International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Determination of Mechanical Properties of Steel Fiber Reinforced Concrete with Mineral Admixtures

Mekala Prathap Reddy[1], Dr. K. Chandrasekhar Reddy[2]

[1]P.G Student, Dept of Civil Engineering, Siddhartha Institute of Engineering & Technology, Puttur, A.P. India

[2]Professor of Civil Engineering & Principal, Siddharth Institute of Engineering & Technology, Puttur, A. P, India

Abstract: ***This paper investigation on M-30 grade of concrete with water cement ratio 0.45 to study the compressive strength, and tensile strength of steel fibers reinforced concrete (SFRC) containing fibers of an interval of 0.5%,1%,1.5% volume fraction of hook end steel fibers of aspect ratio 60 were used. The different percentage of one or more mineral admixtures with combination of steel fibers is used in this study. After curing this specimen were tested as per relevant codes of practice Bureau of Indian standard. A result data obtained has been analyzed as compared with a control specimen. A relationship between compressive strength V_S. days and flexural strength V_S days respected graphically. Result data clearly shows percentage increase in 7, 28 & 54 days compressive strength for M-30 grade of concrete***

Keywords: fiber reinforced concrete, silica fume, Fly ash, mix design, steel fibers.

1. Introduction

Concrete is mainly containing natural sand and gravel or crushed- rock aggregate and water, when placed in the skeleton of form and allowed to cure, becomes hard like stone. Generally weighing about 2400kg/m^3 is called "normal-weight concrete" and it is the most commonly used concrete for structural purposes. High strength concrete is concrete with a compressive strength higher than 40mpa. It is made by lowering the water-cement (W/C) ratio 0.40 or lower. It had widely used in large and long life constructions that demands early age strength, high density, heat of hydration, high flow ability, and high durability. It is very difficult to get a product which additionally fulfills all of the properties. So the different mineral admixtures like Ground Granulated Blast furnace Slag (GGBS), silica fume, Rice husk ash, Fly ash, High Reactive Met kaolin, are some of the admixtures which can be used in concrete as partial replacement of cement, which are very important ingredients to make high strength concrete.

2. Role of fiber reinforced concrete with mineral admixtures

Fibers are generally used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact abrasion, and shatter resistance in concrete. Generally fibers do not increase the flexural strength of concrete, and so cannot replace moment resisting or structural steel reinforcement. Indeed, some fiber. The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (V_f). V_f typically ranges from 0.1 to 3%. The aspect ratio (l/d) is calculated by dividing fiber length (1) by its diameter (d).

3. Material Specifications

3.1 Cement

The cement used in this experimental work is 53 grade ordinary Portland cement confirming to IS: 12269-1987 was used in present study.

Table 3.1: Properties of cement

Properties	*Obtained*
Specific gravity	3.15
Initial setting time	70 min
Final setting time	180 min
Consistency	32%

3.2 Fine aggregate

Locally available sand passed through 4.75mm IS sieved. Natural sand as per IS: 383-1987 was used.

Table 3.2: Properties of fine aggregate

Properties	*Obtained*
Specific gravity	2.67
Fineness moduless	2.544
Bulk density	1094 to 1162 kg/m^3
Water absorption	1.2%
Grading	II

3.3 Coarse aggregate

Crushed aggregate available from local sources conforming to IS: 383-1987.

Table 3.3: Properties of coarse aggregate

Properties	*Obtained*
Specific gravity	2.83
Aggregate impact value	14%
Aggregate crushing value	18%
Water absorption	1.85%

3.4 Silica Fume

Silica fume is a waste by-product of the production of silicon and silicon alloys. Silica fume is available in different forms, of which the most commonly used is in a dandified form. Silica fume used was conforming to ASTM C (1240-2000)

Table 3.4: Properties of silica fume

Property	*Value*
Colour	Dark to light gray
Bulk density	450-650 g/cm^3
Specific gravity	2.22
Moisture content	1.2%
Sio_2	92%

3.5 Fly Ash

Fly ash is a byproduct of the combustion of pulverized coal in thermal power plants. A dust-collection system removes the fly ash, as a fine particulate residue, from combustion gases before they are discharged into the atmosphere. Fly-ash particles are typically spherical, ranging in diameter from <1 μm up to 150 μm.

3.6 Water

According to ACI water used for preparing concrete should be of potable quality. In this investigation ordinary tap water, which is fit for drinking, has been used in preparing all concrete mixes and curing.

