Experimental Analysis of Steel Fibre Reinforced Concrete Composite

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Abstract - *Concrete is powerless in strain and has a fragile trademark. The idea of utilizing strands to enhance the qualities of construction materials is exceptionally old. Early applications incorporate expansion of straw to mud bricks, horse hair to fortify mortar and asbestos to strengthen stoneware. Utilization of constant support in concrete builds quality and pliability, yet requires cautious position and work expertise. On the other hand, presentation of strands in discrete shape in plain or strengthened concrete may give a superior arrangement. Expansion of strands of solid makes it a homogeneous and isotropic material. At the point when solid breaks, the haphazardly situated strands begin working, capture splits arrangement and engendering, and in this way enhance strength and ductility. The disappointment methods of the FRC are either bond disappointing amongst fiber or a grid or material disappointment. In the present study, the mechanical properties of three types of concrete namely plain concrete, steel fibre reinforced concrete and latex modified steel fiber reinforced concrete has been determined on the basis of various test results carried out in laboratory.*

Key Words: Steel fibre reinforcement, fibre reinforced concrete, Compressive strength

1.INTRODUCTION

To increase the tensile strength of concrete many endeavours have been made, one of the effective and most regularly utilized ways is giving steel reinforcement. Steel bars, however, strengthen concrete against local tension only. Cracks in strengthening concrete develop unreservedly until experiencing the bar. Therefore, the requirement for multidirectional and firmly divided steel support emerges there, that can't be for all intents and purposes conceivable. Fiber support is one of the ways, which gives the answer for this sort of issue.

Wide varieties of fibres have been used in concrete and for each application, it needs to be, compulsive which type of fibre is optimal in satisfying the concrete application. The fibres mostly depend and adopt on properties, effectiveness, cost and availability. The various kinds of fibre in order to form Fibre Reinforced Concrete are as follows:

a) Steel Fibre
b) Glass Fibre
c) Synthetic Fibre
d) Natural Fibre
e) Asbestos Fibre

1.1 Steel Fiber

Steel fiber is kind of advanced composite material, which is most widely used for concrete reinforcing in construction and engineering work nowadays. Certain dosage of steel fiber in concrete can cause qualitative change on concrete's physical property, greatly increasing cracking resistance, impact resistance, fatigue resistance, bending resistance, tenacity, durability and other properties. The steel fibers generally used in concrete are made up of carbon steel and are manufactured in various shapes and sizes. Steel fibers mixed into the concrete can provide an alternative to the provision of conventional steel bars or welded fabric in some applications.

1.2 Benefits of Steel Fiber:

The use of steel fiber in concrete can improve its many properties. The benefits of using steel fibers in concrete areas follows:

a) Steel Fibers are generally distributed throughout a given cross section whereas reinforcing bars or wires are placed only where required.
b) Steel fibers are relatively short and closely spaced as compared with continuous reinforcing bars of wires.
c) Steel Fibers are typically added to concrete in low volume dosages (often less than 1%), and have been shown to be effective in reducing plastic shrinkage cracking.
d) Steel Fibers can increase the resistance to cracking and decrease crack width.

1.3 Styrene Butadiene Rubber (SBR) Latex

Styrene-butadiene rubber (SBR), a general-purpose synthetic rubber, produced from a copolymer of styrene and butadiene. SBR is a mixture of approximately 75 percent butadiene (CH2=CH-CH=CH2) and 25 percent styrene (CH2=CHC6H5).

The use of styrene butadiene rubber (SBR) emulsions in concrete has been increasing in concrete construction and repair work due to its benefits to flexure strength, compressive strength, adhesion and impermeability. SBR emulsion can be used as a bonding mortar layer between old and new concrete layers in a certain ratio with improving the compressive and flexural strength of concrete member repaired. The properties of the SBR modified concrete is associated with the corresponding properties of the SBR modified mortar and paste, and their properties changed in the same way with the incorporation of the SBR latex.

2. OBJECTIVES AND SCOPE OF STUDY

The aim of this experimental program is to develop high performance Fibre Reinforced Concrete containing Steel Fibre on strength parameter of concrete. The detailed objectives of this study are as follows:

a) To study the changes in the properties of concrete such as flexural strength, compressive strength etc on addition of steel fiber with Styrene Butadiene Rubber (SBR) latex.
b) To find the appropriate percentage of steel fiber and SBR for making the best mix of concrete.

Several scopes should be concerned for the determination of properties of rconcrete with additions of fibres through the following tests to analyse the effect of fibres on the compressive strength of the concrete.

3. MIX PROPORTIONS

The mix design was carried out for M-25 Grade of concrete conferring to the guidelines provided by IS:10262-2009 "Code of Concrete Mix proportioning" and IS:456-2000 "Code of practice for Plain and Reinforced Concrete".

