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Behavior of Steel Fiber Reinforced Concrete for M-25 Grade

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Abstract

It is now well established that one of the important properties of steel fibre reinforced concrete (SFRC) is its superior resistance to cracking and crack propagation. As a result of this ability to arrest cracks, fibre composites possess increased extensibility and tensile strength, both at first crack and at ultimate, particular under flexural loading; and the fibres are able to hold the matrix together even after extensive cracking. The net result of all these is to impart to the fibre composite pronounced post – cracking ductility which is unheard of in ordinary concrete.

In this paper, the mechanic properties i.e. Compressive, Flexural and split tensile strength of SFRC are discussed.

Keywords: *Steel fiber, concrete, properties, crack.*

Introduction

Concrete is the most widely used structural material in the world with an annual production of over seven billion tons. For a variety of reasons, much of this concrete is cracked. The reason for concrete to suffer cracking may be attributed to structural, environmental or economic factors, but most of the cracks are formed due to the inherent weakness of the material to resist tensile forces. Again, concrete shrinks and will again crack, when it is restrained. It is now well established that steel fibre reinforcement offers a solution to the problem of cracking by making concrete tougher and more ductile. It has also been proved by extensive research and field trials carried out over the past three decades, that addition of steel fibres to conventional plain or reinforced and prestressed concrete members at the time of mixing/production imparts improvements to several properties of concrete, particularly those related to strength, performance and durability.

The weak matrix in concrete, when reinforced with steel fibres, uniformly distributed across its entire mass, gets strengthened enormously, thereby rendering the matrix to behave as a composite material with properties significantly different from conventional concrete.

Material Methods

Material used

•**Cement:-** PPC of Ultratech brand was used and get was confirming to IS 1480-1991.Tests were conducted to find the properties of cement and result are tabulated in the Table-1.

•**Fine Aggregate:-** locally available river sand was used as fine aggregate. Tests are conducted to find properties of FA and test result are tabulated in the Table-2.

•**Coarse Aggregate:-** Locally available crushed stone is used whose size 12.50mm. Tests are conducted to find the properties of CA and the results are tabulated in the Table-2.

• **Steel Fibers**:- In this experiment Shaktiman crimped steel fibres is used. Properties are given in Table-3.

Table-1: physical test on cement

Test conducated	Result obtained	Result as
Specific gravity	3.15	-
Consistency	31%	-
Setting time (min) Initial	150	30
Final	210	Max 600
Fineness	342	300
Soundness	1.00	10.00mm

Table-2: Properties of fine and coarse aggregate.

Properties	FA (River sand)	CA (Quarry crushed stone)
Fineness modulus	3.25	7.13
Specific gravity	2.63	2.68
Loose bulk density (kg/m3)	1450	1350
Compacted bulk density(kg/m3)	1710	1600

Table-3:- Shaktiman crimped steel fibre used in this study

Fiber	Shaktiman crimped Steel Fiber
Maximum tensile strength	828 Mpa
Fiber length	12 mm
Average equivalent diameter	0.60 mm
Average aspect ratio	20
Deformation	Continuously deformed circular segment

Mix Design- The control mixture was comprised of PPC cement, water, coarse aggregate, fine aggregate with same aggregate to cement ratio and w/c ratio were studied, the mix proportion of control mixes is presented in table-5;

Table-5:- Composition of controlled concrete

Concrete Constitnents	Quantity(kg/m3)
Cement	450
Fine Aggregate	660
Coavse Aggregate	1010
Water	200

Steel Fibre Reinforced Concrete (SFRC): In this research steel fibre reinforced concrete composition containing 0.5%, 1% & 1.5% fibres by unit weigth of concrete were prepared concrete cubes & beams were cast using these fibres reinforced concrete to perform compressive strength & split tensile strength as well as flexural strength respectively.

