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Structural Behavior of Fiber Reinforced Concrete

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Abstract

It's a structural behavior research was done on normal concrete because it possesses low tensile strength shows cracking. The addition of fiber can enhance the compressive and tensile properties of concrete. An experimental study was conducted to evaluate the compressive and tensile strength of fiber-reinforced concrete, confirming the improvements in these mechanical properties. The various aspects covered are compression test, split tensile strength, Effects of fibers on concrete. The study is done on the comparison between nominal concrete and fiber reinforced concrete for that purpose steel fiber is used as reinforcement as it has several characteristics other than any fiber. The test is performed for m25 grade of concrete 12 cubes and 12 cylinders have been cast in which 6 are of normal and other of steel fibers in the Specimens with fiber percentages of 0.9%, 1.2%, and 1.5% were tested for compressive strength and split tensile strength at intervals of 3, 7, and 28 days after casting. The results of the test shows steel fiber reinforced concrete showing better strength in both compression and tension than nominal concrete there is increase in the strength as increase in the dosage of steel fibers. After 28 days of test it is been clear that Fibers can be used as reinforcement with normal concrete.

Keywords: Compression test, compression test, concrete cracking, concrete specimens, fiber dosage, fiber-reinforced concrete, mechanical properties, split tensile test, steel fibers, structural behavior

INTRODUCTION

Fibers are the most durable materials in case of strengthening, mixing, having high load carrying capacity. They are like bond in dry soil which makes the structure highly compatible under varying load, longer life span etc., fibers are of various types like steel, glass, polypropylene, nylon etc., each and every type has its own specialty as we took steel fiber for the experiment it has high bonding properties both mechanical as well as structural properties.

In construction industry, most useful and continuous material that is used from the decades is our normal concrete, which is the mixture of cement sand and aggregate. But as the enhancement in the structures normal concrete is a weaker option as it is poor in tensile and also in compression for that reason we used materials which possess high tensile or compressive strength known as fibers and the concrete made by such materials is known as fiber reinforced concrete. FRC becomes an acceptable material after its results also it has innovative applications [1–5].

LITERATURE REVIEW

A study of fiber reinforced concrete its behavior properties performance, various aspect are been carried out durability, hardness, concrete mechanism. The compressive and flexural tests are carried out for 3, 7, and 28 days varying fiber content is being used and the results are obtained failure of normal concrete and FRC concrete is

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also studied. As a result of it the properties of SRFC are studied an experimental study on steel fiber reinforced concrete with the steel mold having dimension 150 × 150 × 150 mm, with percentage of steel fiber up to 1%. Compressive test is carried out under CTM machine they performs test on various concretes and the strength has been checked. The result shows increase in the strength of concrete with higher content of fibers.

The cracking strength and reserve strength of concrete, in this research they used steel fibers in concrete. The experimental work is carried out for grades of FRC as M20, M25, M30, M40 the aspect ratio of fibers as 50 and the percentage (0, 0.5, 1.0, and 1.5) are been taken of steel fibers. Compressive test, splitting tensile test is being carried out to check the steel fiber reinforced concrete hardness. As a result of the test it is observed that there is an increase in the strength of the concrete when steel fibers are added.

The properties of steel fiber reinforced concrete, focusing on flexural and compressive strength. In their experiments, four aspect ratios were selected: 40, 50, 60, and 70. The percentage of steel fibers in each case varied from 0.5% to 2.5% in intervals of 0.5%. The results of the experiment shows slightly increase in compressive and flexural strength of concrete.

An experimental study on standard concrete of grade M45 and fiber-reinforced standard concrete exposed to elevated temperatures. Six sets of cubes, cylinders, and beams were cast for each type of concrete, with each set containing five specimens, resulting in a total of thirty cubes, thirty cylinders, and thirty beams for both standard and fiber-reinforced standard concrete. These specimens were exposed to elevated temperatures of 50, 100, 150, 200, and 250°C for 3 h, with one set tested at room temperature as control concrete. The specimens were tested for compressive strength, split tensile strength, and flexural strength immediately after removal from the oven. The results indicated that steel fibers are effective in enhancing the performance of concrete at high elevated temperatures.

