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EXPERIMENTAL INVESTIGATION OF FIBER REINFORCED CONCRETE USING DIFFERENT TYPES OF STEEL FIBERS

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Abstract—* *The structural performance of concrete made with commercially available steel fibres has been investigated. Two types of steel fibres, hooked and crimped of aspect ratio 60 were used in the present study. The overall volume fraction of steel fibres was restricted to 1-2% by the volume of concrete. M25 grade of concrete was used to cast the specimens. Reinforced concrete beams were cast with different percentages of steel fibres and the specimens were tested after 7 and 28 days of curing. Tests such as workability of concrete, compressive strength of concrete, flexural strength of concrete and split tensile strength of concrete were conducted. The steel fibres used delays and control the tensile cracking. The combination of steel fibres increases the stiffness, ductility and toughness significantly.

Keywords—* *Fiber reinforced concrete, steel fibers, aspect ratio, compressive strength, split tensile strength, flexural strength

I. INTRODUCTION

Concrete is the most widely used man made construction material. It is obtained by mixing cement water and aggregate in required proportion. The hardening is caused by chemical action between water and cement, it continues for a long time and consequently the concrete grows stronger with age. The strength, durability and other characteristics of concrete depend upon the properties of its gradients on the proportions of mix, the method of compaction and curing. The concrete has high compressive strength. The weak matrix in concrete, when reinforced with steel fibers, 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. Because of the vast improvements achieved by the addition of fibers to concrete, there are several applications where Fibers Reinforced Concrete (FRC) can be intelligently and beneficially used. These fibers have already been used in many large projects involving the construction of industrial floors, pavements, highway-overlays, etc. in India. 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 fiber reinforcement offers solution to the problem of cracking by making concrete tougher and more ductile..

A. Need for Study

Plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of randomly distributes discontinuous fibers is to bridge across the cracks that develop provides some post- cracking “ductility”. If the fibers are sufficiently strong, sufficiently bonded to material, and permit the FRC to carry significant stresses over a relatively large strain capacity in the post cracking stage.

B. Objective of the Study

Objective of the study is to evaluate to investigate the influence of varying percentage of steel fibers on Compressive Strength of Concrete.

II. EXPERIMENTAL INVESTIGATION

In this present study two types of fibers were used and mix design for M25 has been carried out as per IS specification by considering basic properties of all the materials used in the concrete. Two types of fibers i.e hooked and crimped steel fibers has been used with the aspect ratio of 60. The percentage of fibers restricted to 1% with the increment of 0.25% and the properties are compared with conventional concrete.

A. *Materials and their properties*

The basic tests on materials like cement, fine aggregate and coarse aggregate has been carried out as per IS specification before considering for the mix design. For the study OPC 53 grade cement was considered along with natural coarse aggregate and M sand. To maintain the required workability Glenium B233 superplasticizers has been used in optimum dosage. All the materials used in the study are confirmed to the prescribed Indian standard specification and the results are tabulated in table1given below.

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TABLE I

BASIC PROPERTIES OF MATERIALS

Sl No.	Property	Value	Specification
1	**Cement**		OPC 53 grade confirming to I.S 8112 : 1982
	Specific gravity	3.14	
	Fineness(%)	5	
	Standard consistency(%)	29	
	Initial setting time (min)	40	
2	**Fine aggregate**		Confirming to Grading zone 2 of I.S 383 – 1970
	Specific gravity	2.56	
	Fineness modulus	3.82	
	Bulking (%)	4	
	Bulk density (g/cc)		
	Loose	1.32	
	Compacted	1.64	
3	**Coarse aggregate**		Confirming to Table 2 of I.S 383 – 1970
	Specific gravity	2.62	
	Water absorption (%)	0.5	
	Bulk density (g/cc)		
	Loose	1.48	
	Compacted	1.63	
	Flakiness index (%)	11.65	
	Elongiation index(%)	11.87	
4	**Steel Fibers (Aspect Ratio)**		As per Requirement
	Hooked	60	
	Crimped	60	

B. *Compressive Strength Test Results*

From the test results it has been observed that for M25 grade concrete, the compressive strength at the age of 7 and 28 days increase with increase in percentage of steel fibers. Percentage increase in compressive strength of concrete for 0.25% ,0.5%, 0.75% and 1 % of fibers by volume with respect to normal concrete is found to be 10.55%, 18.14%, 25.63% and 30.53% for hooked fibers and 5.51%, 13.82%, 22.28% and 27.11% for crimped fibers at 28 days respectively. Table 2 and Fig 1 shows the observed compressive strength of fiber reinforced concrete.

TABLE 2: COMPRESSIVE STRENGTH

Fiber content (%)	**28 Days Average Compressive Strength (MPa)**	
	Hooked fibers	**Crimped fibers**
0	25	25.00
0.25	28	26.46
0.5	30.5	29
0.75	33	32
1.0	36	34

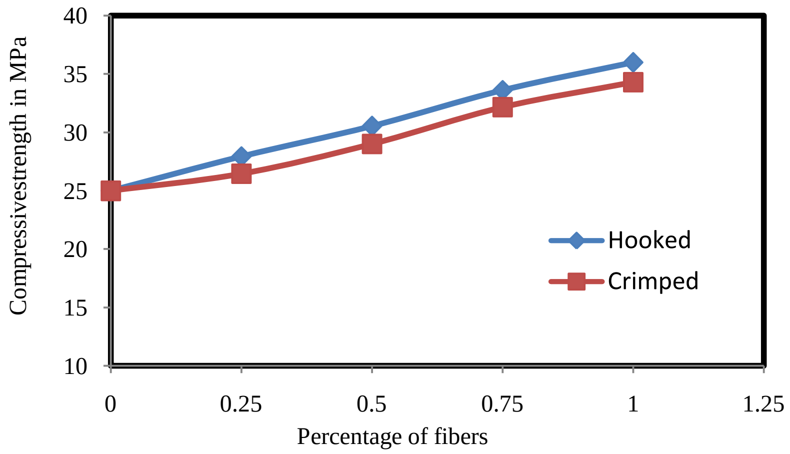

Fig. 1 Variation of compressive strength of concrete with different fibers and percentage

