

Performance Evaluation of Concrete Reinforced with Steel Fibre: An Experimental Approach

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Abstract—The most often utilized building material worldwide is cement concrete. Its superior workability and ability to be molded into any shape account for its widespread use. Ordinary cement concrete has extremely little resistance to cracking, little ductility, and a very low tensile strength. Internal micro-cracks cause concrete to break easily. Since every structure has a specific purpose and modern civil engineering constructions have their own structural and durability criteria, it is now necessary to modify traditional cement concrete in order to achieve these goals. It has been discovered that adding various fiber types to concrete at a certain amount enhances the structure's mechanical qualities, longevity, and serviceability.

I. INTRODUCTION

There have been numerous attempts to raise the concrete's tensile strength. Steel reinforcement is one of the most popular and effective techniques. However, steel bars merely strengthen concrete toward local tension. In reinforced concrete members, cracks spread out freely until they hit a bar. As a result, steel reinforcement that is multidirectional and tightly spaced becomes necessary. Practically speaking, that is not feasible. The remedy to this issue is fiber reinforcement. Therefore, an approach of adding fibers to concrete is being deployed to boost its TS. These fibers stop cracks from spreading by acting as crack arrestors. These fibers are dispersed evenly and organized at random. Fiber reinforced concrete is the name given to this type of concrete. The primary goals of adding fibers to the CM are to increase the concrete's post-cracking reaction, or its apparent ductility and energy absorption capacity, as well as to provide crack resistance & control. It also aids in preserving the material's cohesion & structural integrity. Numerous material formulations that meet the criteria for fiber-reinforced concrete have been developed as an outcome of the initial research & the substantial

amount of follow-up research.

CONCRETE WITH FIBRE REINFORCED

FRC is concrete that has been reinforced with a fibrous material to increase its structural strength. Therefore, a composite substance containing of cement concrete & uniformly scattered fibers is known as FRC. Fiber is a distinct substance with some unique qualities. Anything can be used as the fiber material. However, not all will be cost-effective and efficient. Among the most widely utilized fibers are:

- carbon,
- glass,
- NBD
- Steel
- natural

One of the most widely utilized fibers is steel. Round fibers are typically utilized. The range of the diameter is 0.25 to 0.75 mm. Occasionally; the SF rusts & loses its strength. However, research has shown that fibers only rust on surfaces. Its modulus of elasticity is high. Concrete's flexure, impact, and fatigue strength are all significantly increased by the addition of SF. It has been incorporated into many different kinds of constructions. Recently, glass fiber has been used to make fiber concrete. Tensile strength ranges from 1020 to 4080 MPa, which is extremely high. Glass fiber concretes are mostly utilized as architectural precast concrete and as façade panels for external buildings. This substance is less dense than

steel and works well for creating shapes on the front of any building. There is no established method for using carbon fiber. However, it has a young's modulus and significant strength. Additionally, studies have demonstrated that the addition of carbon to concrete enhances its durability. There is little research on carbon fibers mostly utilized for cladding. Natural fibers are plentiful & inexpensive. They are renewable & non-hazardous. Bamboo, jute, coconut husk, and elephant grass are a few examples of natural fibers. Asbestos can be replaced with them. It improves flexural strength and toughness. It also makes concrete more durable. Non-biodegradable material disposal is a major issue. It causes issues for the environment. The best way to cut waste is to reuse. These NBD materials are lightweight, easy to handle, non-corrosive, and resistant to chemical attack

II. LITERATURE REVIEW

2.1 High conduction hybrid FRC tensile characteristics Author: P.R.Kannan Rajkumar
In conclusion, HSC has a best tensile strength thanks to the actions of fibers at different set of fractions. The conclusions are derived from the numerical inquiry that was performed. Steel fibers (micro steel) can be used to create fiber concrete composites, which have better tensile strength than concrete without fibers. CS rose with the addition of fibers of all kinds, although this gain was not very large and could have been achieved with easier and less expensive techniques, like lowering the water-to-cement proportion. The matrix was effectively strengthened with micro steel fiber.

2.2 Steel fiber reinforced concrete's performance

Author: Milind V. Mohod²

In summary, the investigation conducted led to the following conclusions:

- 1) It was shown that the operate ability of concrete reinforced with SF decreases as the ratio of SF improves.
- 2) Up to the ideal value, compressive strength continues to rise as the fraction of steel fiber improves. It was discovered that 1% was the ideal fiber content for SFRC.
- 3) As the fiber content of concrete improves,

its FS continues to rise until it reaches its optimal value. It was determined that 0.75% was the ideal amount for the FS of SFRC concrete.

