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Experimental Study on Strengthening of Concrete Using Crimped & Hooked Steel Fiber

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ABSTRACT: In this project, effect of fibers on the strength of concrete for M30 grade have been studied by varying the % of fibers in the concrete. Fiber content were varied by 3%, 6% and 9% by weight of cement. Fibers are generally used as resistance of cracking and strengthening of concrete. Admixtures are used in the concrete to improve the strength of the concrete and to reduce the water cement ratio. Steel fiber reinforced concrete is subjected to check the influence of fibers on tensile strength, compressive strength and flexural strength of concrete. The results of fiber reinforced concrete for 7 days, 14 days and 28 days curing with varied % of fibers were studied and it has been found that there is the significant strength improvement in the steel fiber reinforced concrete. Finally it has been observed that with the increase in fiber content up to the optimum value increases the strength of concrete.

KEYWORDS: concrete for M30, Fiber varied by 3%, 6% and 9% by weight of cement, Admixtures to reduce the water cement ratio, Cubes, cylinders, beams. % of fibers were studied

I. INTRODUCTION

Concrete is the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be moulded to any shape. It also replaces old construction materials such as brick and stone masonry. Hence concrete is very suitable for a wide range of applications

The Fiber reinforced concrete may be defined as composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibers. In FRC, thousands of small fibers are dispersed and distributed randomly in concrete during mixing, and thus improve concrete properties in all directions. These fibers are also used as a replacement to reinforcing steel. Fibers in the form of mat are also being used in the development of high performance structural composite. Because of the vast improvements achieved by the addition of fibers to concrete, there are several applications where Fiber Reinforced Concrete (FRC) can be intelligently and beneficially used.

II. EXPERIMENTAL PROGRAM

A. Material

Properties Cement

Ordinary Portland cement of 53 grade was used for casting conforming to IS 1489 (part 1): 1991. Specific gravity of cement is 3.15 and specific surface of cement is 277.8m²/kg.

Fine Aggregate

Clean and dry river sand locally available was used which was passing through IS 4.75mm sieve. Specific gravity of fine aggregate is 2.60, Water absorption is 1.42% and belongs to zone 1

Coarse aggregate

Coarse aggregate passing through 12.5 mm sieve as per IS 383-1970 was used. Specific gravity of coarse aggregate (12mm) is 2.76, Water absorption of (12mm) is 0.66% . The sieve analysis of coarse aggregate is single size aggregate for both sizes.

Water

Clean portable water was used for the entire project from casting to curing of specimens

**Super plasticizer**

Conplast SP430 permits the reduction of water to extend up to 30% without reducing workability.

Steel Fibers

The length and diameter of the steel fiber used is:

Hooked end fiber : 0.45mm diameter and 30mm length.

Undulated fiber: 0.45mm diameter and 30mm length.

The aspect ratio of the fibers is 66.

B. Mix Proportion

M30 grade concrete mix was designed as per IS 10262:2009. The mix proportion calculated was 1:1.81:3.67.

C. Preliminary Studies

In the preliminary studies, standard size cubes of (150 x 150 x 150 mm), cylinder (150 mm diameter and 300 mm height), BEAM (600x150x150) were tested.

III. EXPERIMENTAL RESULTS**Compressive strength of FC Cube**

Cube mould of 150mm × 150 mm × 150mm were casted for finding the compressive strength of FRC. In which fibre with different ratio were added in concrete and compressive strength of cube was calculated by using compression testing machine. Compressive strength of cubes at 14th and 28th day was obtained and tabulated.