3.7 Super Plasticizers

Plasticizers help us to increase the workability of concrete without addition of extra quantity of water. It means that we can use less water without reducing the workability at the same cement content. This is added to avoid formation of flakes, due to less quantity of water. Use of plasticizers is economical as the cost incurred on them is less than the cost of cement saved. Use of super plasticizers becomes essential for designing mix to achieve HPCand also for the preparation of fiber reinforced concrete to increase workability. Super plasticizer used in this study was Glenium B-233.

3.8 Steel Fiber

For improving the mechanical bond between the fiber and matrix, indented, crimped, machined and hook ended fibers are normally produced. Fibers made from mild steel drawn wire conforming to IS: 280-1976 with the diameter of wire 0.5 mm has been used.

Table 3.5: Properties of steel fibers

Fiber properties	*Steel fibers*
Length (mm)	35 mm
Shape	Hooked End
Size / Diameter (mm)	0.5 mm
Aspect Ratio	60
Density (kg / m3)	7850
Young's Modulus (GPa)	210
Tensile strength (MPa)	**532**

4. Experimental Methodology

4.1. Workability Test

Workability is carried out by conducting the slump test and compaction factor test as per IS 1199-1959 on ordinary concrete and fiber reinforced concrete.

4.2. Compressive Strength Test

Compression test is the most common test conducted on hardened concrete, partly because it is easy test to perform and partly because most of desirable characteristic properties of concrete are qualitatively related to its compressive strength. Compression test is carried out on specimens of cubical shape. The size of specimen is 15×15×15 cms were cast for M30 grade of concrete .after curing, these cubes were tested on compression testing machine AS per I.S. 516-1959. The failure load was noted. In each category two cubes were tested and their average value is reported. The compressive strength was calculated as fallows, compressive strength (Mpa)= failure load/ cross sectional area.

4.3. Flexural strength test

For flexural strength test beam specimens of dimensions 15×15×70 cms were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 days. These flexural strength specimen were tested under two points loading as per I.S.516-1959,over an effective span of 600mm divide into three equal parts and rest on flexural testing machine . The load increased &failure load is noted at cracking of beam specimen. In each category two beams was tested and their average valve is reported. The flexural strength was calculated as follows.

Flexural strength (Mpa)=$(P\times L)/(b\times d^2)$,
Where P=failure load, L=centre to centre distance between the support=600mm,b=width of specimen =150mm, d=depth of specimen=150mm.

5. Experimental Result

5.1 Fresh concrete test results

The properties of fresh concrete can be evaluated by slump cone test & compaction factor test with W/C ratio 0.4. The result of properties are given in table 1.

Table 5.1: Result of slump and compaction of fresh concrete

S.No.	*Mix type (SF %, SF&FA %)*	*Slump value(mm)*	*compaction factor*
01	MS0(0.0%, 0.0%&0.0%)	78	0.952
02	MS1 (0.5%, 5%&5%)	23	0.820
03	MS2 (0.5%, 10%&10%)	38	0.810
04	MS3 (0.5%, 15%&15%)	49	0.902
05	MS4 (1.0%, 5%&5%)	18	0.801
06	MS5 (1.0%, 10%&10%)	21	0.786
07	MS6 (1.0%, 15%&15%)	31	0.802
08	MS7 (1.5%, 5%&5%)	12	0.740
09	MS8 (1.5%, 10%&10%)	15	0.792
10	MS9 (1.5%, 15%&15%)	19	0.810

5.2 Hardened Concrete Strength Results

Result of compressive strength for M40 grade on concrete on cube. The specimens are separated by steel fibers, silica fume & fly ash with varying percentage. The table no.2 shows result of compressive strength at 7, 28 & 45 days.

Table 5.2: compressive strength at 7, 28 & 45 days

Mix. No.	*Steel fibers%*	*Silica fume%*	*Fly ash%*	*Compressive strength(N/mm^2)*		
				7 days	28 days	45 days
MS0	0.0%	00%	00%	24.99	36.24	36.24
MS1	0.5%	5%	5%	28.59	31.13	39.24
MS2	0.5%	10%	10%	22.59	28.07	33.71
MS3	0.5%	15%	15%	21.17	23.09	25.93
MS4	1.0%	5%	5%	29.38	33.70	43.59
MS5	1.0%	10%	10%	24.11	31.59	36.99
MS6	1.0%	15%	15%	25.90	29.57	34.90
MS7	1.5%	5%	5%	31.21	34.59	47.35
MS8	1.5%	10%	10%	23.39	32.98	41.34
MS9	1.5%	15%	15%	24.11	31.59	35.37