Cement = 400.98 kg/m3
Water = 172.42 kg/m3
Fine aggregate = 631.21 kg/m3
Coarse aggregate = 1206.81 kg/m3
Chemical admixture = 1.604kg/m3
Water-cement ratio = 0.43

4. RESEARCH ELABORATIONS

Once the mix design and all the required tests on ingredients of concrete are done and their suitability is found satisfactory, the task of casting cubes, beams and cylinders was taken up. The available laboratory equipment were utilized in accomplishing the experimental programme. The guidelines in IS-10262: 1982 were strictly followed in mixing. Coarse aggregate was washed a day before casting to make it silt free and the laid to dry. On the day of casting, coarse aggregate remained satisfactorily moist so that it does not absorb any further water from the mix i.e. the design of water cement ratio is carefully regulated. The moulds used for cubes, beams and cylinders were of steel having an internal dimension of 150 mm x 150 mm for cube, 100 mm x 100 mm x 750 mm for beam and 300 mm x 150 mm for cylinder. The cement, coarse and fine aggregate and superplasticizer were mixed thoroughly with the help of mechanical mixer. Then steel fibre is dispersed to the above mixture while mixer is working. SBR latex is mixed in water and is put into the mixture. For all test specimens, moulds were kept on table vibrator, the concrete was poured into the moulds in three layers by tamping with a tamping rod, and table vibrator effected the vibration after filling up the moulds. The moulds are kept in vibration for one minute and it was maintained constant for all the specimens. The steel fibre is varied in a fraction of 0%, 0.5%, 0.75%, 1%, and 1.25%. The percentage at which maximum strength is obtained was taken to vary SBR latex in a percentage of 5%, 10% 15%. 3 cubes, 3 beams and 3 cylinder specimen are made for each set.

5. RESULTS

5.1. Compressive strength test results

The property like Compressive Strength at the hardened state of SFRC at the age of 28 days evaluated by using automatic compressive strength testing machine by applying the load at the side faces of cube as they were cast in the mould. Three cubes for each percent at different test age have tested to determine the average compressive strength for SRFC.

Table-1 Compressive Strength Test Results of SFRC

Steel fiber (%)	0	0.5	0.75	1	1.25
Compressive strength (MPa)	35.99	38.59	40.07	42.08	37.67

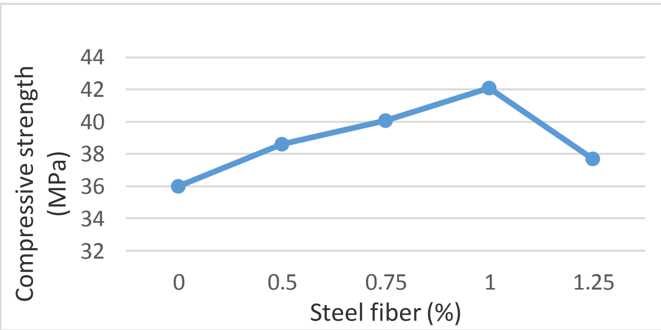

Figure-1. Variation of Compressive Strength for SFRC

Table-1, shows the results of compressive strength of SFRC at the age of 28 days. The above given graph shown in Figure- is plotted from the compression strength test results obtained during testing of SFRC. Figure shows optimum percentage of

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steel fiber in 1% so further SBR addition is done at constant (1%) addition of steel fiber.

Table-2 Compressive Strength Test Results of 1% SFRC with addition of SBR

SBR (%)	5	10	15
Compressive strength (MPa)	37.89	43.88	37.22

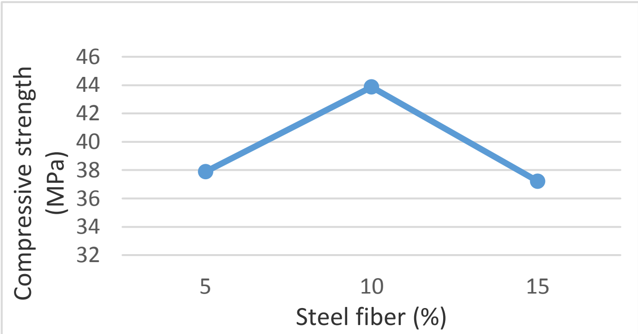

Figure-2. Variation of Compressive Strength for SFRC with addition of SBR

Table-2, shows the results of compressive strength of SFRC with addition of SBR at the age of 28 days. The above given graph shown in Figure- is plotted from the compression strength test results obtained during testing of SFRC with addition of SBR.

5.2. Tensile strength test results

Table-3. Tensile Strength Test Results of SFRC

Steel fiber (%)	0	0.5	0.75	1	1.25
Tensile strength (MPa)	4.78	5.38	5.61	6.05	4.86

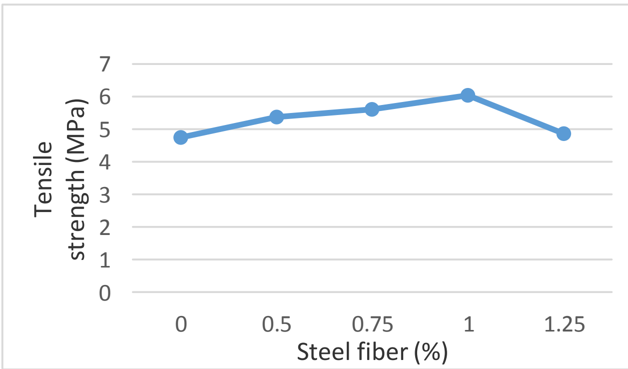

Figure-3. Variation of Tensile Strength for SFRC

Table-3, shows the results of tensile strength of SFRC at the age of 28 days. The above given graph shown in Figure- is plotted from the tensile strength test results obtained during testing of SFRC. Figure shows optimum percentage of steel fiber in 1% so further SBR addition is done at constant (1%) addition of steel fiber.