TABLE1: Results of compressive strength

S.No	% of steel fiber added	Compressive strength of specimens for (undulated steel fibers) 14days	Compressive strength of specimens for (undulated steel fibers) 28days	Compressive strength of specimens for (Hooked steel fibers) 14days	Compressive strength of specimens for (Hooked steel fibers) 28days
		(N/mm ²)	(N/mm ²)	(N/mm ²)	(N/mm ²)
1	0%	31.14	37.7	31.14	37.7
2.	3%	40.5	47.7	33.06	39.01
3.	6%	35	42.1	40.6	46.9
4.	9%	33.4	38.8	46.5	52

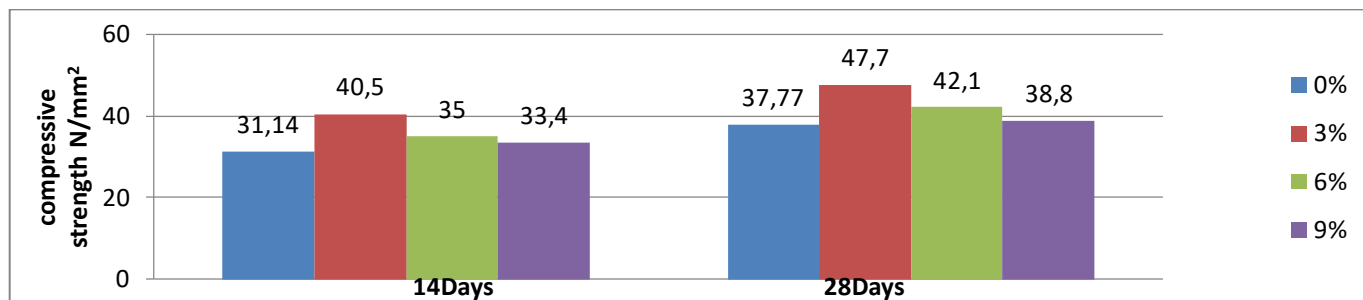


Figure 1: Graph showing the values of compressive strength undulated steel fibers

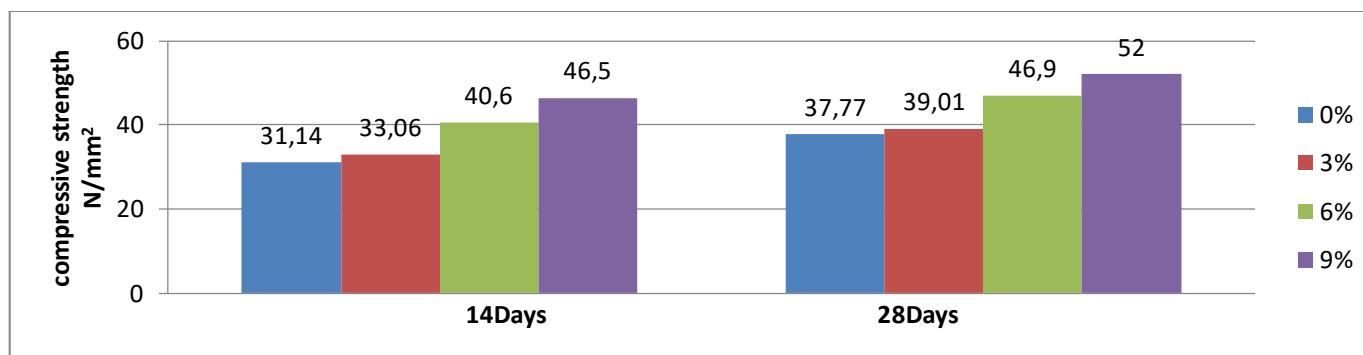


Figure 2: Graph showing the values of compressive strength hooked steel fibers

Split Tensile strength of FC Cylinder

Cylindrical mould of 150 mm diameter and 300mm long are used for casting the specimen for split tensile strength and the results were tabulated below.

TABLE 2: Results of Split tensile strength.