M40 grade concrete to study the compressive, tensile, and flexural strength of steel fiber reinforced concrete. The content of steel fiber (1%, 2%, and 3%) volume fraction of type hooks tain. The results of the test are being calculated after 28 days curing of the specimen they founded there is increase in the compressive and tensile strength of the concrete with the addition of steel fiber.

M30 grade of concrete by varying percentage of steel fibers Fiber content was varied by 0.25%, 0.50%, 0.75%, 1%, 1.5%, and 2% by volume of cement. The compressive strength of concrete cubes and the flexural strength of beams were tested after 3, 7, and 28 days of curing. The optimal fiber content for compressive strength was found to be 1%, while for flexural strength it was 0.75%. It was observed that increasing the fiber content up to the optimal value enhances the strength of the concrete.

Steel fiber reinforced concrete (SFRC), cube and cylindrical specimens were designed with SFRC containing fibers at 0% and 0.5% volume fraction. Hook end and crimped round steel fibers with aspect ratios of 50, 53.85, and 62.50 (copper-coated) were used without admixture. The study compared SFRC with plain M25 grade concrete, validating the positive effect of 0.5% steel fiber content on compressive and splitting strength at 7 and 28 days. The research highlighted the sensitivity of steel fiber in enhancing concrete strength [6–8].

EFFECTS OF VARIOUS FIBERS

Steel fiber reinforced concrete (SFRC) is a composite material with steel fibers uniformly dispersed at random in small percentages ranging from 0.3% to 2.5% by volume. Steel fibers are added to concrete to enhance its structural properties, particularly its tensile and flexural strength. The size of the steel fibers used in SFRC typically varies between 0.25 and 1 mm in diameter and from 12 to 60 mm in length (Figures 1–4).


Figure 1. Steel fiber.


Figure 2. Carbon fiber.


Figure 3. Glass fiber.


Figure 4. Poly-propylene fiber.

Glass fibers, commonly referred to as fiberglass, were added to the mixture at an optimal value of 2% of the total volume. This resulted in a compressive strength of 127.38 MPa, a split tensile strength of 6.844 MPa, and a flexural strength of 10.36 MPa. The density of fiberglass reinforced concrete at this optimal volume was 2224.30 kg m^{-3}, which is lower than that of steel fiber reinforced concrete at its optimal volume, which has a density of 2310.39 kg m^{-3}.

The results showed that the flexural strength of concrete specimens with 0.75% carbon fiber was double that of the reference specimens at 28 days. The increase in flexural strength for concrete mixes with carbon fibers at volume fractions of 0.5% and 0.75% were 23% and 27%, respectively, at 28 days.

These fibers enhance the concrete's crack resistance, impact strength, and durability. It was observed that increasing the polypropylene fiber content in concrete significantly improved its compressive strength. At a 2% polypropylene fiber content, a compressive strength of 28 N mm^{-2} was achieved, compared to 25 N mm^{-2} at 0% fiber content, resulting in a 12% increase in compressive strength.

EXPERIMENTAL STUDY

Steel fibers are used to strengthen the concrete as it is hard in nature due to its durable properties it binds with the concrete mixture and gives the ultimate strength. There are various types of steel fiber are available in market known for their enhanced strength and good bonding properties. Steel fibers are non-corrosive in nature compressive strength of the fibers varies from its aspect ratio, and various dimensions are there from 15 to 60 mm. They are locally available and economical. The steel fibers used are flat crimped steel fiber of 25 mm dimension in the percentage of 0.9, 1.2, and 1.5 for making the concrete mixture. They are bent-up fibers that holds the concrete from getting materials to lose also increase the durability of the concrete and gives higher compressive and tensile Strength (Table 1).

CALCULATIONS

- Cement: 7.200 m^3
- Fly ash: 3.600 m^3
- 20 mm aggregate: 20.277 m^3
- 10 mm aggregate: 11.371 m^3
- Water: 5.754 m^3
- Crushed sand: 26.198 m^3
- Fiber: 31.5 mg

Table 1. Percentage of steel.