Table-4. Tensile Strength Test Results of SFRC with addition of SBR

SBR (%)	5	10	15
Tensile strength (MPa)	4.92	6.60	4.80

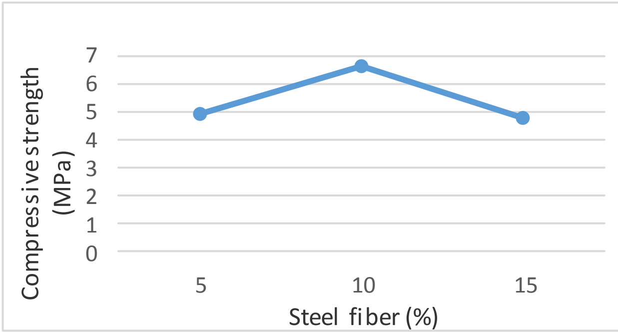

Figure-4. Variation of tensile Strength for SFRC with addition of SBR

5.3. Flexural strength test results

Table-5. Flexural Strength Test Results of SFRC

Steel fiber (%)	0	0.5	0.75	1	1.25
Flexural strength (MPa)	12.23	12.32	12.68	13.3	13.00

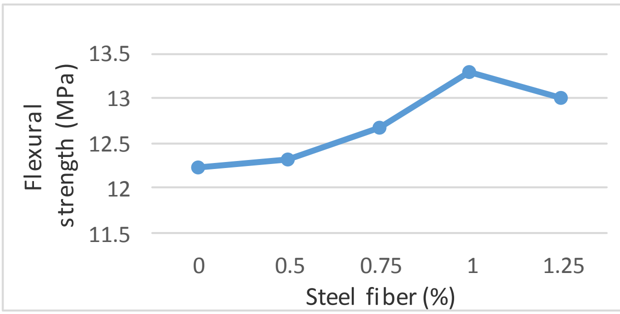

Figure-5. Variation of Flexural Strength for SFRC

Table-5, shows the results of flexural strength of SFRC at the age of 28 days. The above given graph shown in Figure- is plotted from the tensile flexural test results obtained during testing of SFRC. Figure shows optimum percentage of steel fiber in 1% so further SBR addition is done at constant (1%) addition of steel fiber.

Table-6 Flexural Strength Test Results of SFRC with addition of SBR

SBR (%)	5	10	15
Tensile strength (MPa)	13.39	14.56	13.64

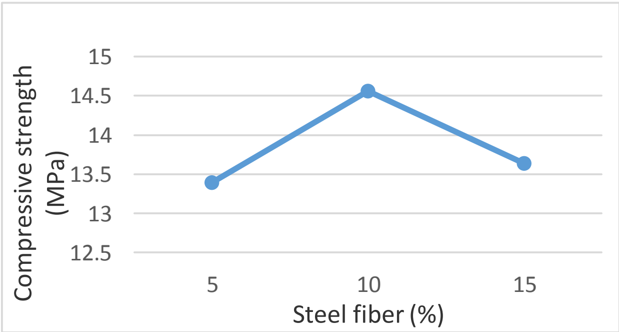

Figure-6. Variation of Flexural Strength for SFRC with addition of SBR

6. CONCLUSIONS

Based on these results and observations made in this experimental research study, the following conclusions are drawn:-

1. It has been found that compressive, split tensile and flexural strength have their maximum values for 1% steel fiber dosage among all fiber variations. The compressive strength is increased by 17.97%, split tensile strength by 26.56% and flexural strength by 3.58% when compared to their nominal strength. For any further increase in fiber content the values of strengths decrease gradually.
2. When SBR latex is added along with 1% steel fiber dosage, maximum strengths are obtained at 10% of latex. The compressive strength is increased by 23.01%, split tensile strength by 38.07% and flexural strength by 13.47% when compared to their nominal strength.
3. The test results show that by using 10% latex along with 1% steel fiber, the compressive strength increased by 4.27%, split tensile strength by 9.09% and flexural strength by 9.54% when compared to strength values for 1% fiber alone.
4. All the three types of strength values (flexural, compressive, tensile) decrease for any further increase in the quantity of latex above 10% dosage.
5. By the addition of SBR latex, there is an increase in the workability of concrete as the polymer content is increased.
6. The addition of fibers plays an important role for arresting, delaying and propagation of cracks.

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