

Effects of Fibers on Strength of Concrete

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ABSTRACT: The aim of this project was to evaluate the performance of high strength concrete (HSC) containing supplementary cementitious materials. Concrete has a good future and is unlikely to get replaced by any other material on account of its ease to produce, infinite variability, uniformity, durability and economy with using of Steel fiber in high strength concrete. The main aim of the project is first to prepare the strength of concrete of grade 30 with locally available materials and then to study the effects of Steel fiber in the mix and to find optimum range of Steel fiber content in the mix. The concrete specimens were tested at different age (7 days & 28 days) for mechanical properties of concrete namely compressive strength, split tensile strength, bond strength and other tests were conducted for cement, coarse aggregate, and fine aggregate.

KEYWORDS: Steel Fiber, Effects of Fiber, Strength of Concrete

I. INTRODUCTION

Concrete is closely related to every human being and their day-to-day life. It is widely used as construction material in world, and it is very difficult to find another material of construction as versatile as concrete. Concrete is nothing but artificial stone resulting from the hardening of mixture of cement, sand, coarse aggregates, water and sometimes mineral and chemical admixtures are also added to enhance properties of concrete in fresh and hardened state. For making good or bad concrete it requires same materials, hence controlling the properties at every stage of concreting play an important role in its quality or strength. Steel fiber (SF) is an inorganic fiber material. It is an all-natural material and originates from iron ore. Iron ore is melted at high-temperature (1450 °C) and rapidly drawn into a continuous fiber. It then can be chopped into various lengths. The basic characteristics of Steel materials are high-temperature resistance, low corrosion resistance, resistance to acids and alkalis, high strength and thermal stability. Steel materials can be used as a reinforcing composite material for the construction industry, specifically as a less expensive alternative to carbon fiber. Concrete made with Portland cement has certain characteristics: it is relatively strong in compression but weak in tension and tends to be brittle. The weakness in tension can be overcome by the use of conventional rod reinforcement and to some extent by the inclusion of a sufficient volume of certain fibers. The use of fibers also alters the behavior of the fiber-matrix composite after it has cracked, thereby improving its toughness.

II. LITERATURE SURVEY

A) Strengths Prediction of Plastic fiber Reinforced concrete (M25)

R. N. Nibudey (February -2013)

This author describes the performance of plastic fiber reinforced concrete (M25). An experimental work has been carried out on the specimens like cubes, Beam, L-Beam, and cylinders which were casted in the laboratory and their behavior under the test was observed. The plastic fibers were added from 1% to 3%. The compressive and split tensile strengths of concrete were determined after 28 days of curing period.



B) SELINA RUBY G et ‘all GEETHANJALI C., JAISON VARGHESE, P. MUTHU PRIYA (January-2014))

The combining of fibers, often called hybridization, is investigated for a M30 grade concrete at a volume fraction of 0.5% in this paper. Control and three hybrid fiber composites were cast using different fiber proportions of steel and polypropylene. Compressive strength, split tensile strength and flexural strength test were performed and results were analyzed to associate with above fiber combinations. They perform tests on maximum compressive, split tensile and flexural strength of concrete.

C) Performance of Steel Fiber Reinforced Concrete

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In this paper effect of fibers on the strength of concrete for M 30 grade have been studied by varying the percentage of fibers in concrete. Fiber content were varied by 0.25%, 0.50%, 0.75%, &1%. Cubes of size 150mmX150mmX150mm to check the compressive strength and beams of size 500mmX100mmX100mm for checking flexural strength were casted. All the specimens were cured for the period of 3, 7 and 28 days before crushing. The results of fiber reinforced concrete for 3days, 7days and 28days curing with varied percentage of fiber were studied and it has been found that there is significant strength improvement in steel fiber reinforced concrete.

D) Strengths prediction of plastic fiber reinforced concrete M30

Dr. P. B. Nagarnaik, Dr. D. K. Parbat, Dr. A. M. Pandey, IJERA Jan – Feb 2013

Portland pozolana cement, river sand, crushed aggregate, potable water, PET. They added 0% to 3% of plastic fiber in M30 reinforced concrete and determine the compressive and tensile strength after 28 days. Strength of concrete increases considerably by using fiber content.

III. METHODOLOGY

Material and grade of concrete mix

- Selection of grade and concrete mix design by an appropriate method trial mixes, final mix proportions.
- Estimating total quantity of concrete required for the whole experimental work.
- Estimating quantity of cement, fine aggregate, coarse aggregate, steel fibers, required for the work.
- Testing of properties of cement, fine aggregate, coarse aggregate.
- Obtaining properties of Steel fibers.

