sides were greased to stop the concrete from adhering to them. The cube was then left undisturbed for 24 hours at a temperature between 8 and 22 degrees Celsius with a relative humidity of at least 90%. (IS 516- 1959).
The load was delivered without shock and raised continuously at a rate of around 140 Kg/sq. cm/min until the specimen's resistance to the rising loads broke down and no further load could be supported, according to IS 516-1959. The specimen's maximum load was then documented in accordance with IS: 516-1959. Figure 1 depicts the compression testing of cubes and cylinders.

The compressive strength was calculated as follows:

Compressive strength (MP) = Failure load / cross sectional

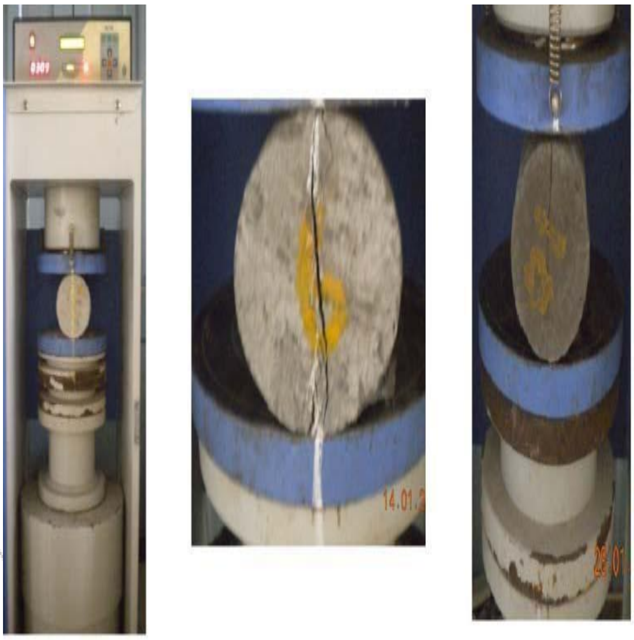
Figure 1: Compression Test on Cube and Cylinders

D. Split Tensile Strength Test

For the tensile strength test, cylindrical specimens with dimensions of 100 mm in diameter and 200 mm in length were cast in accordance with IS 5816:1999. After 24 hours of casting, the specimens were demoded and sent to a curing tank where they were allowed to cure for 7 and 28 days. Three cylinders were evaluated in each category, and the average value was recorded [10]. The digital compression machine with a 2000 ken capacity was used to carry out the split tension test as depicted in Figure 2.

The formula used to compute split tensile strength is split tensile strength (MP) = 2P / DL, where P = failure load (ken)
L = Specimen Length (200 mm) D = Specimen Diameter (100 mm)

Figure 2: Cylinders under Split tension



It was shown that adding a 50 mm long, hook-end steel fiber adds the maximum compressive strength compared to all other fibers.

Because steel fiber reinforced concrete is frequently subjected to compression, such as in tunnels, the compressive strength test is thought to be the most appropriate way to assess the behavior of steel fiber reinforced concrete for subterranean construction at an early stage. In accordance with I.S., the compressive strength of control concrete and concrete reinforced with different fibers was estimated. 516:1959 It has been observed that the presence of discrete fibers in concrete slows the spread of cracks. This is because the fibers are bonded to the concrete, which transforms the material's brittle mode of failure into a more ductile one and increases its ability to withstand post- cracking loads and absorb energy.

Results of compressive strength for M30 grade concrete on cube and cylinder specimens with steel fibers at 0%, 0.50%, and 0.250% by weight of cement.

It was observed that, addition of 0.5%, 50 mm length; hook end steel fibers gives max compressive strength using cylinder specimens among all the fibers.

Results of Flexural Test

Flexural Test (Beams) M30 Steel fiber								
Days	BeamNo	0%			0.50%			
		KN	Kg/cm^2	Mean(N/mm^2)	KN	Kg/cm^2	Mean(N/mm^2)	% Decrease
28	1	1600	33.18	3.39	1400	29.03	3.1	9.35
	2	1680	34.84		1600	33.19		

Figure3: Flexural Test of Beam on M 30(0, 0.5% Steel Fiber)
It shows following resultBy addition of 0.5% Steel fibers, **decreases** in flexuralStrength of fiber by **9.35 %** for 28 days

3. Conclusions

The as long as the issue of concrete's brittleness is a concern, the investigation into the impact of fibers of various diameters and qualities can be fruitful.

The According to the study's findings, concrete with steelfibers added at a volumetric concentration of 0.5 percent breaks less under various stress conditions.

Concrete's brittleness can also be increased by using steel rather than glass fibers. Steel fibers are used in axial-stress to boost tensile strength because concrete is particularly weak in tension.

The inquiry could lead to the following conclusions. Now we conclude that from the present investigation.

1. Hook end, 50 mm long steel fibers were added to concrete of grade M30 to achieve the maximum compressive strength.
2. Hook end, 50 mm long steel fibers were added to concrete of the M30 grade to achieve the maximum split tensile strength.
3. It was discovered that the ratio of the compressive strength of cylinders to that of the cube was almost 3:4.
4. The insertion of fibers affects the workability of concrete. Steel fiber addition decreases concrete's workability compared to other fibers at various volume fractions.
5. It was discovered that the deflection continues in theflexural test.

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