*Impact Factor (SJIF): 5.301*

**International Journal of Advance Research in Engineering, Science & Technology**

*e-ISSN: 2393-9877, p-ISSN: 2394-2444*

***Volume 5, Issue 4, April-2018***

# EXPERIMENT ON FIBER REINFORCED CONCRETE

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*Abstract* — ***There is an increasing worldwide awareness in applying fiber reinforced concrete structures for civil infrastructure applications. Concrete is most largely used construction material in the world. The fibers used in FRC may be of different materials like steel, G.I., carbon, glass, asbestos, polypropylene, jute etc. In this project we have use POLYPROPYLENE & STEEL FIBERS. The addition of these fibers into concrete mass can intensely increase the compressive strength, flexural strength and impact strength of concrete. Comparing the result of FRC with plain M20 grade concrete, this project authorized the positive effect of different fibers with percentage increase in compression of sample at 7, 14 and 28 days, analyzed the thoughtfulness of accumulation of fibers to concrete with different strength.***

***Keywords- Concrete, Fiber Reinforced Concrete, Polypropylene Fiber, Steel Fiber, Compressive Strength, Durability, Ductility.***

## I. INTRODUCTION

Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers – each of which lends varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities.

What is Fiber Reinforced Concrete?

Fiber reinforced concrete (FRC) is a new structural material which is gaining increasing importance. Addition of fiber reinforcement in discrete form improves many engineering properties of concrete. Fiber reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and including discrete discontinuous fibers.

Application of FRC -

It is used on account of the advantages of increased static and dynamic tensile strength and better fatigue strength

It has been tried on overlays of air-field, road pavements, industrial footings, bridge decks, canal lining, explosive resistant structures, refractory linings, etc. Used for the fabrication of precast products like pipes, boats, beams, stair case steps, wall panels, roof panels, manhole covers etc.

It's also used in,

- Industrial flooring
- Sprayed concrete
- Slender structures (usually in precast plants)
- Fire resistant structures
- Mortar applications (rehabilitation)

## II. MATERIALS

1. Steel Fiber-Reinforced Concrete

Steel fiber reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete.

Steel fiber-reinforced concrete uses thin steel wires mixed in with the cement. This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fiber is often used in conjunction with rebar or one of the other fiber types.

Fig.1 steel fiber

**Properties of Steel Fibers**

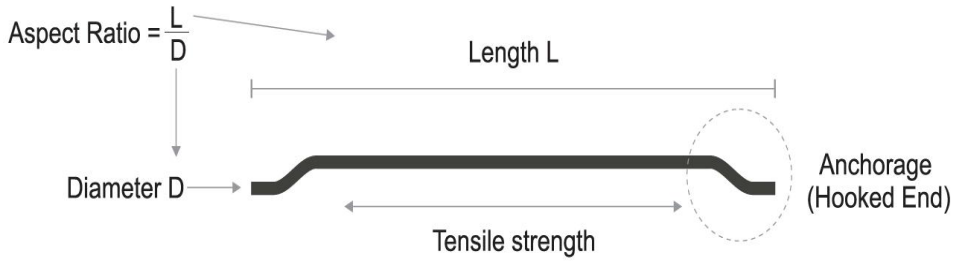
| | |
|---|---|
| Appearance/ Colors | Clear, Bright, Glued Fibers with Hooked End Anchorage |
| Dimension | Length (l):- 60 mm<br>Diameter (d):- 0.75 mm<br>Aspect ratio (l/d) : 80<br>  |
| Aspect | Low Carbon Steel |
| Density | 7.850 kg/m3 |
| Fiber Concentration | 4,500 - 5,500 fibers/kg |
| Tensile Strength | >1100 Mpa |
| Storage Condition | Store in dry condition. Protect from frost, rain and water |

Table.1-property of steel fiber

2. Polypropylene Fiber Reinforced Concrete

Polypropylene Fiber Reinforced Concrete is an embryonic construction material which can be described as a concrete having high mechanical strength, Stiffness and durability. By utilization of Polypropylene fibers in concrete not only optimum utilization of materials is achieved but also the cost reduction is achieved. This paper presents a comprehensive review on various aspects Polypropylene Fiber Reinforced Concrete concerning the behavior, applications and performance of Polypropylene Fiber Reinforced Concrete.

