IFERP
ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 3, March 2017

Experimental Study of Steel Fibers Reinforced Concrete over Conventional Concrete

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***Abstract:*— paper suggests the experimental study of fiber reinforced concrete using M20 grade concrete over conventional concrete. 0.5%, 1% of fiber was used to prepare the reference mix. Comparison of experimental results has been carried out. The basic parameters taken for comparison are Workability, Compressive strength, Spilt Tensile test, Flexural Strengths over 7 days, and 28 days. Steel fiber reinforced concrete is very effective in repair works such as Leakage, seepage etc. It is also a better solution to minimize cavitation /erosion damage in structures such as navigational locks, sluice-ways, and bridge piers where high velocity flows are encountered. Saving of substantial amount of weight can be done by using SFRC by providing thin sections having the equivalent strength over plain concrete sections.**

***Index Terms:*— fiber reinforcement concrete, conventional cement concrete, steel fiber, etc.**

I. INTRODUCTION

Concrete is well known for its brittle failure. Property of material can be overcome by the inclusion of a small amount of short steel, glass, synthetic and natural fibers. Such fibers help in minimizing weaknesses of concrete. Major weaknesses of concrete such as low growth resistance, high shrinkage cracking and low durability, etc. As concrete has major deficiency such as Low tensile strength, Brittleness, Low post cracking capacity, Low impact strength, low ductility, Limited fatigue life and large deformations are not permitted. Long term strength, toughness and high stress resistance can be achieved by using steel fibers in reinforced Concrete (SFRC). Use of SFRC is increasingly being used for various purposes like flooring, precast, housing, tunneling, mining and heavy duty pavement. Aspect ratios of steel fibers used in concrete mix are varied from 50 to 100. Volume fraction values for concrete mixes are between 0.5% and 1.5% by volume of concrete are most suited. The fibers interlock the aggregate particles as well as considerably reduce the workability. The mix becomes more cohesive and less prone to segregation. Steel Fibers help in improving compressive strength, tensile strength, flexural strength, post peak ductility performance, pre-crack tensile strength, fatigue strength, impact strength and eliminate temperature and shrinkage cracks in concrete. By using SFRC, we can prepare cement concrete with low tensile and impact resistances, into a strong mix with superior crack resistance, improved ductility and other distinct properties.

This paper gives the results on parametric study made on concrete against compressive strength, flexural strength and tensile strength. For the study purpose we have used concrete with variable grades, aspect ratio and percentage of steel.

II. EXPERIMENTAL MATERIALS

Cement, sand, coarse aggregate, water and steel fibers were the ingredients to carry out experimental study. Each ingredient is further summarised below in table 2.1.

Table 2.1 Concrete Mix Ingredients

Cement	Ordinary Portland cement of 43 grade conforming to I.S. 8112:1989
Sand	Locally available sand in zone II with specific gravity 2.45, fineness modulus 2.92 and water absorption 2% conforming to I.S. 383:1970
Water	Potable water was used for the experimentation
Steel Fibers	Two different Hook End Steel fibers were used

The Steel fibers with aspect ratios, length and diameter adopted were shown in table 2.2.

Table 2.2 Steel Fiber Dimensions

Aspect Ratio	Length (mm)	Diameter (mm)	Shape of Fiber
50	50	1	Hook End

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ISSN (Online) 2456-1290
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III. EXPERIMENTATION

A. Compressive Strength Test

Cube specimens of dimensions 150 x 150 x 150 mm and cylindrical specimens of length 200 mm and diameter 100 mm were casted for M20 grade of concrete. The moulds were prepared by incorporating 0% and 0.5%, 1.0% &1.5% fibers. The specimen was properly prepared with good compaction and special care. After 24 hours the specimens were demolded and kept in curing tank for 7 days and 28 days. Testing of cubes is done on 7th and 28th day of curing on digital compression testing machine as per I.S. 516:1959. The failure load was noted. In each category, three individual cubes and cylinders were tested and their average value is reported. The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

B. Flexural Strength Test

Two point Flexural strength test was conducted as per I.S. 516:1959. Beams specimens of dimension 15x15x70 cm length were casted. Further demoulding, curing and testing is done in the same manner as specified above and their average value is reported.

Flexural strength was calculated as follows: Flexural strength (Kg/cm2)

$$f_b = \frac{PL}{bd^2}$$

Where, P = failure load in Kg, d= depth of beam in cm, L = length of beam in cm, b = breadth of beam in cm

I.S. 456:1978 gives the formula for flexural strength in terms of Characteristic of compressive strength of Concrete.

$$f_{cr} = 0.7\sqrt{f_{ck}}$$

IV. RESULTS

A. Compressive Strength Test:

Using cube Specimen:

Compressive strength results for M-25 grade of concrete on cube and cylinder specimen with 0% and 0.5%, 1.0% and 1.5% steel fibers for aspect ratio 50 are shown in table 4.1 and figure 4.1.

