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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. 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. Now a day's usage of concrete is increasing day to 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 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 decrease the thermal cracking. Using of 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. 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.

3. METHODOLOGY

To find the compressive strength the cubes were casted in the moulds of dimensions 150x150x150mm is 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 time of casting after 24 hours the cubes were remoulded and were kept for curing in curing tank for 28days. After 28days curing is done these specimens have been tested in compression testing machine. Generally for each category three cubes were taken and average of them is considered. The compressive strength is calculated as follows

Compressive Strength (Mpa) = Failure load/Cross sectional area

3.1 For 0% fiber concrete

The normal M20 concrete is prepared with 0% of fibers and compressive strength is computed. The results are tabulated below.

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

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

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3.2 Additions 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 for1, 2 and3% steel fibers.

Aspect ratios of fibers	Adding 1% of steel fiber		Adding 2% of steel fiber		Adding 3% of steel fiber	
	Compressive strength (Mpa)					
		Avg		Avg		Avg
50	26.00 25.78 26.22	26.00	26.66 27.33 26	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

3.3 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 is decreases with increases of aspect ratio.

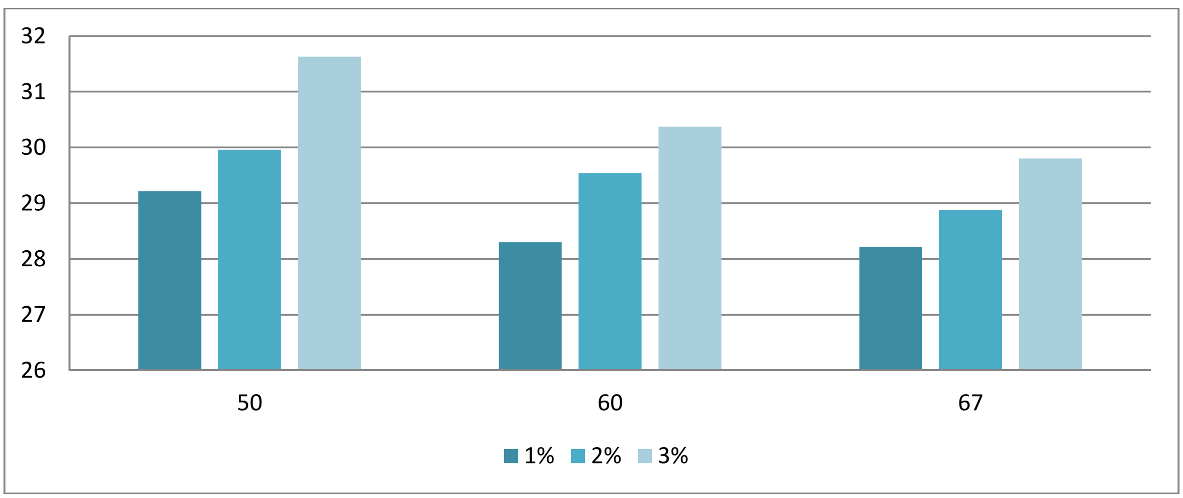

Figure-1. Aspect ratio vs compressive strength.

3.4 Effect of flexural strength on steel fiber concrete:

To find the flexural strength the beams were casted in the moulds of dimensions 100 x 100 x 500mm with M20 grade 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 time of casting after 24 hours the cubes were remoulded and were kept for curing in curing tank for 28days. After 28days curing is done these specimens have been tested in flexural testing machine. This flexural strength specimen were 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:

Flexural Strength (Mpa) = (P x L)/ (b x d_2)

P=Failure Load, L=c/c distance=400mm, b=width of the specimen=100mm, d_2=Depth of the specimen=100mm

3.5 For 0% fiber concrete

The normal M20 concrete is prepared with 0% of fibers and Flexural strength is computed. The results are tabulated below.

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Table-3. Average flexural strength for 0% steel fibers.

Flexural strength (Mpa)	**Avg. flexural strength**
3.8 3.6 3.8	3.73

3.6 Additions 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-4. Average flexural strength for1, 2 and3% steel fibers.

Aspect ratios of fibers	**Adding 1% of steel fiber**		**Adding 2% of steel fiber**		**Adding 3% of steel fiber**	
	Flexural strength (Mpa)					
		Average		**Average**		**Average**
50	4.4 4.6 4.2	4.4	4.4 4.8 5	4.735	5.2 5 5.4	5.20
60	4.2 4.4 4.0	4.2	4.4 4.6 4.8	4.60	4.8 5 5.2	5.00
67	4.0 4.0 4.4	4.135	4.00 4.5 5	4.50	4.4 5.2 5	4.865