C. Split Tensile Strength Results

From the test results it has been observed that for M25 grade concrete, the Split Tensile Strength at the age of 7 and 28 days increase with increase in percentage of steel fibers. Percentage increase in Split tensile strength of concrete for 0.25%,0.5%,0.75% and 1% of fibers (by mass) with respect to normal concrete is found to marginal increase for hooked fibers compared with crimped fibers at 28 days. Table 3 and Fig 2 shows the observed Split tensile strength of fiber reinforced concrete.

TABLE 3: SPLIT TENSILE STRENGTH

Fiber content (%)	**28 Days Split Tensile Strength (MPa)**	
	Hooked fibers	**Crimped fibers**
0	2.55	2.55
0.25	2.8	2.62
0.5	3.18	2.97
0.75	3.54	3.39
1.0	4.18	4.03

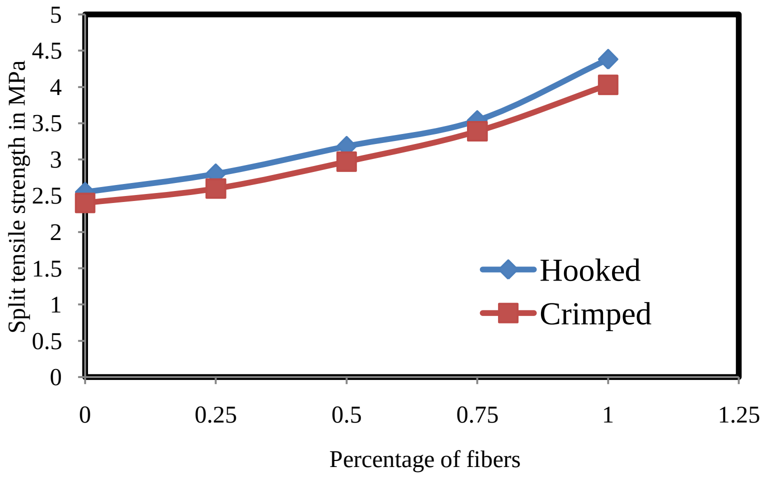

Fig. 3 Variation of Split Tensile strength of concrete with different fibers and percentage

D. Flexural Strength Test Results

From the test results it has been observed that for M25 grade concrete, the Flexural Strength at the age of 28 days increase with increase in percentage of steel fibers. Percentage increase in Flexural strength of concrete for 0.25%,0.5%.0.75%and 1% of fibers (by mass) with respect to normal concrete is found to **1.88%, 2%, 2.38% and 2.75%** for hooked fibers and **1.75%, 1.88%, 2.13% and 2.63%** for crimped fibers at 28 days. Table 4 and Fig 3 shows the observed compressive strength of fiber reinforced concrete.

TABLE 4:FLEXURAL STRENGTH

Fiber content (%)	**28 Days Split Tensile Strength (MPa)**	
	Hooked fibers	**Crimped fibers**
0	2.55	2.55
0.25	2.8	2.62
0.5	3.18	2.97
0.75	3.54	3.39
1.0	4.18	4.03

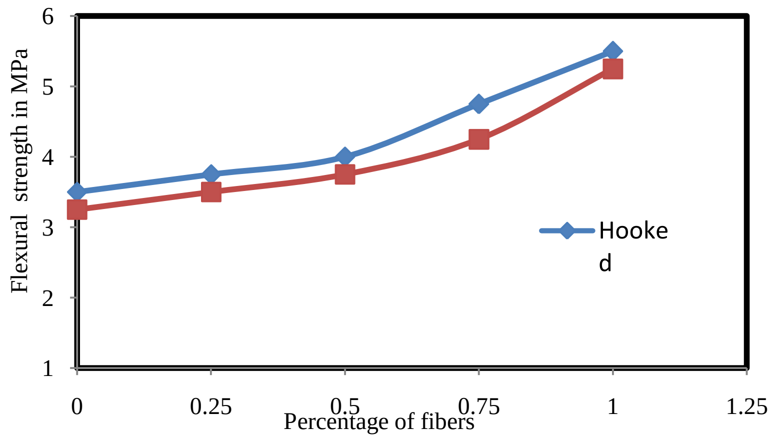

Fig. 3 Variation of Flexural strength of concrete with different fibers and percentage

III. CONCLUSIONS

A detailed experimental investigation was carried out on M25 grade concrete by using two types of steel fibers i.e hooked and crimped fibers with the varying percentage from 0% to 1% with the increment of 0.25%.Compressive, split tension and flexural strength test were carried out as per specification. Based on the test results, following major conclusions were drawn.

- From the present study it is seen that there is a considerable increase in compressive strength with addition of steel fibers. The maximum increase in the compressive strength of concrete with increase in the volume of fibers is 30.53% for hooked fibers and 27.11% for crimped fibers at 28 days..
- Split tensile strength is also increased with varying percentage of fibers, thereby eliminating the cracks by bridging action of fibers. The maximum increase in the split tensile strength of concrete with increase in the volume of fibers is 0.06% for hooked fibers and 0.057% for crimped fibers.
- Flexural strength is increased with varying percentage of fibers, thereby withstanding great forces without any major defects. The maximum increase in the flexural strength of concrete with increase in the volume of fibers is 2.75% for hooked and 2.63% for crimped fibers at 28 days

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