Fig.2 P.P. fiber

The physical properties of the PP fibers

| | |
|---|---|
| Thermal conductivity | 0.95 Btu-in/ft2.hr.°F |
| Coefficient of linear thermal expansion | 4.0 x 10-5/°F |
| Decomposition temperature range | 328 - 4100 C |
| Specific gravity | 0.9 |
| Density | 0.92 kg/m3 |

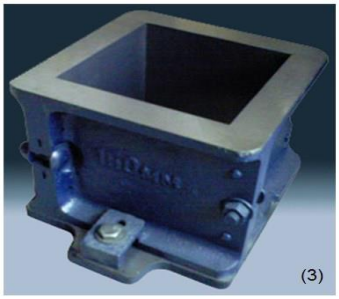
Table. 2-property of polypropylene fiber

### A. Material Used

- Cement
- Sand
- Coarse aggregate
- Water
- Polypropylene & Steel fibers were used
- Grease or Oil

### B. Tool Required

1. Compression Machine



2. Standard Cube size 150mm x 150mm (6" x 6" x 6")

3. Weighting machine

4. Hand Float

5. Steel Rod size 16 mm dia
.

Fig. 3 Equipment used in Project

## III. AIM AND OBJECTIVE

### A. General Objective

The main aim of this project is to investigate the performance of Polypropylene & Steel Fibers as micro reinforcement in concrete mixes when used to improve the mechanical properties of the concrete.

### B. Specific Objective (Aim)

To characterize the Polypropylene & Steel Fibers reinforced concrete using experimental methods on their mechanical strength. The objectives will be achieved by testing different concrete cubes and cylinder which have been cast with a varying fiber content percentage by volume of concrete. From a control of 0% fiber content, then increasing the fibers as follows 0.5%, 0.75% and 1%. The tests to be done is the cube crushing test.

## IV. IMPLEMATION STRATEGY

We have decided the following strategy for our Fiber Reinforced Concrete Project.
Phase-1 Preparation of Material Used
Cement,
Sand,
Coarse aggregate,
Fine Aggregate,
Water,
Polypropylene & steel fiber was used.

**Cement**

The cement used was Ordinary Portland cement (53 Grade) with a specific gravity of 3.15. Initial and final setting time of the cement was 20 min and 227 min, respectively. Ordinary Portland cement of 53 Grade was used, conforming to I.S-12269-1987

**Sand**

Good quality river sand was used as a fine aggregate. Locally available sand, confirming to zone II with specific gravity 2.45, water absorption 2% and fineness modulus 3.18 conforming to I.S. – 383-1970 [21].

**Coarse aggregate**

Crushed granite stones of maximum 20 mm size having specific gravity of 2.67, fineness modulus of 7.10, conforming to IS 383-1970 [21].

**Water**

Potable water was used for the experimentation.

**Fibers**

In this work, effects on strength of concrete with two hook end steel fibers and crystalline polypropylene fibers at low volume fraction were studied.

Crystalline polypropylene fiber having 12 mm length and of & Steel wire form, Hook end 60 mm length having density of 7.850 kg/m3 and minimum tensile strength as 345 Mpa, at 0.5%,0.75% & 1% by volume of concrete. The aspect ratios adopted were 80 with diameter of fiber 0.75 mm.

| Description of used Fibers | Length (mm) | Description | Dosage of Fibers & by volume of concrete | Aspect Ratio (L/D) |
|---|---|---|---|---|
| PPF | 12 mm | crystalline | 0.50,0.75,1% | ---- |
| SCF | 60 mm | Hook End | 0.50,0.75,1% | 80 |
| PPF + SCF | ---- | ---- | 0.25-0.25%<br>0.50-0.50% | ---- |

Table No.3 Physical Properties of used fibers

Phase-2 Design Concrete Mix Proportions

Mix Design of Concrete for M20 grade were prepared as per I.S.10262:2009 with w/c 0.5