S.No	% of steel added	Split tensile strength of specimens for (undulated steel fibers)14days	Split tensile strength of specimens for (undulated steel fibers)28days	Split tensile strength of specimens for (hooked steel fibers)14days	Split tensile strength of specimens for (hooked steel fibers)28days
		(N/mm ²)	(N/mm ²)	(N/mm ²)	(N/mm ²)
1.	0%	3.22	3.91	3.22	3.91
2.	3%	6.45	7.2	5.71	6.40
3	6%	6.3			

			6.81	6.32	7.05
4.	9%	5.57	6.41	6.75	7.35

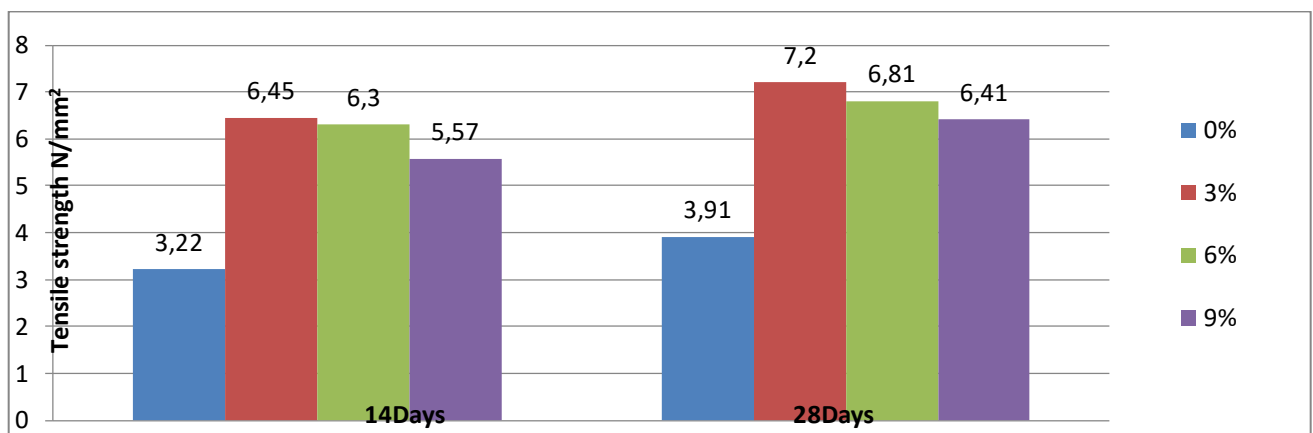


Figure 3: Graph showing the values of split tensile strength undulated steel fibers

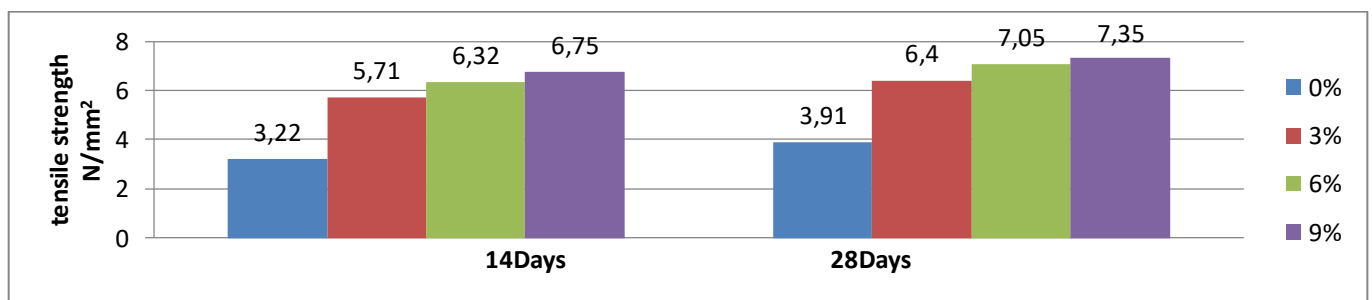


Figure 4: Graph showing the values of split tensile strength hooked steel fibers

Flexural Strength of beams

The flexural of the beam was determined over the beam size having of 600mm*150mm*150mm . The beam was casted for the optimum percentage of strength obtained in the testing of beam

TABLE 3: Results of flexural strength.

