STUDY ON USE OF STEEL FIBER AS REINFORCEMENT MATERIAL WITH CONCRETE

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ABSTRACT

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. . It contains short discrete fibers that are uniformly distributed and randomly oriented. In order to achieve the desired goal, different dosages of steel fiber (0.5%, 1%, 1.5% & 2%) in the concrete grade of M-40.According to the results of experimental study, it is concluded that with the addition of steel fibers, The concrete mix M2, M3 M4 and M-5 shows percentage increment in compressive strength by 4.86%, 9.34%, 11.64% and 18.76% at 7 days of curing period with respect to concrete mix M1. The compressive strength by CTM (destructive testing technique) is found to increase with increase in percentage of steel fibers in the conventional concrete. The concrete mix M2, M3 M4 and M-5 showed increment in compressive strength by 4.54%, 7.32%, 9.08% and 11.72% at 28 day of curing period with respect to concrete mix M1. Tensile strength of cylinder specimen is maximum at 2% of steel fibers which having strength of 3.18 and 4.69 Mpa after 14 and 28 days respectively. Percentage increase for 2% steel fiber of 14 and 28 days is 25.19% and 18.43% respectively.Maximum flexural strength after 28 days is 10.43 MPa. Percentage increase for 2% of steel fiber is 13.36% as comparison to M-1 mix so it can be analyse that this variation of steel fiber is good for flexural strength of concrete. This experimental study shows that the steel fibers improve the properties of the conventional concrete and it enhances the tensile strength of concrete.

1. INTRODUCTION

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Fiber reinforced concrete are of different types and properties with many advantages. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibers. Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Within these different fibers that character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities. Fiber-reinforcement is principally employed in shotcrete, however may be employed in traditional concrete.

2. Materials & Methods

2.1 Cement

The cement taken was Ordinary Portland Cement (OPC) of 43 grade of uniform consistency, conforming to IS 8112-1989. The test for specific gravity, standard consistency, initial and final setting time and 28 day compressive strength have been conducted Table 1.

Table 1: Physical Properties of Ordinary Portlandcement

Sr.No.	Characteristics	ValuesObtained	StandardValues
1.	SpecificGravity	3.15	-
2.	NormalConsistency	30%	-
3.	Initial SettingTime	48 min	Not to be less than 30minutes
4.	Final SettingTime	580 min	Not to be greater than 600minutes
5.	Soundness	8mm	10 max

2.2 Steel Fibers

It is made of cold drawn steel wire with low content of carbon (C) or stainless steel wire (SS 302/ SS 304). Steel fibers are manufactured in different types: hooked, undulated or flat and the properties of steel fibers as shown in table 2.Fiber-reinforced normal concrete is mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, pilars, foundations etc) either alone or with hand-tied rebars.

Table 2: Physical Properties of Steel Fiber (Value from Supplier)

Properties	Value
Fiber Length	50mm
Equivalent Diameter	0.80 to 1.25mm
Tensile Strength	1000N/mm^2
Deformation	Continuously Deformed
Appearance	Bright and clean wire

2.3 Fine Aggregate:

The fine aggregate (river sand- Badarpur) used in the experimental work is locally procured. Sieve analysis of the fine aggregate was carried out in the laboratory as per IS 383-1970, and the results are tabulated in Table 3.

Table3:PhysicalPropertiesofFineAggregate

Characteristics	Type	Specificgravity	FinenessModulus	GradingZone	Water absorption
Value	NaturalSand	2.5	2.46	II	4.06

2.4 Coarse Aggregate:

The aggregates which are retained over IS sieve 4.75mm are called as coarse aggregate. The coarse aggregate used in the present study was locally available crushed stones of maximum size of 10 mm. Specific gravity and other physical properties of coarse aggregates are given in Table 4.

Table4: PhysicalPropertiesofCoarseAggregate

Characteristics	Colour	Shape	Maximum Size	Specific Gravity	FinenessModulus	Water absorption
Value	Grey	Angular	20 mm	2.72	6.61	8.58%

2.5 WATER

Tap water without any salts or chemicals was used in the study

3. CONCRETE MIX DESIGN

The mix design of fiber reinforced concrete is not different from that of conventional concrete and the same mix design procedure as per given in IS 10262:2000 adopted for the M-40 grade of concrete. The ratio of the ingredients material is 1:1.73:3.076 and the water/cement ratio is 0.40 the for all the mix proportions. The concrete specimens are prepared with steel fibers as percentage of (0%, 0.5%, 1%, 1.5% and 2%) for the M-40 grade of concrete. Three cubes, cylinders and beams of each variation of steel fibers are casted and the average of three test results is taken for the accuracy of the results. The ingredients of mix design and the gradation of the concrete are as shown in Table 5 & 6.