Percentage of steel fiber for 0.035 m^3 batch (%)	Weight in kg for 1 m^3 batch (kg)
0.9	28
1.2	30
1.5	32

METHODOLOGY

The procedure followed is, the batch taken for steel fiber reinforced concrete is 0.035 m^3, steel fibers are taken of 25 mm size with all the other ingredients like cement, sand, aggregate are mixed for the design proportion of m25 grade concrete. Twelve cubical steel molds are kept ready for making of cubes and 12 cylindrical molds for split tensile test. The mortar has been ready after the workability check by slump cone test slump found is 40. After the check molds have been filled by proper compaction and tamping rod, it tampers in three layers the section is being filled. Same process is been followed for making concrete cylinders now, the work is done after 24 h of duration the concrete cubes and cylinders are open out of molds and kept for curing in the water tank having temperature of 27° ± 2 for the next 28 days and taken for compression and split tensile test on 3, 7, and 28 days duration.

Materials Contents

Fly ash 120 kg m^{-3}, aggregate 10 mm 385 kg m^{-3}, aggregate 20 mm 686 kg m^{-3}, and crush sand 904 kg m^{-3} water content also taken as per requirement.

Normal Concrete Mixture

The batch taken is 0.025 m^3, content of materials taken same as of steel fiber reinforced mixture excluding steel fibers.

Structural Properties

Normal concrete and fiber reinforced concrete structural changes are been observed its cracks, brittleness, varying conditions, stability.

Casting of Specimens

The percentage requirement is fulfilled by casting different mixture of ingredients and changing in fiber content three cubes and three concrete cylinders are being casted for each percentage of steel fiber.

Load Carrying Capacity

Checked both concretes compression capacity and tensile strength.

RESULTS

Results are described in Tables 2 and 3.

Table 2. Compression test.

Test	Weight	Load	MPA
3 Days	8.96	293.8	**13.05**
7 Days	8.699	418.5	**18.60**
28 Days	**8.587**	**687.7**	**30.56**

Table 3. Steel fiber load calculation.

Test	% of Steel Fiber	Load	MPA
3 Days	0.9	241.8	10.74
	1.2	250.0	11.11
	1.5	260.2	11.80
7 Days	0.9	338.8	14.83
	1.2	337.1	14.98
	1.5	442.1	19.64
28 Days	0.9	607.4	28.85
	1.2	649.3	36.88
	1.5	829.8	**46.99**

Reinforced Concrete

Reinforced concrete details are shown Figures 5–7 and Table 4.

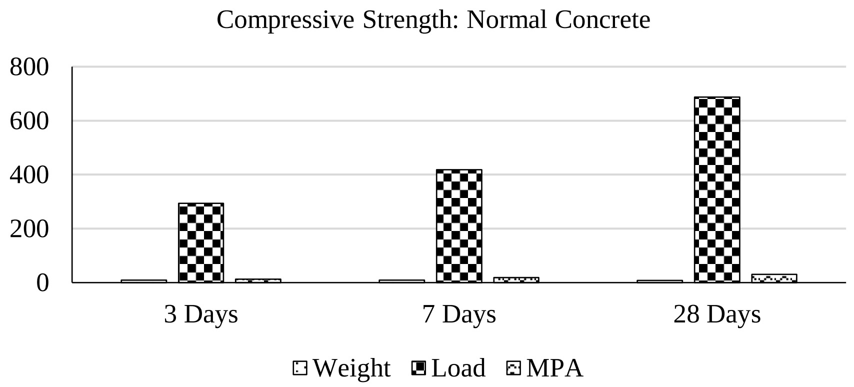

Figure 5. Compressive strength: Normal concrete.

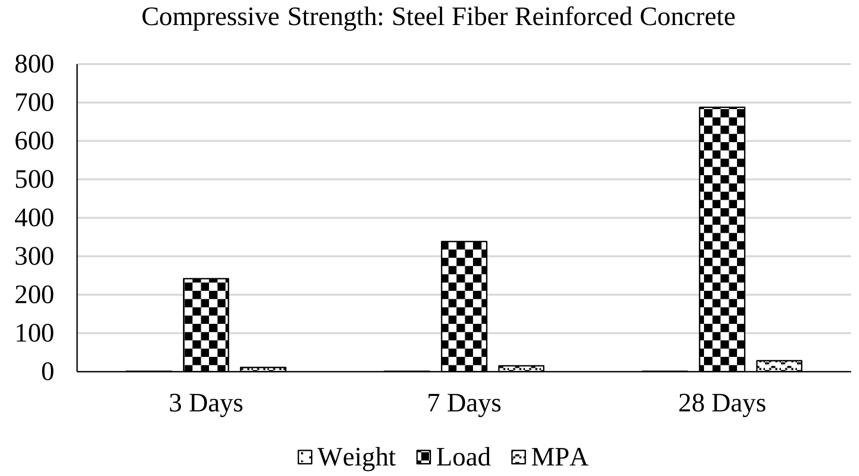

Figure 6. Compressive Strength: Steel Fiber Reinforced Concrete.

