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Experimental Investigation on Strength Properties of Standard Concrete by Addition of Steel Fibers

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Abstract:- **The experimental investigation is to study the effect of steel fibers on strength properties of standard concrete. The variables considered in the research work are fiber % by weight of cement i.e. 1%, 2%, 3%, 4%. The fibers considered in this study were Hook end type with aspect ratio 40. The grade of concrete designed for investigation was M30 by using IS 10262-2009 having mix proportion (1: 1.82: 3.35: 0.45) cubes of size 150 x 150 x 150 mm to check compressive strength and cylinders of size 300mm length and 150mm diameter to check split tensile strength were casted. All the specimens were cured for 7, 28 days. The workability can test by using C.F Apparatus. The cubes & Cylinders are tested on 200T DCTM.**

Key Words:- Aspect ratio, Compressive strength, Fiber reinforced concrete, Hook end type steel fibers, Split tensile strength, Workability.

1. INTRODUCTION :

Plain cement concrete is most widely used material for construction of various structures; however it suffers from numerous Drawbacks such as low tensile strength, Brittleness & unstable concrete propagation and low fracture resistance.

Addition of steel fibers to plain cement concrete results in improving structural properties such as compressive strength, Split tensile strength, Flexural Strength, Shear and bond strength ete., Ductility also increased by adding steel fiber concrete. Hence Steel Fiber Reinforced Concrete (SFRC) has been proved as a reliable composite construction material having superior performance characteristics compares to conventional concrete characteristics.

SFRC is the concrete made with hydraulic cement containing fine and coarse aggregates and discrete fibers. In SFRC thousands of small fibers are dispersed and distributed randomly in the concrete during mixing and thus improve concrete properties. The unique properties of SFRC suggest the use of such material for making structural applications with and without traditional internal reinforcement.

The use of SFRC is, thus, particularly suitable for structures when they are subjected to loads over the serviceability, limit state in building & shear and when exposed to impact and dynamic forces as they occur under seismic action.

The fibers help to transfer the loads at the internal micro cracks.

2. LITERATURE REVIEW

1. Milind V. Mohod has studied the effect of fibers on strength of concrete (M30) with varying % of fibers in concrete. Fiber content was varied by 0.25%, 0.5%, 0.75%, 1%, 1.5%, 2% by volume of concrete. He had used hookend type fibers in the investigation. The compressive strength of cubes is found to be make 1%, The flexural strength of cubes is found to be make 0.75%, The workability gets reduced by increases the fiber contents.

2. Job Thomas and Anant Swami Laqe studied on mechanical properties of steel fiber reinforced concrete. The type of fiber used was hooked type with aspect ratio 55. All the specimens are cured for 28 days. The volume of fraction of fibers was 0.1%, 0.5%, 1%, 1.5% & 2%. The grades of concrete are M35, M68 & M85. The max increase in compressive strength due to addition of steel fibers was found to be very small in various grades of concrete. The max increase in split tensile strength due to addition of steel fibers was found to be also 40% in various grades of concrete.

3.S. A. Balachandra and Pawse Amit Baji Rao have studied reinforcement of steel fiber reinforced self compacting concrete. The types of fibers used are hookend type with Volume fractions of 0%, 0.5%, 1%, 1.25%, 1.5%, 1.75%, 2%, **2.5**% and 3%. The grade of concrete is M30. The curing period of samples is 7 & 28 days. The increase of compressive strength is 25.75% of SFRSCC (Steel fiber reinforce self compacting concrete) over normal self compacting concrete. The increase of flexural strength is 19.47% of SFRSCC over normal self compacting concrete. The optimal fiber content is 1.75% for split tensile strength and flexural strength.