Table 5: Design Mix of the Concrete for 1m^3

Ingredients	Cement	W/C Ratio (0.40)	Fine Aggregate	Coarse aggregate	Admixture (Litre)	Total Weight
Quantity	393.33	157	682	1210	4.72	2447.7

Table 6: Gradation of the steel fiber concrete mix

Concrete Mix	Mix Content
M1	M-40 (control mix)
M2	M-40 + 0.5% S.F.
M3	M-40 + 1% S.F.
M4	M-40 + 1.5% S.F.

M5	M-40 + 2% S.F.

4. RESULT & DISCUSSION

4.1 Compressive Strength

The compressive strength test result and percentage reduction in compressive strength for various concrete mixes is tabulated in Table 7, after curing period of 7, 14 and 28days. The value ranges from 41.62 to 46.50 for concrete mix M1 to M5 respectively for 28 days of curing. Result is shows that the increment of compressive strength of concrete specimen at 28 days was found to be 4.54%, 7.32%, 9.08% and 11.72% for M2, M3, M4 and M5 respectively as shown in figure 4.1.

Table 7: Compressive strength results of the concrete mix

Gradation of Concrete	Compressive Strength Results		
	7 days	14 days	28 days
M-1(control mix)	32.3	34.57	41.62
M-2	33.87	36.45	43.51
M-3	35.32	37.5	44.67
M-4	36.06	38.06	45.4
M-5	38.36	39.76	46.5

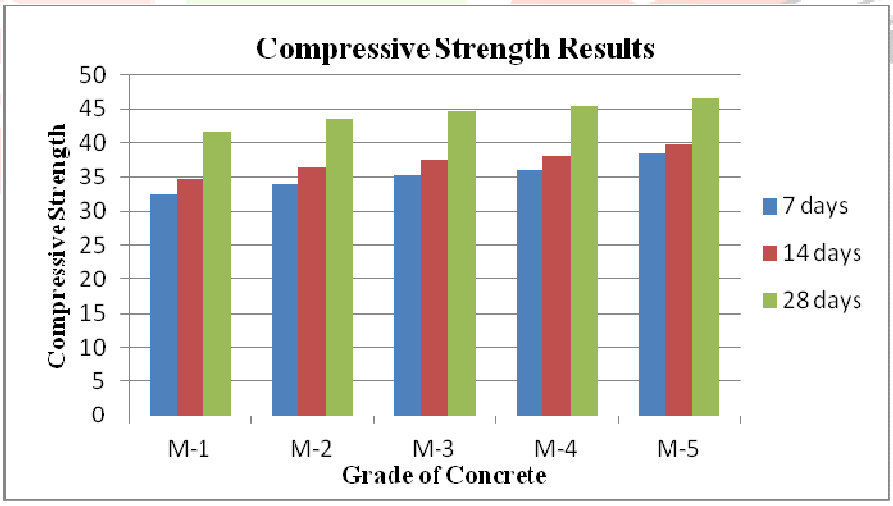

Figure 4.1: Compressive strength results of the concrete mix

4.2 Split Tensile Strength

Split tensile strength of concrete is increased as the percentages of fibers increase simultaneously. The value of split tensile strength after 7 days of curing is maximum at 2% of steel fibers which increase the strength of 17.77 % as comparison to conventional concrete. 25.19% and 18.43% increase in tensile strength at 2% addition of steel fibers after curing of 14 and 28days.The split tensile strength results of all the specimen is tabulated in the Table 8 and the results of all the mixes shown in figure 4.2.

Table 8: Split tensile strength results of the concrete mix

Gradation of Concrete	Split Tensile Strength Results		
	7 days	14 days	28 days
M-1(control mix)	2.25	**2.54**	3.96
M-2	2.37	2.83	4.41
M-3	2.52	2.92	4.47
M-4	2.55	2.98	4.58
M-5	2.65	3.18	4.69