4) The plain cement concrete samples had a typical fracture propagation design during testing, which resulted in beam splitting in two-piece geometry. However, the inclusion of steel fibers to concrete stops cracks, which makes SFRC more ductile.

2.3 Impact of steel fiber inclusion on high performance concrete's strength and longevity

Author: B. Siva Konda Reddy³

In brief: The following results are reached after examined in this area shown an impressive set of substance characteristics:

By adding steel fibers to regular concrete, the concrete's tensile and compressive strengths rose by 9% and 8%, respectively.

2. The resistance to chloride ion penetration was enhanced when steel fibers were added to HPC.

2.4 A comparative analysis of reinforced steel fiber Concrete under flexural & deflection control.

Author: Shende

In conclusion, the current study may lead to the following findings.

1. Steel fibers with a 3% FS are shown to have a somewhat higher flexural strength than those made with 0%, 1%, & 2% fibers.

2. It has been noted that using SF enhances FS from 13 to 48.35%. Additionally, FS rises from 13.35 to 23.35% with the addition of 1% steel fibers. Through adding 2% steel fibers, the FS rises from 18.35 to 31.65%. By adding 3% steel fibers, the FS rises from 20.80% to 48.35%.

3. The conductance of the beam in flexural loads has been greatly improved by the inclusion of fibers. By minimizing the crack widths & spacing, it was clearly evident during the test that the SFRC specimen had better crack control.

4. During testing, it was noted that the SFRC specimen maintained its geometric integrity while the control concrete sample fractured into 2 pieces when tested for split tensile & flexural strength. It shows

that the addition of SF to control concrete enhances the ductility of SFRC

5. A proportion of steel fiber is shown to result in very little beam deflection when compared to a control beam.

2.5 An numerical research on the SFRC beam's structural performance Author: Jyoti Narwal, Ajay Goel, Devender Sharma

In conclusion, it is possible to make the following conclusions:

I. The incorporation of SF to the concrete mix increased the ultimate load carrying ability, fracture widths, deviation of beam samples of all of the sets.

II. For all series, the ideal fiber quantity ratio was found to be 1.5%. Due to poor concrete compaction brought on by fiber balling, the specimens' ability to support loads was diminished as the fiber concentration increased.

III The onset of the first crack was postponed when SF were added to the specimens' concrete mix. Because of the crack arresting phenomena, steel fibers also enhanced the specimens' post-cracking behavior across all series.

2.6 FS Analysis of Concrete Reinforced with SF Author: Patil

In conclusion: 1. The FS of concrete is greatly enhanced by the inclusion of SF or binding wire.

2. When contrasted to the strength of plain concrete, the FS improves from 36.7% to 58.65% when the fiber percentage is maintained at 1.5% and the AR of fiber is improved from 40 to 70.

3. When contrasted to plain concrete, the FS is found to be greatly raised from 29.2% to 119.69% at a fixed AR of 70 and by improving the ratio set of fibers from 0.5% to 2.5%.

4. It was found that the concrete's compressive strength somewhat dropped when binding wire, a SF, was added.

5. The AR of 70 and the ratio set of fiber of 1.5% result in the largest minimize in CS.

2.7 Overview of SFRC impact on concrete's engineering conductance

Author: Vikrant

Conclusion: Since steel fiber RC is used to build durable and sustainable concrete frameworks, research on the incorporation of steel fibers can still be fruitful. Around the world, steel fibers are frequently used in FRC. SFRC has been the subject of extensive study, and authors continue to work on it. This research attempted to concentrate on the consequences of adding SF to concrete mixtures. Out of all the fibers accessible on the market, SF are the most popular utilize for FRC. Various researchers believe that adding steel fiber to concrete outcomes in low or insufficient workability; Moreover, superplasticizer might be explained to address this issue without compromising other concrete characteristics.

