Experimental Investigation on Performance of M25 Grade Steel Fiber Reinforced Concrete

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Abstract— Concrete is the most versatile construction material that can be used in fabricating of structures. Concrete is available in various types depending upon the necessity of structure. The key parameters that influence any structure are its strength and durability. In order to attain higher strength with normal concrete, there is a need of using some additional materials along with the main components in concrete i.e. Cement, fine aggregate, coarse aggregate and water. These additional materials function as reinforcement to concrete to increase the strength. In this research steel fiber is used in M25 concrete to target the strength. Steel fibers are one of the metallic fibers which possess high tensile property. Therefore influence of steel fiber on structural properties of M25 concrete is studied. In this regard various proportions of steel fiber i.e. 0%, 2%, 4%, 6%, and 8% by weight of binder are added to concrete. Each proportion of fiber is added to concrete and six specimens of cubes, cylinders and prisms are casted and cured for 7 days and 28 days. These specimens are tested for compressive strength, split tensile strength and flexural strength after specified curing period and the results of the tested specimens are noted and discussed for further analysis.

Keywords: Concrete, Steel Fiber, Compressive strength, Split tensile Strength, Flexural Strength

I. INTRODUCTION

Construction industry is one of the most important strand for all the countries in their development activities. Now a days infrastructure became a great concern in development. According to the need, the construction of structures are classified and the components for the type of construction are defined. Among various components used in construction, concrete became heart of civil engineering. Many structures around world, takes the form of concrete for their infrastructural and architectural purpose

A. Steel Fiber

It is world known fact that "Concrete is strong in Compression and weak in Tension". In order to increase the strength of concrete wide range of materials are used. Among these one of the material is steel fibre. Steel possess greater tensile strength. These are available in short and discrete lengths with aspect ratio of 20 to 100 with different cross sections.

B. Steel fiber in concrete

Steel has one of the most important property to integrate with concrete is its coefficient of thermal expansion. Use of steel fibres in concrete increases the strength and durability of concrete. Many case studies have been undergone using steel fibre at various proportions up to maximum limit of 3%. In this research work, study is carried out by increasing the percentage of steel fibre up to 8 % at an interval of 2%. Tests are carried out and results are noted for futher discussion

II. LITERATURE REVIEW

Jun Wei Luo (2014), investigated on behavior and analysis of steel fiber reinforced concrete subjected to reversed cyclic loading.

Anurag Mishra, Prof. Kirti Chandraul, Prof. Manindra Kumar Singh (2017), investigated the paper by adding steel fibers 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3% by weight of cement. It is observed that the compressive strength and split tensile strength has increased drastically from 0% to 3%.

III. METHODOLOGY

Step 1: Literature review
Step 2: Material collection
Step 3: Material characteristics

A. Cement

Cement used to carry out this investigation is of 53 grade OPC confirming to Indian standard. Various tests like sieve analysis, specific gravity, intitial and final setting time of cement are carried out.

Property	Results obtained	Requirement
Fineness (%)	6%	Maximum of 10%(ordinary portland cement) IS 12269:1987
Normal consistency (%)	30%	22-30% (IS 40311988 part 4)
Initial setting time	32 min	Minimum 30min (IS: 4031 (part 5) -1988)
Specific gravity	3.15	-

Table 1: Physical properties of cement

B. Fine Aggregate

The aggregate used in this investigation is fine natural river sand free from salts and organic matter. Various tests like sieve analysis, bulking of sand, specific gravity and blk density are carried out.

Property	Results obtained
Fineness modulus	2.97
Specific gravity	2.65
Bulking of sand	11.11%
Bulk density	1620 Kg/m^3

Table 2: Physical properties of fine aggregate

C. Coarse Aggregate

The coarse aggregate used in this project is extracted from crushed natural rock quarry passing through sieve of size 20mm. This aggregate is tested for specific gravity, impact value, crushing value and bulk density.

Property	Results obtained
Fineness modulus	8.64
Specific gravity	2.7
Elongation index	9%
Flakiness index	7%
Aggregate impact value	19
Aggregate crushing value	20
Bulk density	1680 Kg/m^3

Table 3: Physical properties of coarse aggregate

D. Steel Fibre

Steel fiber used is available in chopped form. Steel fiber of size 32 mm is used in this study. It is free from corrosion and have high tensile strength. It is a metallic fibre of non-hygroscopic in nature.

E. Water

Water used to carry out this project is potable and free from acids, salts and organic matter which severely affect the concrete after hardened.

F. Super Plasticizer

Super plasticizer is the admixture used to improve the workability of concrete. To carry out this study conplast SP43 is used to reduce the water content in the concrete for attaining high strength.

Step 4: Mix design

As per IS 10262:2009, normal M25 grade concrete is designed with suitable water cement ratio.

S.No.	Material	Quantity(kg/m^3)	Proportion
1.	Cement	438	1
2.	Fine aggregate	654.25	1.49
3.	Coarse aggregate	1156.6	2.63
4.	Water	197	0.45
5.	Super plasticizer	0.438	0.1

Table 4: Proportion of materials

IV. TESTS AND RESULTS

A. Compressive Strength

The test is conducted on 100mmx100mm cubes after 7 days and 28 days of curing and an average of three specimen results is considered.