S.No	% steel added of fiber	Flexural strength of specimens for (undulated steel fibers)14days	Flexural strength of specimens for (undulated steel fibers)28days	Flexural strength of specimens for (hooked steel fibers)14days	Flexural strength of specimens for (hooked steel fibers)28days
		(N/mm ²)	(N/mm ²)	(N/mm ²)	(N/mm ²)
1.	0%	4.80	5.06	4.80	5.06
2.	3%	5.70	7.81	5.13	6.05
3.	6%	5.11	6.26	5.86	8.06
4.	9%	4.98	5.41	7.5	8.77

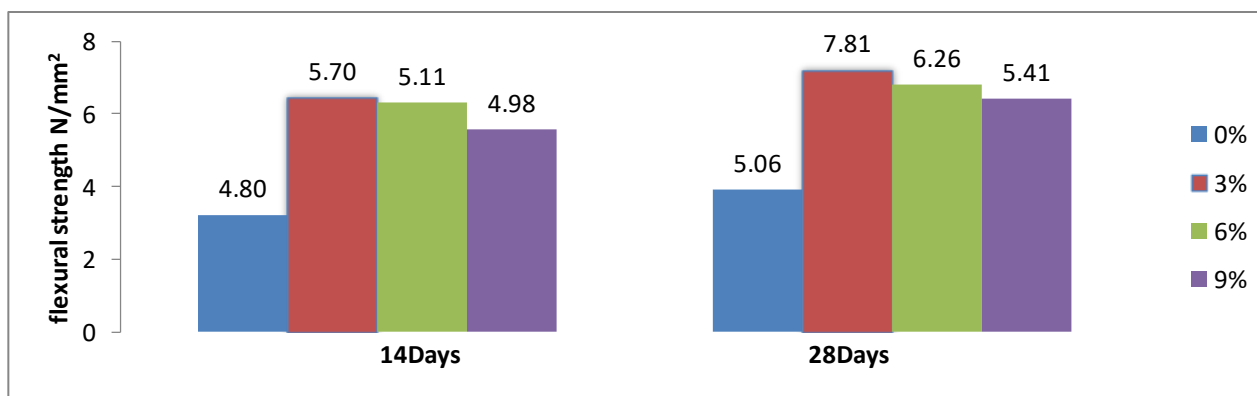


Figure 5: Graph showing the values of flexural strength undulated steel fibers

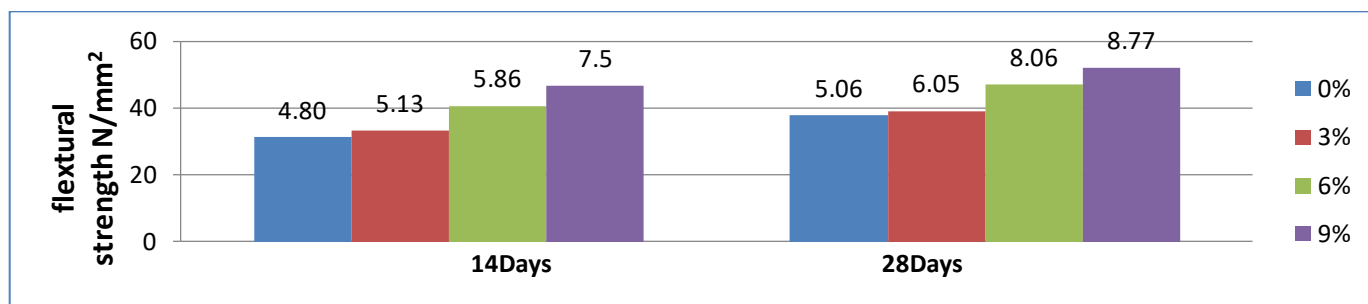


Figure 6: Graph showing the values of flexural strength hooked steel fibers

FLEXURAL STRENGTH ON REINFORCED BEAM

The flexural strength of casted reinforced concrete beam was determined by the same formula used for determining the flexural strength of prism but with the change in dimension of specimens.