2.8 A review of the application of SF as a concrete reinforcement substance

Author: Nitin Kumar, Sangeeta⁸

In conclusion, numerous review research have been carried out to accomplish the impact of combining concrete as the parent material with steel fiber as a reinforced material. Numerous small and large-scale research tests, like compressive, flexural were carried out using concrete that had been mixed with steel fiber at different percentages. The majority of the evaluation investigations showed that concrete combined with varying amounts of steel fiber increased a number of mechanical, chemical, or technical qualities, including flexure strength. Base The majority of the evaluation investigations showed that concrete combined with varying amounts of steel fiber increased a number of mechanical, chemical, or technical qualities, including split tensile strength, compressive strength, impact resistance, or flexure strengths on the talks above, it could be concluded that steel fiber worked well as reinforcing material and was a cost- effective way to increase the power of concrete.

III. DISCUSSION

4.3.1 (M30) STS and Compressive Strength:

It is possible to see how variations in the fiber composition affect the compressive & split tensile stresses. It is evident from the outcomes that the concrete's maximum compressive & STS occurs at 2% fiber content. Thus, comparing the strength distinct among fiber-reinforced concrete & regular

concrete at 2% fiber content.

concrete with different fiber percentages is compared:

After 28 days of curing, the CS of plain concrete &

Table no. 4.3.1.1

PC	SFRC	Percentage Improve in Strength
0	32.89	0
0.5	34.68	5.44
1	35.88	9.09
1.5	37.96	15.41
2	38.78	17.90

Table no. 4.3.1.2

PC	SFRC	Percentage Improve in Strength
0	3.22	0
0.5	3.51	9
1	3.98	23.60
1.5	4.46	38.50
2	4.57	41.92

It is evident from the figures that in comparison to ordinary concrete, the power of SFRC with 2% fiber has risen by 15.49% for compression and 43.45% for split tension.

4.3.2 Flexural Strength

Depend on the information, it could be produced that adding 2% of fibers leads in the largest rise in the modulus of rupture. Thus, contrasting the MoR values:

Table no 4.3.2

PC	SFRC	Percentage Improve in Strength
0	5.99	0
0.5	6.81	13.68
1	7.60	26.87
1.5	7.88	31.55
2	8.16	36.22

It is evident from the data that, in comparison to ordinary concrete, the FS of SFRC with 2% fiber has improved by 35.23%.

4.3.3(M40) STS & Compressive Strength:

It is feasible to see how variations in the fiber composition affect the compressive and split tensile stresses. It is clearly seen from the outcomes that the concrete's highest compressive & STS occurs at 2% fiber content. Thus, contrasting the strength difference of 2% fiber-reinforced concrete and regular concrete. After 28 days of curing, the CS of plain concrete with different fiber percentages is compared:

Table 4.3.3.1

PC	SFRC	Percentage Improve in Strength
0	42.50	0
0.5	43.92	3.34
1	44.72	5.22
1.5	45.66	7.43
2	47.55	11.88

After 28 days of curing, the STS of plain concrete & concrete with different fiber ratios is compared:

Table no. 4.3.3.2

PC	SFRC	Percentage Improve in Strength
0	4.2	0
0.5	4.31	2.61
1	4.53	7.85
1.5	4.97	18.33
2	5.33	21.20

It is evident from the data that, in comparison to ordinary concrete, the power of SFRC with 2% fiber has improved by 11.26% for compression and 26.2% for split tension.

4.3.4 FS (Rupture Modulus):

Depend on the data, it could be explained that adding 2% of fibers leads in the largest rise in the MoR . Thus, contrasting the MoR values:

Table no. 4.3.4

PC	SFRC	Percentage enhance in Strength
0	6.82	0
0.5	7.64	12.02
1	8.55	25.36
1.5	9.06	32.84
2	9.88	44.86

It is evident from the data that, in comparison to ordinary concrete, the FS of SFRC with 2% fiber has improved by 31.33%.

for use in set construction, especially for load-bearing structural devices & a variety of apps, particularly in earthquake-prone regions. Such materials will soon be utilized to create safer and better structures in the future.

IV. RESULTS

- The Steel fibers when compared to traditional concrete, the straight employed in this study has demonstrated a significant enhancement in all of the concrete's qualities, including.

- Water does not absorb into the steel fibers.

- Since the relationship between fiber properties and composite or structural performance has been better understood, fibers can now be tailored

M30 concrete:

- A 15.49% increase in compressive strength with 2% steel fibers.
- For every 2% of steel fibers, the TS is split through 43.45%.
- For 2% of steel fibers, the FS increased through 35.23%.

M40 concrete:

- An 11.26% increase in compressive strength for 2% steel fibers.
- For every 2% of steel fibers, the TS is split by 26.2%.
- For 2% of steel fibers, the FS increased through 31.33%

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