S.No.	% Addition of steel fibre	Compressive strength(N/mm^2)
1.	0	17.16
2.	2	21.00
3.	4	21.80
4.	6	23.30
5.	8	24.50

Table 6: Compressive strength at 7 days of curing

S.No.	% Addition of steel fibre	Compressive strength(N/mm^2)
1.	0	27.16
2.	2	31.20
3.	4	35.70
4.	6	38.70
5.	8	38.83

Table 7: Compressive strength at 28 days of curing

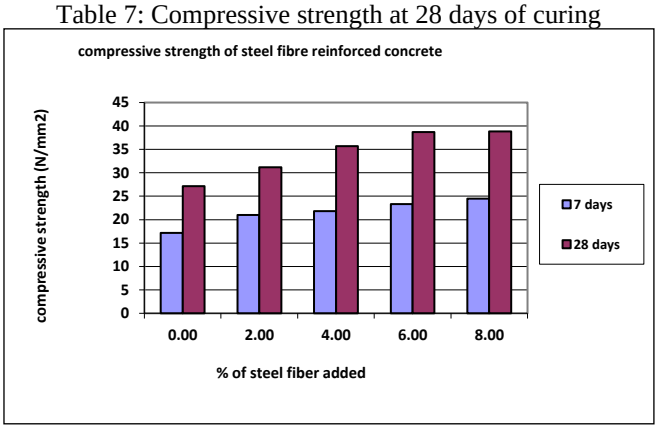

Chart 1: Compressive strength at 7 days and 28 days

B. Split Tensile Strength

The tensile strength of concrete is tested using cylinders of 150mm diameter and 300mm length are casted and cured for 7 days and 28 days. Later these specimens are tested under compressive testing machine, where the specimen is placed parallel to the longitudinal axis of the cylinder.

S.No.	% Addition of steel fibre	Split Tensile Strength (N/mm^2)
1.	0	1.74
2.	2	1.91
3.	4	2.54
4.	6	2.8
5.	8	2.64

Table 8: Split tensile strength at 7 days of curing

S.No.	% Addition of steel fibre	Split Tensile Strength (N/mm^2)
1.	0	2.65
2.	2	2.77
3.	4	3.8
4.	6	4.06
5.	8	4.01

Table 9: Split tensile strength at 28 days of curing

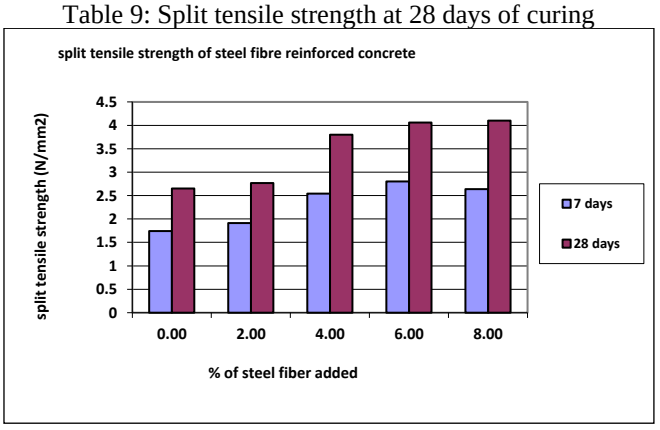

Chart 2: Split Tensile strength at 7 days and 28 days

C. Flexural Strength

The test is conducted using specimens of size 100mmx100mmx500mm which are casted and cured for 7 days and 28 days. Flexural strength of concrete gives the rate of bending load that a beam can be able to carry under two point load system.

S.No.	% Addition of steel fibre	Flexural strength(N/mm^2)
1.	0	4.1
2.	2	7.12
3.	4	7.41
4.	6	7.67
5.	8	8.03

Table 10: Flexural strength at 7 days of curing

S.No.	% Addition of steel fibre	Flexural strength(N/mm^2)
1.	0	6.4
2.	2	11.21
3.	4	12.16
4.	6	13.1
5.	8	13.38

Table 11: Flexural strength at 28 days of curing

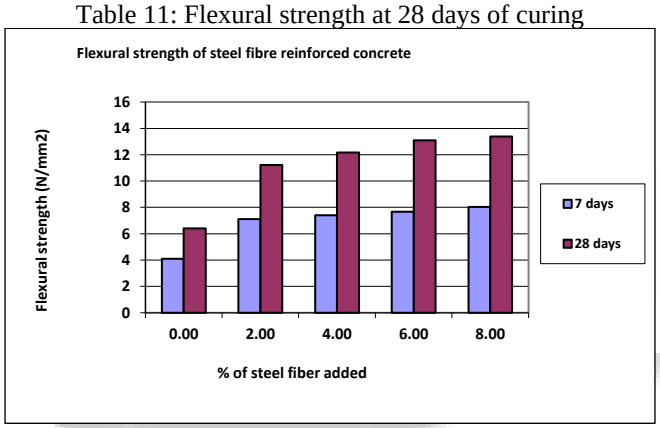

Chart 3: Flexural strength at 7 days and 28 days

V. CONCLUSIONS

Based on the experimental study of test results conducted it is observed that:

- Compressive strength of concrete has increased drastically from 0% of steel fibre to 8% of steel fibre. The strength of concrete is up to 42.77% for 7 days and 43 % for 28 days
- Split tensile strength of concrete has increased up to 6% addition of fibre and then a slight decrease in strength has been observed.
- Flexural strength of concrete has shown increment in its strength up to 8% as steel is strong under tension. Therefore this steel fibre has shown resistance to flexural loading and the strength has increased up to 90%.

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