The dimension values are standard for all the beam setup thus it is given as, L – Length between supports – 1000mm
B – Cross sectional width of beam – 150mm D – Cross sectional depth of beam – 200mm

TABLE 4: Comparison of Flexural strength, initial load, ultimate load and deflection

Types of fiber	% of fiber added	Initial Load (KN)	Ultimate Load (KN)	Flexural strength (N/mm ²)	Deflection (mm)
M30	0%	28.92	30.84	5.13	6.7
Undulated fiber	3%	47.76	53.58	8.89	8.6
	6%	40.84	47.49	7.91	7.82
	9%	36.72	42.32	7.04	6.9
Hooked fiber	3%	35.67	41.85	6.93	7
	6%	42.66	48.04	8.00	7.6
	9%	48.64	54.32	9.05	8.5

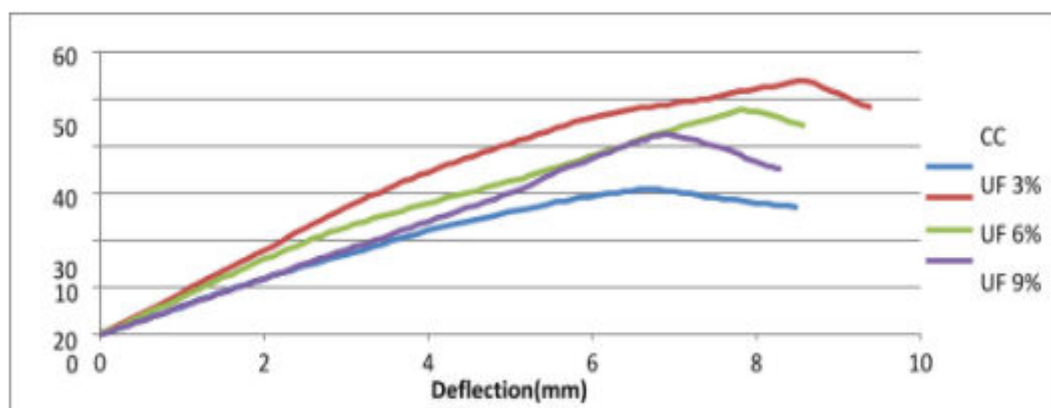


Figure 7: Graph showing the values of Comparison of Load vs Deflection curve for 0%,3%,6%,9% undulated fiber

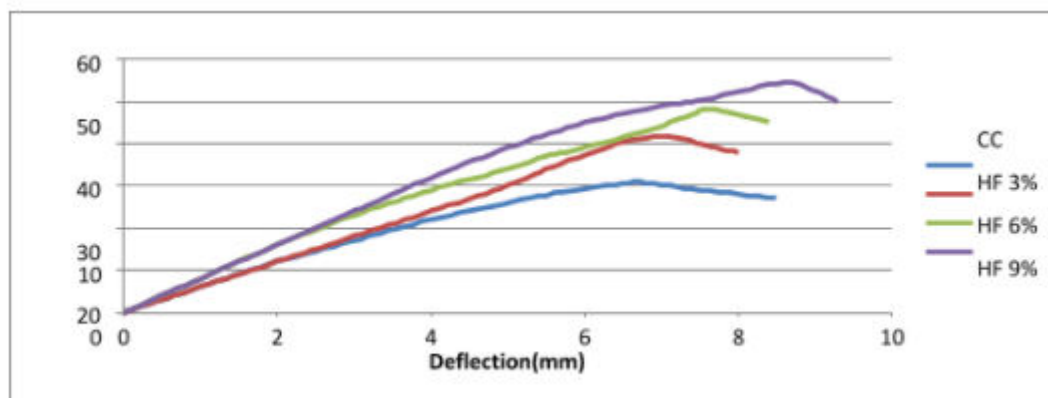


Figure 8: Graph showing the values of Comparison of Load vs Deflection curve for 0%, 3%, 6%, 9% hooked fiber