The total quantities of ingredients for M20 grade concrete are as follows:

| Materials | Quantity | Proportion |
|---|---|---|
| Cement | 383 Kg/ m3 | 1 |
| Sand | 575 Kg/ m3 | 1.5 |
| Coarse Aggregates | 1150 Kg/ m3 | 3 |
| Water | 192 Kg/ m3 | 0.5 |

Table No.4 Total quantities of ingredients

The tests have been performed to determine the mechanical properties such as compressive strength of concrete mix with Polypropylene & Steel Fibers 0.50%, 0.75% & 1% by volume of concrete.

| **Types** | **Days Of Curing** | **Cube Type** |
|---|---|---|
| **Plain Concrete** | 7 DAYS | PC-1 |
| | | PC-2 |
| | | PC-3 |
| | 14 DAYS | PC-1 |
| | | PC-2 |
| | | PC-3 |
| | 28 DAYS | PC-1 |
| | | PC-2 |
| | | PC-3 |
| **Polypropylene Fiber Concrete 1%** | 7 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| | 14 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| | 28 DAYS | PPF-1 |
| | | PPF-2 |

| | | |
|---|---|---|
| | | PPF-3 |
| **Polypropylene Fiber Concrete 0.75 %** | 7 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| | 14 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| | 28 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| **Polypropylene Fiber Concrete 0.5 %** | 7 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| | 14 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| | 28 DAYS | PPF-1 |
| | | PPF-2 |
| | | PPF-3 |
| **Steel Carbon Fiber Concrete 1 %** | 7 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| | 14 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| | 28 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| **Steel Carbon Fiber Concrete 0.75 %** | 7 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| | 14 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| | 28 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| **Steel Carbon Fiber Concrete 0.5 %** | 7 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| | 14 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| | 28 DAYS | SCF-1 |
| | | SCF-2 |
| | | SCF-3 |
| **Combination Of Polypropylene & Steel Carbon Fiber (0.25-0.25%)** | 7 DAYS | PPF + SCF-1 |
| | | PPF + SCF-2 |
| | | PPF + SCF-3 |
| | 14 DAYS | PPF + SCF-1 |
| | | PPF + SCF-2 |
| | | PPF + SCF-3 |
| | 28 DAYS | PPF + SCF-1 |
| | | PPF + SCF-2 |
| | | PPF + SCF-3 |
| | | PPF + SCF-1 |

| | | |
|---|---|---|
| **Combination Of Polypropylene & Steel Carbon Fiber (0.50-0.50%)** | 7 DAYS | PPF + SCF-2 |
| | | PPF + SCF-3 |
| | 14 DAYS | PPF + SCF-1 |
| | | PPF + SCF-2 |
| | | PPF + SCF-3 |
| | 28 DAYS | PPF + SCF-1 |
| | | PPF + SCF-2 |
| | | PPF + SCF-3 |

Table No.5-Total No. of Cube is 81.

**TEST-**

**Compressive Strength Test -**

CTM (Compressive testing machine) is used for testing of cubes; Capacity of compressive testing machine is 3000 KN. Compressive strength test is done for Plain concrete, Steel fiber concrete, polypropylene fiber concrete cubes. Purpose of the experiment is to compare Compressive strength of above different types of fiber concrete with various proportion. Specimens size of 150 mm x 150 mm x 150 mm for concrete cubes. Figure shows set-up for compressive strength test.


Fig. 4 compressive strength machine

| Notation | Description |
|---|---|
| PC | Plain Concrete |
| PPF | Polypropylene |
| SCF | Steel Carbon Fiber |

Compressive Strength (N/mm2) = P x $10^3$ / A

P = Failure load of cube (KN)
A = Area of cube (150 X 150) (mm2)