4.K. R. Muthuswamy and G. S. Thirugnanam: have studied on mechanical properties of hybrid fiber reinforced, high performance concrete. The grade of concrete used is M30. They were used round crimped steel fibers of aspect ratio 60. The volume fraction of steel fibers was 1% by weight of concrete. Polyester fiber of 0.035mm diameter, 12mm cut length are used. The volume fraction of polyester fiber was 0.02% by volume of concrete. They were adding alkali glass resistant fibers of 14mm length with filament dia 14μ of 0.03% weight of concrete hybrid fiber reinforced concrete. Hybrid fiber reinforced concrete offers greater resistant against split tensile and balance force than mono fiber reinforced concret.

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3 EXPERIMENTAL PROGRAMMES

3.1 Materials used

In this experimental study, Cement, Sand, Coarse aggregate, Water and Steel fibers were used.

Cement: - Portland Pozzolana Cement (PPC) was used in this experiment confirming to IS- 1489-1(1991)

Sand: - Locally available sand Zone II with specific gravity 2.57 confirming to IS -383-1970

Water: - Portable water was used for the experiment

Coarse aggregate: - 2/3 from 20mm passing and 10mm retaining, 1/3 from 10mm passing and 4.75mm retaining from the weight approved in mix design. Specific gravity 2.78

Steel fiber: - Hooked type with Aspect Ratio 40 (l = 30, d = 0.75)

Mix proportion for M30:- 1:1.82:3.35 confirm to with W/C ratio 0.45 (Using- 13262- 2009)

3.2 Casting and Curing of Specimen

The size of cubes 150 X 150 X 150 mm used to find compressive strength of concrete. The size of Cylinder 300mm Length & 150mmØ were used to find split tensile strength of concrete. The specimens were demoulded after 24 hours from the time of casting and the specimens under water till the time of testing i.e. 7 & 28 days.

3.3 Testing of Specimen:- The cubes of cylinders are tested on 200T DCTM. The workability test is conducted on Compacting factor apparatus.

4. EXPERIMENTAL METHODOLOGY:

4.1 Compressive strength test:

For compressive strength test above specimens of 150 X 150 X 150 mm were cast for M30 grade standards concrete. The % of fibers added were 0,1,2,3, 4% by weight of cement. Vibration was given to the moulds using table vibrator. After 24 hours the specimens were demoulded and are shifted to curing tanks where they allowed to cure for 7 & 28 days. After completion of curing period these cubes were tested on DCTM (200KN) as per IS 516-1959. The tensile load was tested. In each category three cubes and three cylinders were tested and their average value is reported i.e. compressive strength was calculated as below.

$$\text{Compressive strength} = \frac{\text{Failure load}}{\text{Cross sectional area}}$$

4.2 Split tensile strength test:

For tensile strength, cylindrical specimens of 300mm height and 100mmØ were cast. The specimens were demoulded after 24 hours of casting and were shifted to curing tank where they were allotted to cure for 7 & 28 days. These specimens were tested under DCTM (200KN). In each category three cylinders were tested and their average value is reported as per IS 5816- 1999.

Tensile strength was calculated as follows

$$\text{Tensile strength} = \frac{2P}{\Pi DL}$$

Where,

P= Failure load

D= Diameter of cylinder

L=Height of Cylinder

4.3 Workability test: Workability is carried out by conducting the C.F test as per IS 1199-1959with w/c ratio 0.45

5. EXPERIMENTAL RESULTS

5.1 Compressive strength:-

Fig-1: Compressive strength test

Compressive strength of SFRC, Mpa (Hook end type fiber), l/d = 40, M30 concrete

Table-1

Fiber content by weight of cement (%)	Compressive strength(Mpa)		% increase in compressive Strength	
	7 Days	28 Days	7 Days	28 Days
0	19.2	37.28	-	-
1	24.85	39.71	29.43	6.52
2	28.09	40.92	46.30	9.76
3	28.57	42.98	48.80	15.29
4	23.48	41.20	22.29	10.52