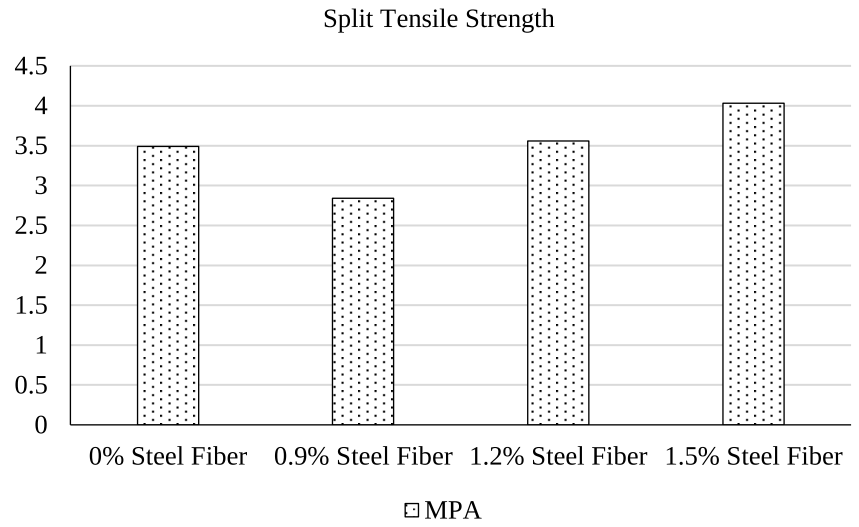

Figure 7. Split tensile strength.

Table 4. Split tensile test.

Concretes	**MPA**
Normal	3.49
0.9% Steel Fiber	2.84
1.2% Steel Fiber	3.56
1.5% Steel Fiber	4.03

CONCLUSION

The results indicate that after 28 days, the compressive strength and split tensile strength of fiber-reinforced concrete (FRC) are significantly higher than those of normal concrete. Therefore, FRC is preferred for applications requiring enhanced strength. The steel fiber reinforced concrete find to be useful as reinforcement in ordinary concrete. The comparison between the FRC and conventional concrete gives an explanation about the setting time, temperature effect, crack formation and the suitability of concrete. There is 15% higher compressive strength found in FRC and 1% higher tensile strength than normal concrete. Research states that fiber reinforcement is more effective than normal concrete in both tension and compression behavior.

REFRENCES

1. Mohamed AM, Tayeh BA. Exploring the performance of steel fibre reinforced lightweight concrete: a case study review. Case Stud Constr Mater. 2023; 18: e01968.
2. Bhaladhare BR, Hadge PN. Fibre reinforced concrete–a case study. Int Res J Eng Technol. 2020; 7 (9): 1530–1534.
3. Joshi A, Reddy P, Kumar P. Experimental work on steel fibre reinforced concrete. Int J Sci Eng Res. 2016; 7 (10): 90–95.
4. Shweta P, Kavilkar R. Study of flexural strength in steel fibre reinforced concrete. Int J Recent Dev Eng Technol. 2014; 2 (5): 52–55.
5. Srinivasarao K, Rakeshkumar S. Comparison of performance of standard concrete and fibre reinforced standard concrete exposed to elevated temperatures. Am J Eng Res. 2013; 2 (3): 17–21.
6. Mohod MV. Performance of steel fiber reinforced concrete. Int J Eng Sci. 2012; 1 (12): 1–4.
7. Shende M, Pande AM. Experimental study on steel fibre reinforced concrete for M-40 grade. Int Ref J Eng Sci. 2012; 1 (1): 43–48.
8. Vairagade VS, Kene KS, Deshpande NV. Investigation of steel fiber reinforced concrete on compressive and tensile strength. Int J Eng Res Technol. 2012; 1 (3): 1–7.