

Experimental study on Steel Fibre Concrete

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ABSTRACT

Experimental study on Steel Fiber concrete for M20 grade having mix proportion 1:1.96:2.63 and water cement ratio of 0.45 to study the compressive, flexural and split tensile strength of Steel Fibred Reinforced Concrete (SFRC) containing fibers of 1%, 2%, 3%, volume fraction. In this study steel fibers of Aspect Ratio 50, 60 and 67 were used. The result obtained is analyzed and compared with a control specimen (0% steel fiber). The Relationship between Aspect ratio vs Compressive strength, Aspect ratio vs flexural strength and Aspect ratio vs split tensile strength is represented graphically. The result shows the percentage increase in compressive strength, flexural strength and split tensile strength for 28days.

Keywords : - steel fibre, compressive strength, tensile strength and split tensile strength.

1. INTRODUCTION

Concrete is the widely used material exceeding other materials in construction due to its ability in getting casted in any size and shape. Nowadays the usage of concrete is increasing day by day. Materials used in the concrete are being replaced by some alternate materials. Concrete is a composite material composed of Cement, Coarse aggregate, fine aggregate and water. According to the type of the binder used concrete is classified into different types like Portland cement concrete, asphalt concrete, epoxy concrete etc. In the modern practice along with the materials used in the concrete admixtures were also added. An admixture is defined as the materials other than the aggregate, cement and water added to the concrete immediately during the mixing or before the mixing of concrete. The use of admixtures is mainly to modify the setting and hardening of cement by influencing the rate of hydration of cement. Different types of admixtures are there to reduce the water content by reducing the surface tension of water; other admixtures are used to increase the durability of concrete and decrease the thermal cracking. Using concrete is beneficial because it is Economical, Ambient temperature hardened material, Ability to cast, Energy efficiency, Excellent resistance to water, High temperature resistance, Ability to consume water, Ability to work with reinforcing steel and Less maintenance required. Along with the advantages there are some limitations like Low tensile strength, Low toughness, long curing time and Frame work is needed and working with cracks.

2. LITERATURE REVIEW

Rui D. Neves and Joao C. O. Fernandes de Almeida varied the percentage of volume of fibre in the concrete up to 1.5%. Their results indicate that the addition of fibres to concrete enhances its toughness and strength and peak stress, but can slightly reduce Young's modulus. Many other researchers had worked on it, the recommended reinforcement of steel fibre in concrete is up to 3% by weight of cement only. Thus this thesis is on reinforcement of steel fibre upto 3% in 0.5% interval.

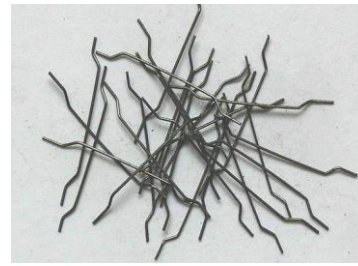
3. MATERIALS

The materials used are cement, coarse aggregate sand as fine aggregate, water and steel fibres.

- **Cement:** Ordinary Portland cement of 53 Grade
- **Fine Aggregate** (sand): Locally available zone II sand with specific gravity 2.6 confirming with code book IS 393-1970.
- **Coarse aggregate:** Crushed stone of 10mm size having specific gravity 2.76 confirming code book IS 393-1970.
- **Water:** Potable water for Experiments.
- **Steel fibers:** In this Experiment Hook tain steel fibers are used with different aspect ratios 50, 60 and 67 having lengths 35, 30 and 20mm with diameter 0.7, 0.5 and 0.4.



(a) Steel Fibre Concrete



(b) Steel Fibre

Properties OF SFRC: In steel fibre reinforced concrete various mechanical properties are as

- compressive strength
- split tensile strength
- flexural strength

4.METHODOLOGY

To find the compressive strength the cubes were casted in the moulds of dimensions 150x150x150mm and filled with M20 concrete. Along with the concrete steel fibers of 0%, 1%, 2%, 3% were also added. While casting the cubes the compaction is done using the table vibrator. At last the top layer of the specimen is fully levelled and well finished. From the time of casting after 24 hours the cubes were remoulded and were kept for curing in a curing tank for 28days. After 28days curing is done these specimens have been tested in a compression testing machine. Generally for each category three cubes were taken and the average of them is considered. The compressive strength is calculated as follows :- $\text{Compressive Strength (Mpa)} = \text{Failure load} / \text{Cross sectional area}$

4.1For 0% fiber concrete

Table-1. Average compressive strength of 0% steel fibers.