DURABILITY TEST RESULT

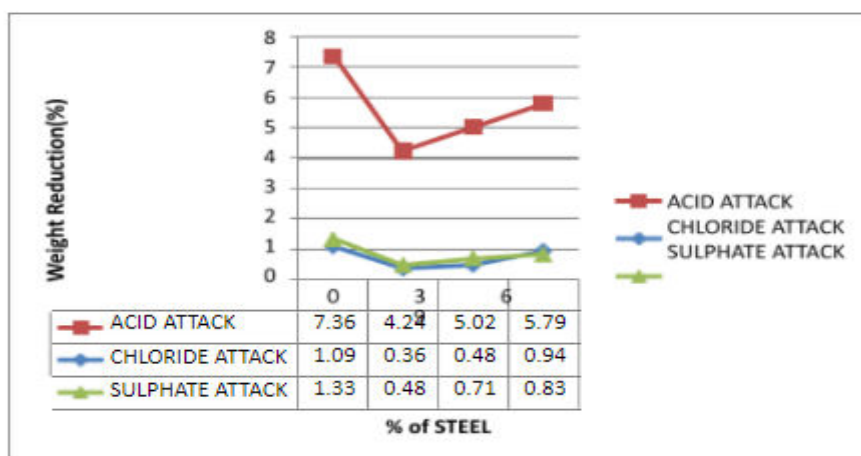


Figure 9: Graph showing the values of Comparison of weight reduction in cube after acid, chloride, and sulphate attack for undulated steel fiber

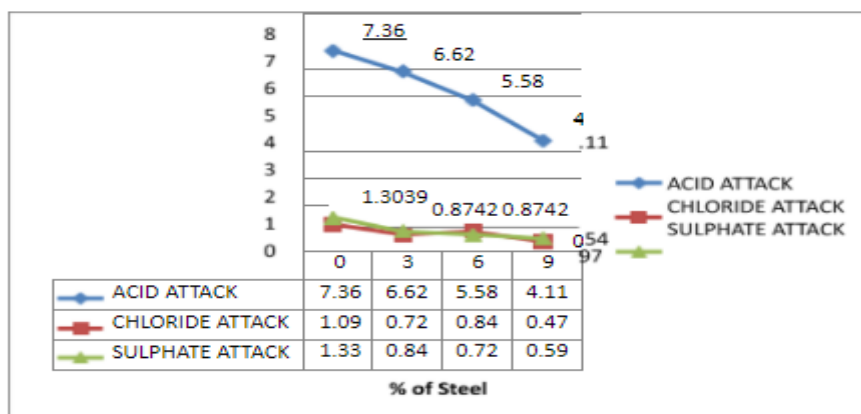


Figure 10: Graph showing the values of Comparison of weight reduction in cube after acid, chloride, and sulphate attack for hooked steel fiber.

IV. CONCLUSION

The following conclusions were drawn from the work carried out:

1. It is observed that the workability of steel fiber reinforced concrete gets reduced as the percentage of steel fiber increases.
2. In this project work, it is observed that the increase of 26% of compressive strength, 85% of split tensile strength and 55% flexural strength in undulated fiber when compared with conventional concrete.
3. In this project work, it is observed that the increase of 38% of compressive strength, 87% of split tensile strength and 73% flexural strength in hooked fiber when compared with conventional concrete.
4. In case of undulated fibers it is noted that the compressive strength, split tensile strength and flexural strength are on higher side for 3% fibers as compared to that produced from 0%, 6% and 9% fibers.
5. It is observed that the compressive strength, split tensile strength and flexural strength are on higher side for 9% hooked end fibers as compared to that produced from 0%, 3% and 6% hooked end fibers.
6. In case of undulated fibers it is noted that Percentage of weight reduction is less for 3% fibers as compared to that produced from 0%, 6% and 9% fibers.
7. In case of hooked fibers it is noted that Percentage of weight reduction is less for 9% fibers as compared to that produced from 0%, 3% and 6% fibers.
8. While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which led into splitting of specimens into two piece geometry. But due to addition of steel fibers in concrete cracks get ceased which results into the ductile behavior of SFRC.

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