**RESULT AND ANALYSIS**

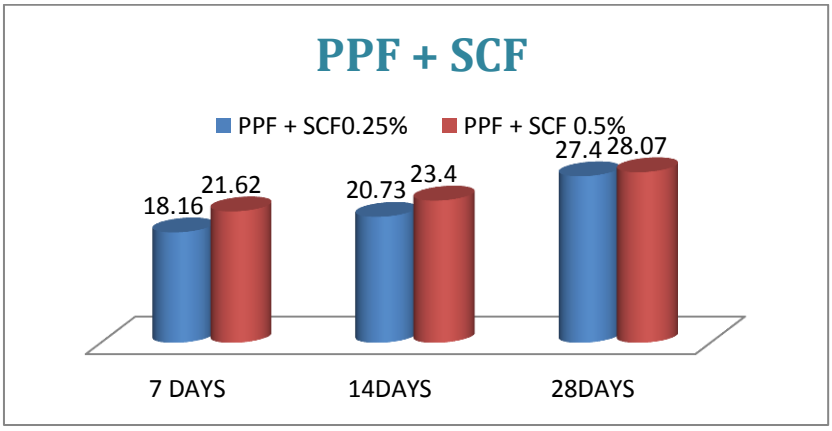



Chart.1- PPF+SCF

Above charts shows comparison for compressive strength of fiber concrete specimens.
The analysis indicates the results of 7, 14 & 28 days of strength of concrete.

A. Comparison of above chart the strength of steel fiber & combination of PPF + SCF is higher than Plain concrete. Result of 0.50%, 0.75% polypropylene fiber is higher than Plain concrete & with 1% polypropylene fiber is lower than Plain concrete.

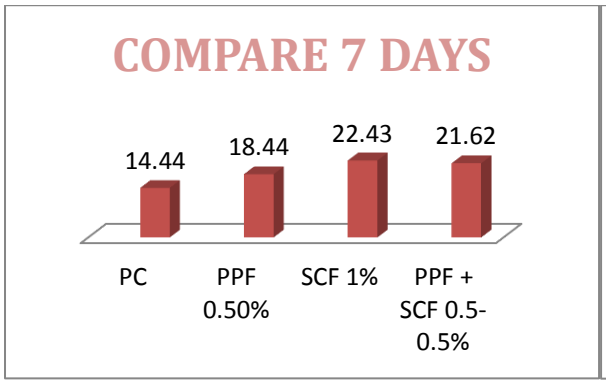



Chart.2- 7 days

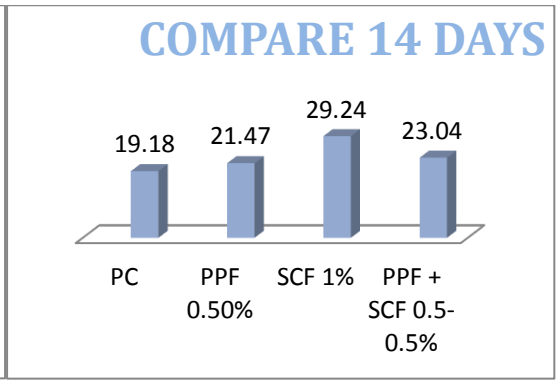



Chart.3- 14 days

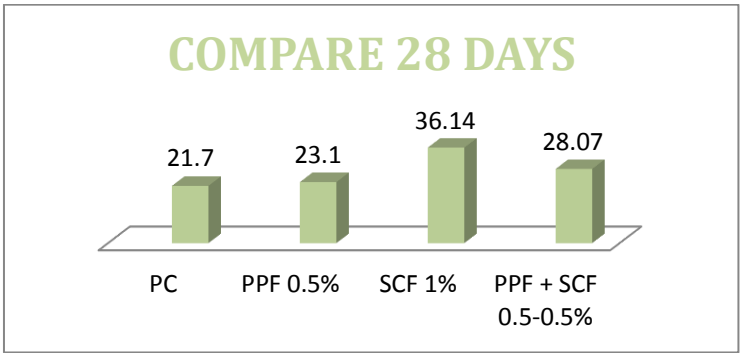



Chart.4 – 28 days

Comparison of 7, 14 & 28 days of our best result the higher compressive strength is 36.1 KN/m2 (28 Days) for 1% steel carbon fiber.