Test conducted on Material used in experimental work

The ingredients of concrete i.e. cement, fine aggregates, coarse aggregate are tested before producing concrete. The relevant Indian Standard codes were followed for conducting various tests on concrete

Tests on cement

The cement used in this experimental work is “UltraTech 53 grade Pozzolona Portland Cement”. All properties of cement are tested by referring IS 12269 - 1987 Specification for 53 Grade Ordinary Portland cement.

Table no. 1: Physical Properties of Cement

Sr. No.	Description of Test	Results
1	Fineness of cement (residue on IS sieve no 9)	3%
2	Specific gravity	3.15
3	Standard consistency of cement	29%
4	Setting time of cement a) Initial setting time b) Final setting time	135 mint 288 mint



5	Soundness test of cement	1.5 mm
6	Compressive strength of cement a) 7 days b) 28 days	57.8 N/mm 79.5 N/mm

Table no. 2: Physical Properties of Fine Aggregate (sand)

Sr. No.	Property	Results
1	Particle shape, size	Round, 4.75 mm (down)
2	Fineness Modulus	3.17
3	Silt content	0.5%
4	Specific Gravity	2.63
5	Surface Moisture	Nil

Table no. 3: Physical Properties of Course Aggregate (20mm)

Sr. No.	Property	Results
1	Particle Shape, size	Flaky, 20 mm down
2	Fineness Modulus	6.87
3	Specific gravity	2.65
4	Surface moisture	Nil

Table no. 4: Physical properties of Steel Fiber (Steel)

Sr. No.	Property	Results
1	Thickness	1 mm
2	Length of fiber	60mm
3	Tensile Strength (MPa)	400-1200
4	Elongation at Failure (%)	-3.5
5	Specific gravity	7.86
6	Used Dosage	2.4 Kg/m ³

Mix Design of Concrete M30 (IS: 10262:2009)

Step 1: To determine the target strength for mix proportion

$$S = fck + 1.65 * s$$

Where,

s = Assumed standard deviation in N/mm²

s = 5 (as per table-1 IS 10262-2009)

$$= 30 + 1.65 \times 5$$

$$S = 38.25 \text{ N/mm}^2$$

Step 2: Selection of water-cement ratio

Ratio = 0.45 (Table-5 IS 456, maximum w/c)

Step 3: Selection of water content

Maximum water content for 20mm aggregate

$$= 160 \text{ kg/m}^3 \text{ (Table-2 IS 10262-2009)}$$

Step 4: Calculation of cement content

Water-cement ratio = 0.45

Water content = 160

$$\text{Cement content} = \frac{\text{water content}}{\frac{w}{c} \text{ ratio}}$$

$$\text{Cement content} = \frac{160}{0.45} = 355.55 \text{ kg/m}^3 \text{ (Table 5 IS 456)}$$

Minimum cement content for moderate exposure condition = 320 kg/m³

355.55 kg/m³ > 320 kg/m³ Hence OK

Maximum cement content = 450 kg/m³ Hence OK

Step 5: Proportion of volume of coarse & fine aggregate content *Table 3 of IS 10262 – 2009*

Volume of coarse aggregate corresponding to 20mm size fine aggregate (zone 1) = 0.6

Step 6: Estimation of concrete mix calculation

1) Volume of concrete = 1m³

$$2) \text{ Volume of cement} = \frac{\text{mass of cement}}{\text{specific gravity of cement}} \times \frac{1}{1000}$$

$$= \frac{355.55}{3.14} \times \frac{1}{1000}$$

$$\text{Volume of cement} = 0.1132 \text{ m}^3$$

$$3) \text{ Volume of water} = \frac{\text{mass of water}}{\text{specific gravity}} \times \frac{1}{1000}$$

$$= \frac{160}{1} \times \frac{1}{1000}$$

$$\text{Volume of water} = 0.160 \text{ m}^3$$

$$4) \text{ Volume of Steel fiber} = \frac{\text{mass of fibre}}{\text{specific gravity of fibre}} \times \frac{1}{1000}$$

$$= \frac{2.4}{7.86} \times \frac{1}{1000}$$

$$\text{Volume of fiber} = 3.05 \times 10^{-4} \text{ m}^3$$

5) Total volume of aggregate = 1- (a + b + c)

$$= 1- (0.1132 + 0.16 + 3.05 \times 10^{-4})$$



Volume of aggregate = 0.726 m³

6) Mass of course aggregate = Total volume of aggregate × 0.6 × specific gravity × 1000

= 0.726 × 0.6 × 2.65 × 1000

Mass of course aggregate = 1154.34 kg/m³

7) Mass of fine aggregate = Total volume of aggregate × 0.4 × specific gravity × 1000