Compressive strength (Mpa)	Avg. compressive strength (Mpa)
24.44 21.11 22.22	22.56

The normal M20 concrete is prepared with 0% of fibers and compressive strength is computed. The results are tabulated as in table- 1.

4.2Additions of steel fibers to the concrete

Now the steel fibers are added with varying percentages like 1%, 2% and 3% with varying aspect ratios 50, 60 and 67.

Table-2. Average compressive strength for 1, 2 and 3% steel fibers.

Aspect ratios of fibers	Adding 1% of steel fiber		Adding 2% of steel fiber		Adding 3% of steel fiber	
	Compressive strength (Mpa)					
		Average		Average		Average
50	26.00 25.78 26.22	26.00	26.66 27.33 26.03	26.66	27.78 28.22 28.44	28.15
60	26.66 24.44 24.44	25.185	26.66 26.44 25.78	26.29	26.66 26.89 27.55	27.03
67	25.33 25.78 24.22	25.11	26.66 25.78 24.66	25.70	25.78 26.22 27.55	26.52

4.3.Effect of compressive strength on steel fiber concrete

The Graph is plotted aspect ratios on X-axis and compressive strength is in Y-axis. It is observed that the compressive strength is more for aspect ratio -50 and least for aspect ratio -67. The compressive strength decreases with increases of aspect ratio.

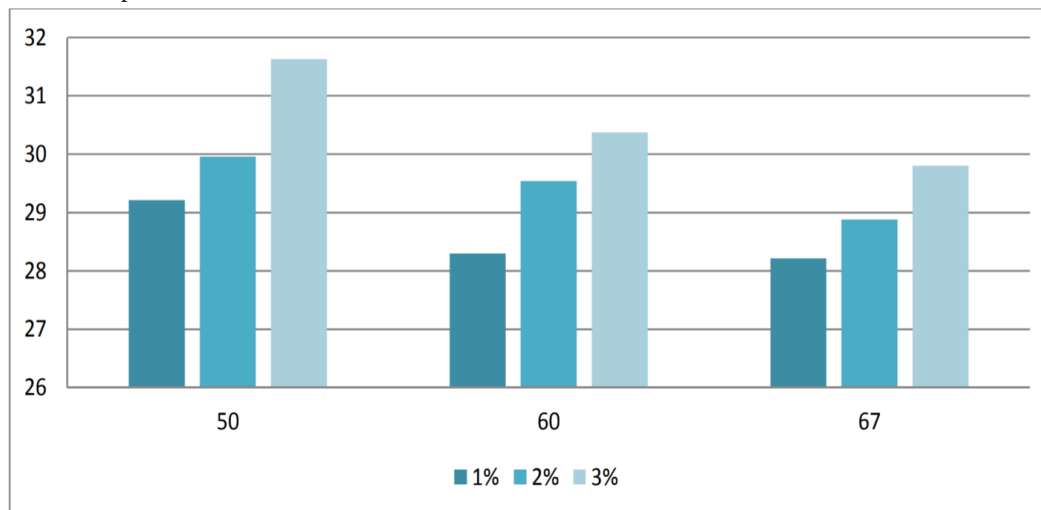


Chart : Aspect ratio vs compressive strength.

4.4.Effect of flexural strength on steel fiber concrete:

To find the flexural strength the beams were casted in the molds of dimensions 100 x 100 x 500mm with M20grade concrete. Along with the concrete steel fibers of 0%, 1%, 2%, 3% were also added. While casting the beams the compaction is done using the table vibrator. At last the top layer of the specimen is fully levelled and well finished. From the time of casting after 24 hours the cubes were remoulded and were kept for curing in a curing tank for 28days. After 28days curing is done these specimens have been tested in a flexural testing machine. This flexural strength specimen was tested under two point loading as per IS 516-1959 over an effective span of 400mm. Generally for each category three beams were taken and average of them is considered. The compressive strength is calculated as follows:

$$\text{Flexural Strength (Mpa)} = (P \times L) / (b \times d^2)$$

P=Failure Load, L=c/c distance=400mm, b=width of the specimen=100mm, d2=Depth of the specimen=100mm