Table 4.1 Compressive strength Results of cube specimen

Days	Average Compressive strength (N/mm2			
	0%	**0.5%.**	**1.0%**	**1.5%**
7	27.85	30.2	32.95	34.29
28	36.93	40.79	44.91	46.32

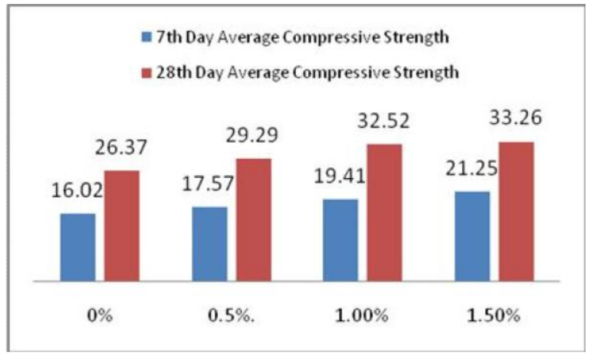

Figure 4.1 Average Compressive Strength of cube

Using cylindrical Specimen:

Compressive strength results for M-25grade of concrete on cylinder specimen with 0% and 0.5%, 1.0% and 1.5% steel fibers shown in table 4.2 and Figure 4.2.

Table 4.2 Compressive strength Results of cylinder specimen

Days	Average Compressi strength(N/mm2)			
	0%	**0.5%.**	**1.0%**	**1.5%**
7	16.02	17.57	19.41	21.25
28	26.37	29.29	32.52	33.26

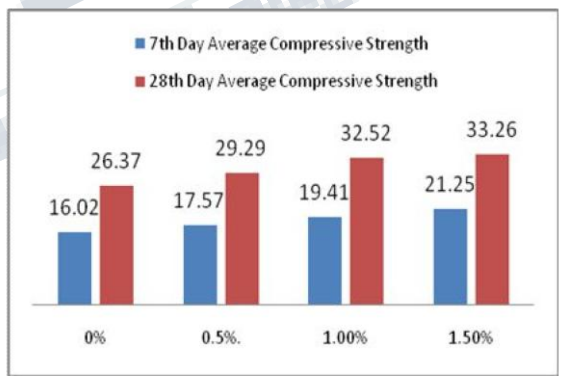

Figure 4.2 Average Compressive Strength of cylinder

B. Flexural test:

Flexural strength results for M-25 grade of concrete with 0%, 0.5%, 1.0%, and 1.5% steel fibers for aspect ratio 50 is shown in table 4.3 and figure 4.3.

Table 4.3 Flexural strength results for Cube specimen

Days	Average Flexural strength (N/mm2)			
	0%	**0.5%**	**1.0%**	**1.5%**
28	2.81	3.5	3.76	4.02

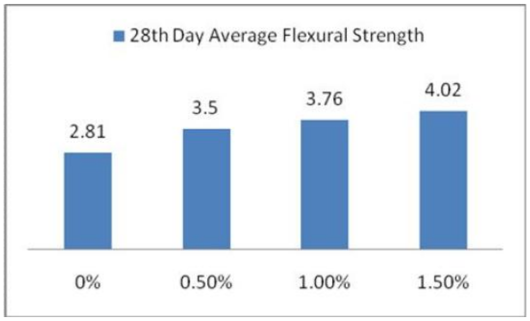

Figure 4.3 Average Flexural Strength of Cube

IV. CONCLUSION

1. It is observed that by adding fiber, it gives near about 10% more compressive strength than the strength gained for conventional concrete. The comparison of result of compressive strength for cube specimen of M25 grade of concrete is shown in figure 4.1.
2. Similarly for cylindrical specimen gives about 10% more compressive strength than conventional concrete at same volume. Its comparison is shown in figure 4.2.
3. It is also observed that by adding 1.5% of steel fiber gives maximum flexural strengthat28 days. Figure 4.3 gives average flexural strength of cube specimen.
4. Experimental results tell that the compressive strength of cube and cylinder for different proportions of steel fiber was more than that of results obtained from conventional concrete.
5. It is also observed that adding steel fibers affects the workability of concrete. Addition of 0.5% steel fiber reduces the slump value of fresh concrete. The problem of workability of concrete can be overcome by using admixtures such as Super plasticizers.
6. In flexural Test, the deflection of beam was reduced with increase the percentage of Fiber dose.

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