= 0.726 × 0.4 × 2.63 × 1000

Mass of fine aggregate = 763.75 kg/m³

Step 7: Size of Cube & Cylinder used and measurement of quantity

Cube size = (0.15 × 0.15 × 0.15) × 4

Cube size = 0.0135 m³

Cylinder size = (πr²h) × 4

Cylinder size = 0.022 m³

Table no. 5: Quantity of Materials per Cubic Meter of Concrete

Material	Proportion by weight	Volume in kg/m ³
Cement	1	355.55 kg/m ³
Fine Aggregate	2.15	763.75 kg/m ³
Course Aggregate (20mm)	3.24	1154.34 kg/m ³
Water	0.45	160 kg/m ³
Fiber (Steel)	0.00675	2.4 kg/m ³

IV. ANALYSIS AND RESULTS

A) Compressive Strength Test on Cube:

The result of compressive strength are obtained using equation ($F_{cu} = P_c/A$) and are presented. The equation of compressive strength (stress) is as shown below.

Compressive Strength (stress), $F_{cu} = P_c/A$

Where, P_c = Failure load

A = Surface Area of cube that is, $150 \times 150 \text{ m} = 22500 \text{ mm}^2$

Table no. 6: Compressive Strength Test (Cube) MPa

Specimen	Grade	Steel fiber content	Compressive Strength MPa in (7 days)	Compressive Strength MPa in (28 days)
Ordinary	M30	-	20.64	36.01
Steel added	M30	32.4 gm	23.47	46.50

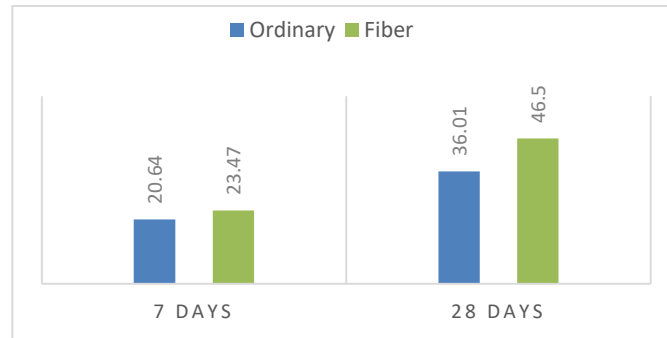


Fig no. 1 Compressive strength test

B) Split Tensile Strength Test on Cylinder:

The result of tensile strength are obtained using equation $F_{cu} = 2P_c/\pi DL$ and are presented. The equation of tension strength is as shown below.

Compressive Strength (stress), $F_{cu} = 2P_c/\pi DL$

Where, P_c = Failure load

D = Diameter of cylinder (150mm)

L = Length of cylinder (300mm)

Table no. 7: Split Tensile Strength Test (Cylinder) MPa

Specimen	Grade	Steel fiber content	Split tensile Strength MPa in (7 days)	Split tensile Strength MPa in (28 days)
Ordinary	M30	-	1.43	2.90
Steel added	M30	52.78 gm	1.76	4.25

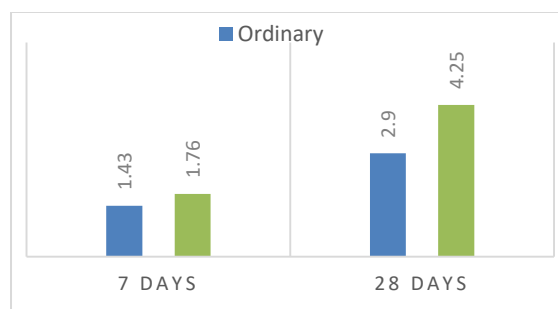


Fig. no. 2 Split Tensile Strength

IV. CONCLUSION

- Maximum gain in strength of concrete is found to depend upon the amount of steel fiber content. The optimum steel content to impart maximum gain in various strengths.
- The steel content concrete of compressive strength is increased by 1.5% of its total strength.
- The steel fibers have no toxic reactions with air or water, and they are low in weight.
- The cracks in concrete is also decreased and the long life of concrete by adding steel fibers in it.

V. FUTURE WORK

- Investigation of ductility characteristics of SFRC for potential application in seismic design and construction.
- Behavior under creep and shrinkage.
- Behavior of mechanical and physical properties of SFRC at low temperatures.
- Study the coatings for steel fiber to modify bond with the matrix and to provide corrosion protection.
- Same parameters with recycled aggregates.
- Fracture analysis.
- Stress transfer mechanism.
- Study of impact resistant, abrasion resistant and permeability of SFRC and resistant to chemical attack.

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