4.5.Compressive strength test

The reinforcement provided by fibres can work at both a micro and macro level. The ability of the fibre to control Micro cracking growth depends mainly on the number of fibres, deformability and bond to the matrix. A higher number of fibres in the matrix leads to a higher probability of a micro-crack being intercepted by a fibre, it is observed that Compressive Strength increases as volume of Steel fiber increases. As per the previous research it is observed that the using Steel fiber upto 3% in concrete is good. The Compressive Strength of concrete with steel Fiber reinforced in proportions of 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% is 27.3MPa, 29.2MPa, 29.8MPa, 31.4MPa, 32.3MPa, 32.7MPa and 33MPa at 28th day of curing respectively. The Compressive strength is in increasing order and the maximum strength is gained at 3.0% of steel fiber use concrete that is 33 MPa.

4.6. Tensile strength of sfrc

It is observed that Split Tensile Strength increases as volume of Steel fiber increases. As per the previous research it is observed that the using Steel fiber upto 3% in concrete is good. The Split Tensile Strength of concrete with steel Fiber reinforced in proportions of 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% is 2.4MPa, 2.7MPa, 3.2MPa, 3.5MPa, 3.9MPa, 4.3MPa and 4.8MPa at 28th day of curing respectively. The Split Tensile strength is in increasing order and the maximum strength is gained at 3.0% of steel fiber use concrete that is 4.8MPa.

5.ADVANTAGES OF STEEL FIBRES IN CONCRETE

- The increased load-bearing capacity of concrete
- Reduction of concrete slab thickness
- Load capacity is not diminished by concrete cracks (crack control)
- Increased durability
- Low maintenance costs – extended service life
- Improved flexural properties
- Reduced absorption of water, chemicals, etc.

- Can be used on the fast track schedule.
- Easier positioning of joints (fewer joints required)
- Reduced site labour for managing steel reinforcement
- Reduced project costs – ensures economical designs
- Increased impact and abrasion resistance
- Even distribution of fibres throughout the concrete (concrete tensile strength can be specified)
- Tougher surface with fewer bleed holes (improved concrete quality expected)
- Savings will be greater for heavier crack control systems
- No requirement for heavy lifts of rebar and labour requirements. Reinforcement is incorporated in the mix.
- Corrosion-free surface finish.
- Reduces permeability of concrete (because micro-cracks are controlled).

6. DIS-ADVANTAGES OF STEEL FIBRES IN CONCRETE

- More expensive than traditional rebar. Can't be used in heavy loadings situations – rebar is preferred.
- May require a manufacturer license for batching this type of concrete mixes.
- Labour workers may require training.

7. USES OF STEEL FIBRES IN CONCRETE

- Steel decks
- Pile-supported floors.
- Power-station floor slabs
- The opportunity of pre-fabricated slabs manufactured at the factory and brought on-site for installation.
- Use with rebar reinforcement increasing strength using less rebar.
- Flat pavements.
- Existing columns strength reinforcement.

8. CONCLUSIONS

The Compressive Strength of SFRC (Aspect ratio 60) for proportions of 0%, 0.5%, 0.10%, 1.5%, 2%, 2.5% and 3% are 27.3 MPa, 29.2 MPa, 29.8 MPa, 31.4 MPa, 32.2 MPa, 32.7 MPa and 33MPa respectively at 28th day of curing. The Split Tensile strength of SFRC for proportions of 0%, 0.5%, 0.10%, 1.5%, 2%, 2.5% and 3% are 2.4 MPa, 2.7 MPa, 3.2 MPa, 3.5 MPa, 3.9 MPa, 4.3 MPa and 4.8MPa respectively at 28th day of curing. With the use of 3% of steel fibre gives the maximum result in compression as 25.7MPa, 30.05MPa and 33MPa at 7th day, 14th day and 28th day of curing respectively.

With the use of 3% of steel fibre gives the maximum result in Split Tensile Strength as 3.36MPa, 4.52MPa and 4.8 MPa at 7th day, 14th day and 28th day of curing respectively.

From the result it is observed that the workability of Steel Fibre reinforced concrete decreases as the percentage of steel fibres increases.

The addition of Steel Fibre in concrete increases the Tensile properties of concrete and also improves resistance to cracking.

From this study it is observed that ~ The increase in aspect ratio of steel fiber decreases the strength of concrete and increase of steel fibre content increases the strength of the concrete.

From this we have come to a conclusion that ~ The strength of the concrete increases with increase in percentage of steel fiber but due to increase in aspect ratio the strength of concrete decreases.

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