Experimental methodology

Sample Preparation: All concrete mixtures (controlled concrte & fibre reinforced concrete) were prepared using a mechanical mixture. Cube specimen of 100*100*100mm were cast. The specimen of concrete beams 100*100*500 mm were cast. All the specimen were cured in a curing room at 30’ C temperature and 90% relative humidity. Both control and fibre reinforced concretes were tested at 7 & 28 days of age to get compressive, flexural and split tensile strength values.

Compressive strength test:

For compressive strength test, cube specimens of dimensions 100 x 100 x 100 mm were cast for M25 grade of concrete. The moulds were filled with 0%, 0.5% 1% and 1.5% fibres. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank where in they were allowed to cure for 7 and 28 days. After 7 and 28 days curing, these cubes were tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category three cubes were tested and their average value has been presented in fig. 1.

Flexural strength

For flexural strength test beam specimens of dimension 100x100x500 mm were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 and 28 days. These flexural strength specimens were tested under two point loading as per I.S. 516-1959, over an effective span of 460 mm on Flexural testing machine. Loads were noted up to failure. In each category three beams were tested and their average value has been presented in fig 2 .

Split Tensile Strength Test

For Split tensile strength test, cube specimens of dimension 100x100x100 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 and 28 days. Diagonally placed specimens were tested under compression testing machine. In each category three cubes were tested and their average value has been presented in fig. 3

Results and Conclusion

Compressive Strength: The result of compressive strength test performed for control mix and fiber rainforced concrete containing different percentage are graphically represented in fig.1

It is observed that there is considerable increment in the compressive strength due to addition of Shaktiman steel fiber at 7 and 28 days of age. That is about 25-34% gain in the strength compare to control mix.

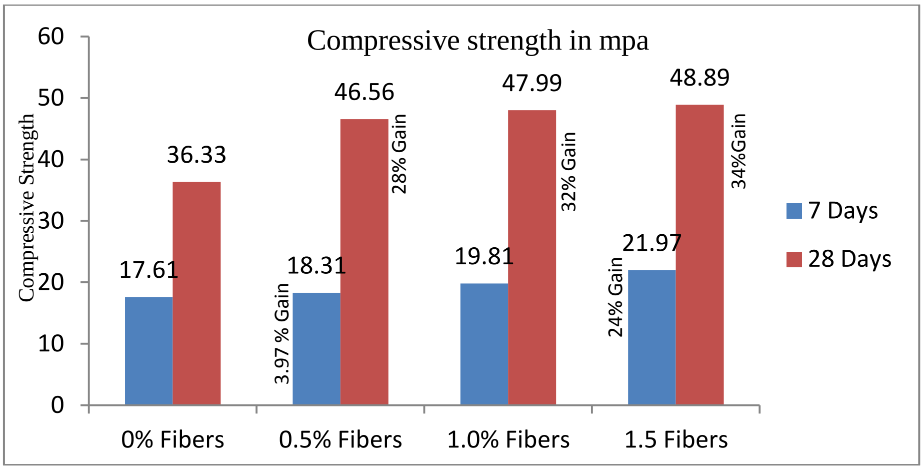

Fig.1 Compressive strength of mix containing different % of steel fibres

Flexural Strength

The result of flexural strength test performed for control mix and fiber reinforced concrete containing different percentage are graphically represented in fig.2

It is observed that flexural strength increases from 20 to 25% with addition of steel fibers.