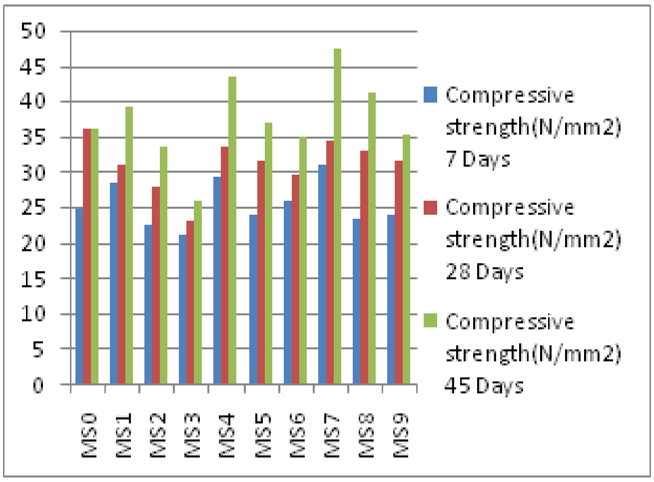

Figure 5.1: Type of mix vs compressive strength (N/mm^2) at 7, 28 & 45 days

5.3. Flexural Strength

The table No. 3 & Fig No.2 shows flexural strength of specimen for 7 days.

Table 3: flexural strength (N/mm^2) for 7 days

Mix. No	*Steel fibers %*	*Silica fume%*	*Fly ash%*	*Flexural strength(N/mm^2) 7 Days*
MS1	0.5%	5%	5%	3.53
MS2	0.5%	10%	10%	3.09
MS3	0.5%	15%	15%	3.13
MS4	1.0%	5%	5%	3.88
MS5	1.0%	10%	10%	3.24
MS6	1.0%	15%	15%	3.67
MS7	1.5%	5%	5%	4.63
MS8	1.5%	10%	10%	4.44
MS9	1.5%	15%	15%	3.39

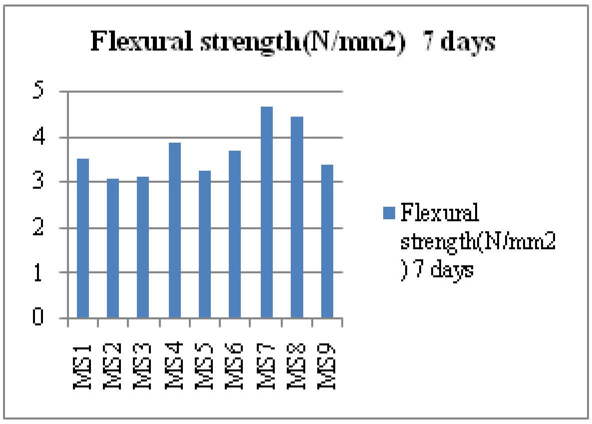

Figure 2: Type of mix vs Flexural strength (N/mm^2) at 7 days

6. Conclusions

The study on the effect of steel fibers with Fly Ash and silica fume can still be a promising work as there is always a need to overcome the problem of weakness of concrete. The following conclusions could be drawn from the present research.

1) Marginal increase is observed in the workability as percentage of Fly Ash and silica fume increases.
2) Density of concrete is more as the proportion of steel Fiber increases.
3) Compaction factor is increases as the Steel Fiber proportion decreases.
4) Higher percentage of Steel Fibers slump was down.
5) Water falling agent is required for workable mix as percentage of Steel Fiber increases.
6) Stiffness of specimens is increased because of Steel Fibers, Fly Ash and silica fume.
7) The strength of specimen is about 82% at 28th day and 95 to 100% at 45 days, because of steel fibers, Fly Ash and silica fume.
8) Specimen of MS1, MS4&MS7 having high Flexural strength as well as Compressive strength.
9) For small quantity of Fly Ash and silica fume (10%&20%) Compressive Strength is more for 1.0% & 1.5% Steel Fibers.

References

[1] B. Krishna Rao, V. Ravindra (2010), "Steel Fiber Reinforced Self compacting Concrete Incorporating Class F Fly Ash", International Journal of Engineering Science and Technology Vol. 2(9),4936-4943.
[2] Rahul.D.Pandit, S.S.Jamkar, "mechanical behavior of high strength fibre reinforced concrete"
[3] IS 383: 1970, Specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian standards, New Delhi, India.
[4] IS 10262-2009, recommended guidelines for concrete mix design, Bureau Standards, New Delhi, India.
[5] IS: 516-1959, Indian standard methods of tests for strength of concrete, Bureau of Indian standards, New Delhi, India.