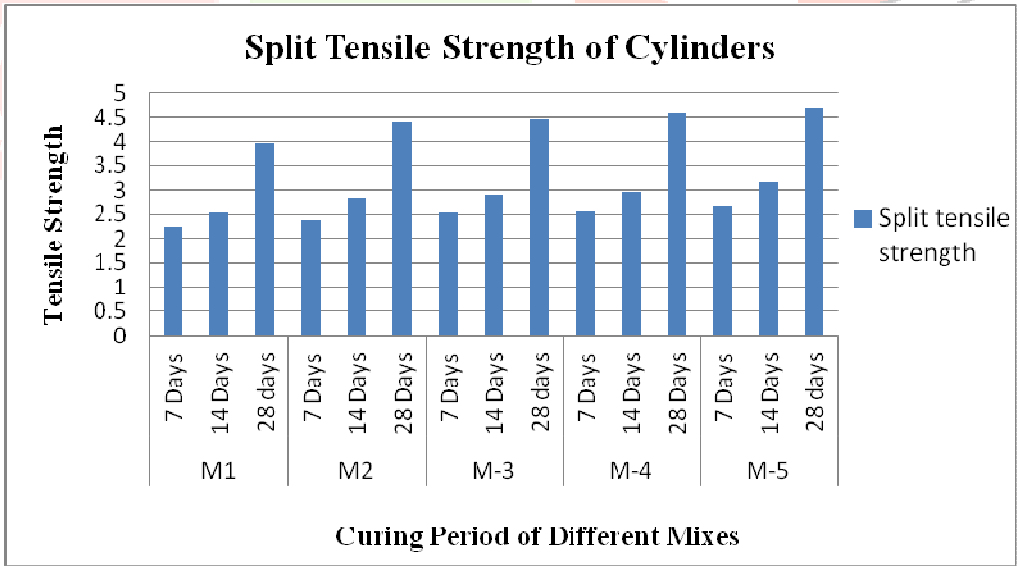

Figure 4.2: Split tensile strength results of the concrete mix

4.3 Flexural Strength

The flexural strength of concrete beams is maximum at 2% of steel fibers as shown in figure 4.3. Increase in flexural strength by 13.36% is as comparison to the 0% addition of steel fibers. The results of the flexural strength after 28 days are given in Table 4.4.

Table 8: Flexural strength results of the concrete mix

Concrete Mix Designation	Avg. Load	Strength (N/mm^2)	% increase in strength
M-1 (control mix)	20.46	9.20	0
M-2	21.41	9.63	4.67
M-3	22.46	10.10	9.78
M-4	22.40	10.08	9.56
M-5	23.19	10.43	13.36

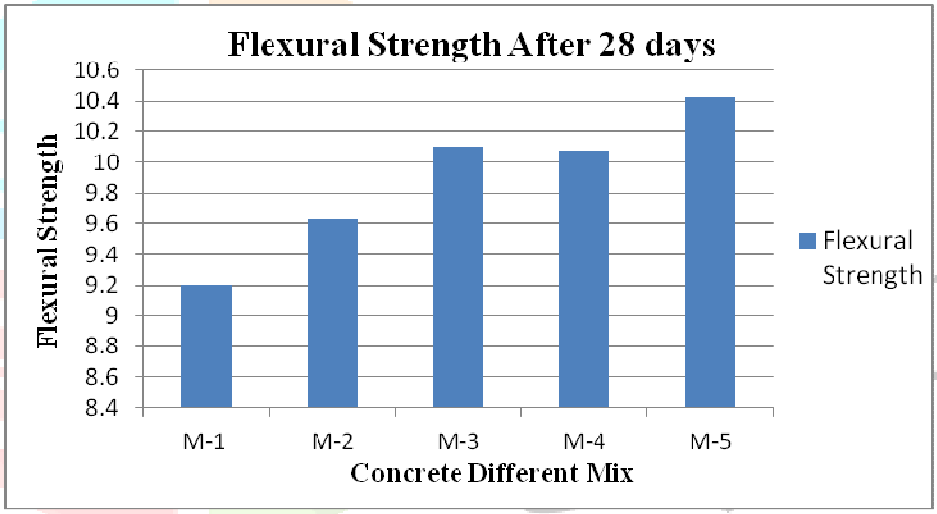

Figure 4.3: Flexural strength results of the concrete mix

5. CONCLUSION

The concrete mix M2, M3 M4 and M-5 shows percentage increment in compressive strength by 4.86%, 9.34%, 11.64% and 18.76% at 7 days of curing period with respect to concrete mix M1. The compressive strength (by CTM) of concrete mix M2, M3 and M4 are 33.87 MPa, 35.32 MPa, 36.06 MPa and 38.36 MPa respectively, at curing period of 7 days.

The concrete mix M2, M3 M4 and M-5 shows increment in compressive strength by 5.43%, 8.47%, 10.09% and 15.01% at 14 days of curing period with respect to concrete mix M1. The compressive strength (by CTM) of concrete mix M2, M3 and M4 are 36.45 MPa, 37.50, 38.06 MPa and 39.76 MPa respectively, at curing period of 14 day.

The compressive strength by CTM (destructive testing technique) is found to increase with increase in percentage of steel fibers in the conventional concrete. The concrete mix M2, M3 M4 and M-5 showed increment in compressive strength by 4.54%, 7.32%, 9.08%

and 11.72% at 28 day of curing period with respect to concrete mix M1. The compressive strength (by CTM) of concrete mix M2, M3 and M4 are 43.51 MPa, 44.67 MPa, 45.40 MPa and 46.50 MPa respectively, at curing period of 28 day.

Split tensile strength of cylinders after 7 days is maximum at 2% of steel fibers. Maximum tensile strength after 7 days is 2.65 MPa and the percentage increase is 17.77. Tensile strength of cylinder specimen is maximum at 2% of steel fibers which having strength of 3.18 and 4.69 Mpa after 14 and 28 days respectively. Percentage increase for 2% steel fiber of 14 and 28 days is 25.19% and 18.43% respectively.

Flexural strength of concrete beam specimen after 28 days is maximum at 2% of steel fibers. Maximum flexural strength after 28 days is 10.43 MPa. Percentage increase for 2% of steel fibre is 13.36% as comparison to M-1 mix so it can be analyse that this variation of steel fiber is good for flexural strength of concrete.

6. REFERENCES

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