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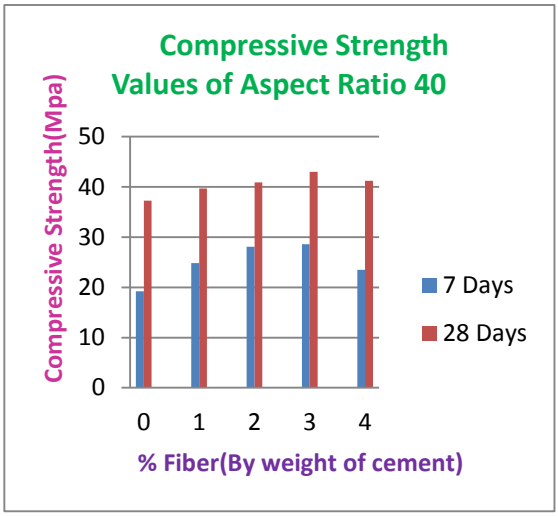

Fig-2: Bar chart

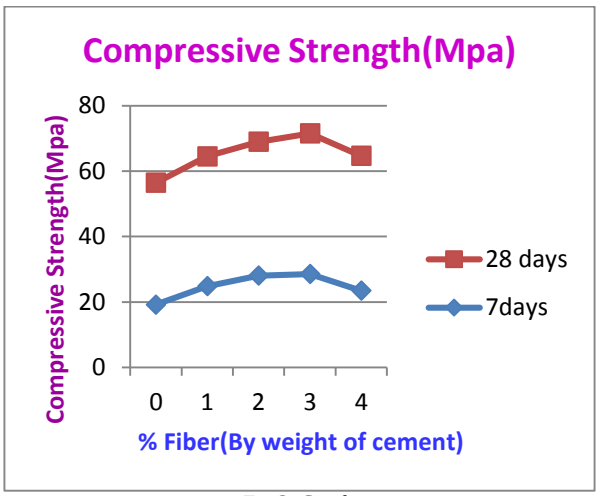

Fig-3 :Graph

5.2 Split tensile strength (N/mm²):-

Fig-4 : split tensile strength test

Split tensile strength of SFRC, Mpa (Hook end type fiber), l/d = 40, M30 concrete

Table-2

Fiber content by weight of cement (%)	Spilt tensile strength(Mpa)		% increase in compressive strength	
	7 Days	28 Days	7 Days	28 Days
0	2.135	2.809	-	-
1	2.243	2.850	5.06	1.46
2	2.326	2.944	8.95	4.81
3	2.392	3.206	12.04	14.13
4	2.306	3.105	8.01	10.54