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

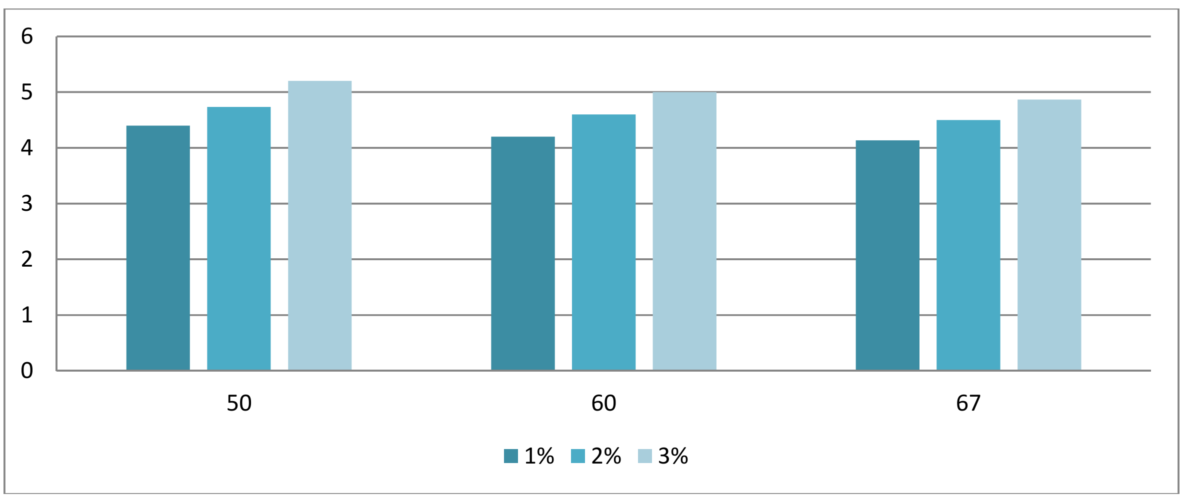

Figure-2. Aspect ratio vs flexural strength.

3.7 Effect of split tensile strength on steel fiber concrete

To find the split tensile strength the cylinders were casted in the moulds of dimensions 300mm length and 150mm diameter with M20 grade concrete. Along with the concrete steel fibers of 0%, 1%, 2%, 3% were also added. While casting the cylinders the compaction is done using the table vibrator. At last the top layer of the specimen is fully levelled and well finished. From time of casting after 24 hours the cylinders were remoulded and were kept for curing in curing tank for 28days. After 28days curing is done these specimens have been tested in compression testing machine. The split tensile strength is calculated as follows:

Split tensile strength (Mpa) = $2P/\pi DL$

Where

P=Failure load, D=Diameter of Cylinder, L=Length of cylinder

3.8 For 0% fiber concrete

The normal M20 concrete is prepared with 0% of fibers and Split tensile strength is computed. The results are tabulated below:

Table-5. Average flexural strength for 0% steel fibers.

Flexural strength (Mpa)	**Avg. split tensile strength**
1.415 1.555 1.63	1.535

3.9 Additions 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-6. Average split tensile strength for1, 2 and3% steel fibers.

Aspect ratios of fibers	**Adding 1% of steel fiber**		**Adding 2% of steel fiber**		**Adding 3% of steel fiber**	
	Split tensile strength (Mpa)					
		Avg		**Avg**		**Avg**
50	1.55 1.77 1.63	1.65	1.91 1.91 2.05	1.96	2.195 2.125 2.195	2.17
60	1.485 1.70 1.63	1.605	1.98 1.77 1.77	1.84	2.125 2.05 2.195	2.125
67	1.415 1.63 1.7	1.58	1.77 1.98 1.70	1.815	1.91 2.125 2.265	2.10

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

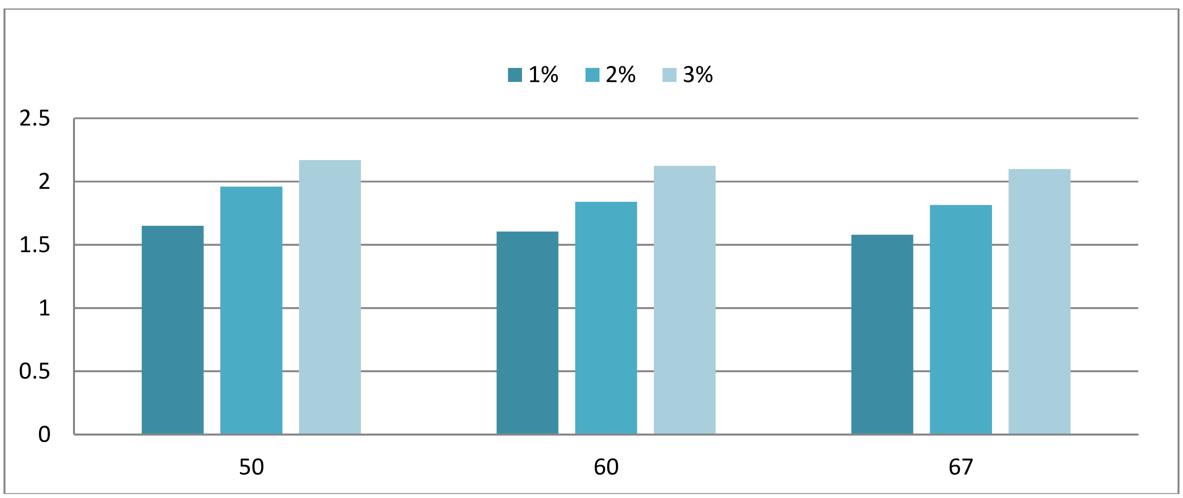

Figure-3. Aspect ratio vs split tensile strength.

4. CONCLUSIONS

From this study 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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