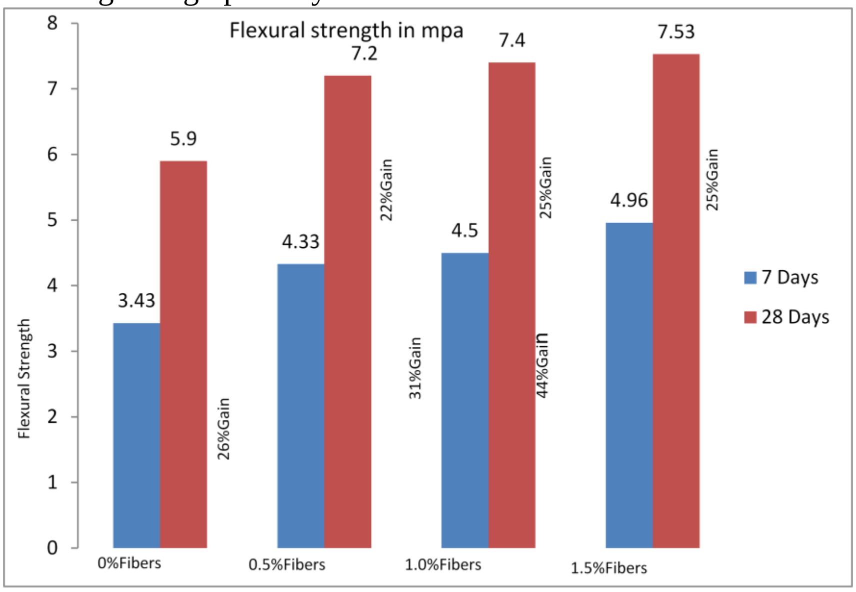

Fig.2 Flexural strength of mix containing different % of steel fibres

Split tensile Strength

The result of tensile strength test performed for control mix and fiber rainforced concrete containing different percentage are graphically represented in fig.3

It is observed that tensile strength increases from 21to24% with addition of steel fibers.

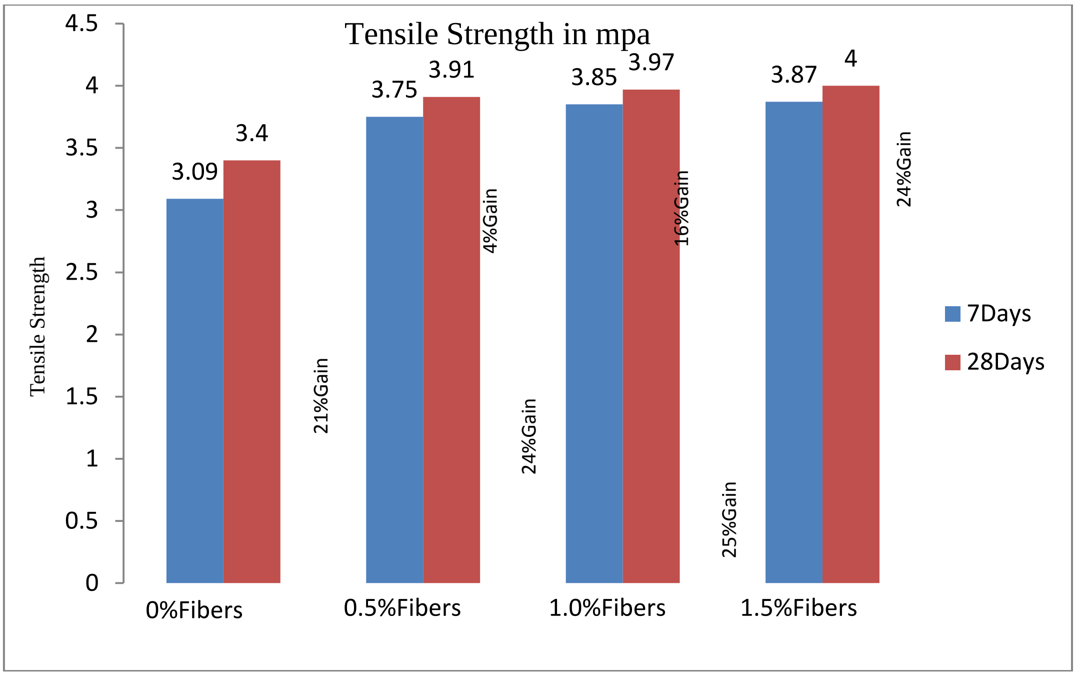

Fig.3 Split tensile strength of mix containing different % of steel fibres

Workability

It is observed that workability is slightly decreases due to addition of steel fiber.

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