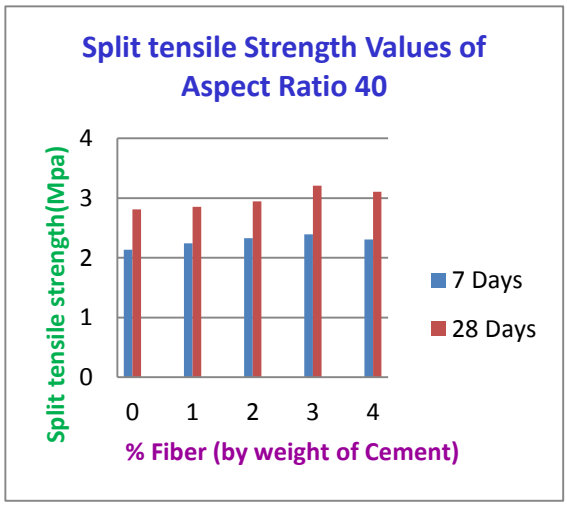

Fig-5: Bar chart

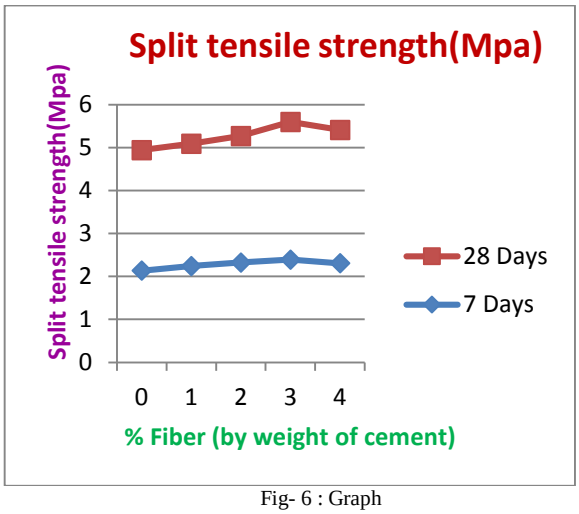

Fig- 6 : Graph

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5.3 Workability test (C.F):-

Fig- 7 : Workability test

Workability of fresh concrete, M30, Hook end type fiber with different aspect ratios.

Table-.3

Fiber content by weight of cement (%)	C. F Value		
	l/d = 40	l/d = 50	l/d = 60
0	0.823	0.823	0.823
1	0.801	0.830	0.834
2	0.814	0.835	0.828
3	0.801	0.825	0.831
4	0.816	0.821	0.816

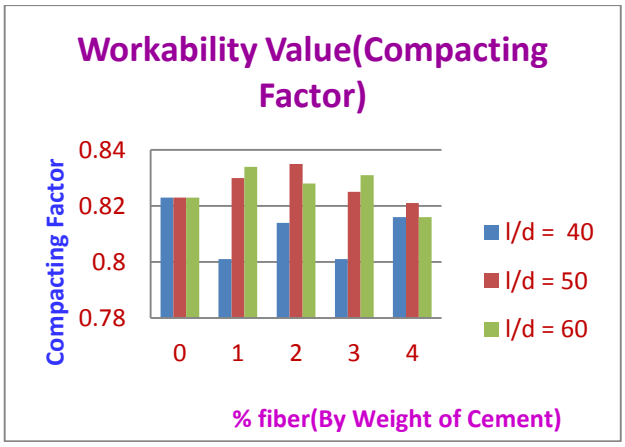

Fig-8: Bar chart

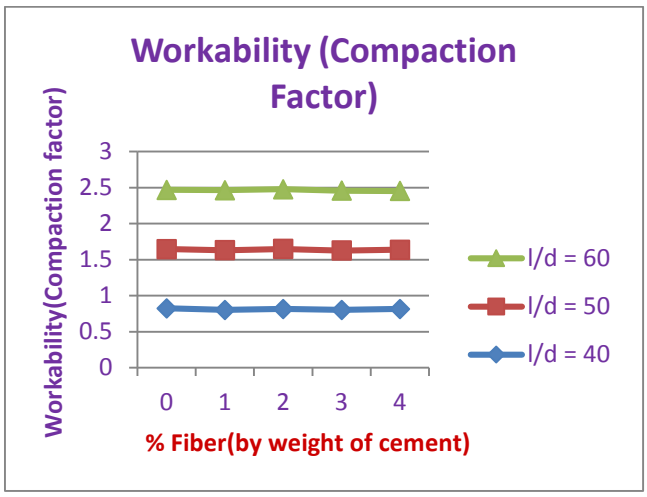

Fig-9 : Graph

6. CONCLUSION

1 The compressive strength of fiber reinforced concrete composed with steel fiber is found to be maximum at 3% of total fiber content by weight of cement.

2 The maximum increase in compressive strength at 3% fibre content is 15.29% at 28days.

3 The split tensile strength of fiber reinforced concrete composed with steel fibers is found to be maximum at 3% of total fiber content.

4 The maximum increase in split tensile strength at 3% fibre content is 14.13% at 28days.

5 The workability SFRC will be only marginally effected as % of steel fibers increases.

6 Results indicate that SFRC has potential to be used in high rise buildings and bridge constructions where ductility and high strength are to be met.

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