B. Comparison of 14 days' plain concrete to 7 days of Polypropylene Fiber Concrete.

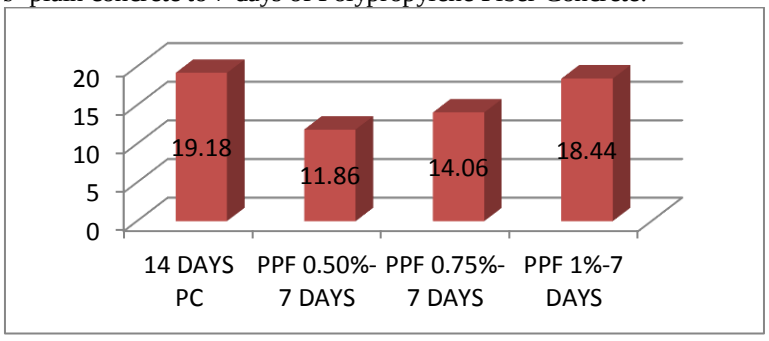



Chart.5- 14&7 Days

C. Comparison of 14 days' plain concrete to 7 days of Steel carbon e Fiber concrete.

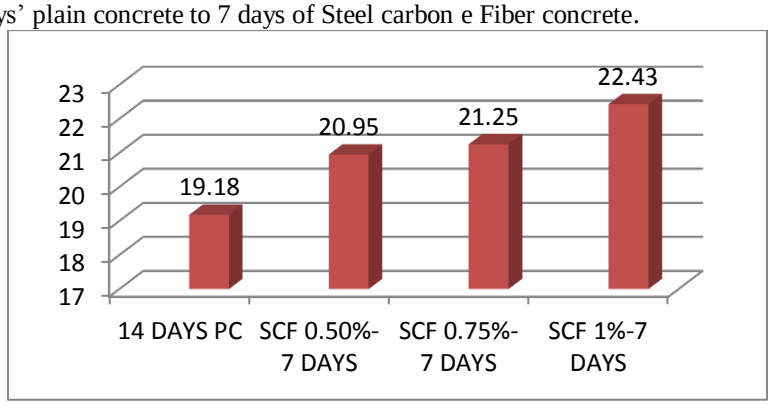



Chart.6- 14&7 Days

D. Comparison of 14 days' plain concrete to 7 days of PPF +SCF Fiber concrete

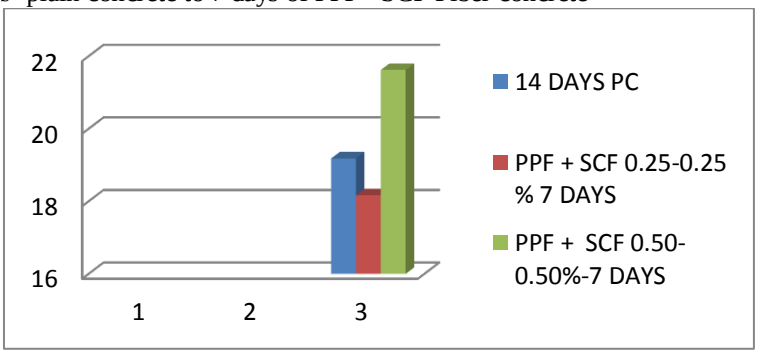



Chart.7– PPF+SCF

E. Comparison of 28 days' plain concrete to 14 days of Polypropylene Fiber Concrete

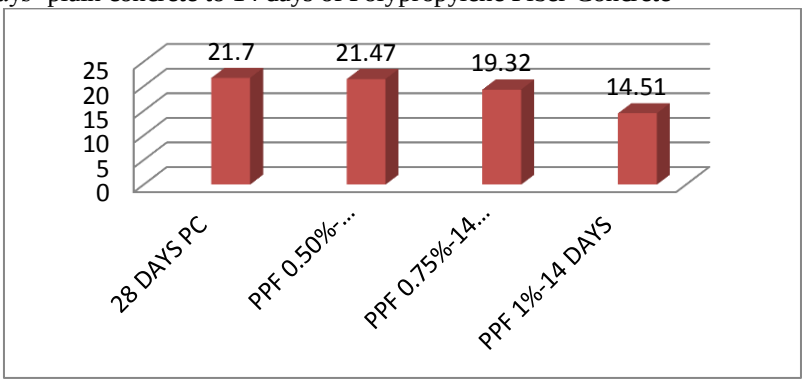



Chart.8– PC+PPF

F. Comparison of 28 days' plain concrete to 14 days of Steel Carbon Fiber concrete

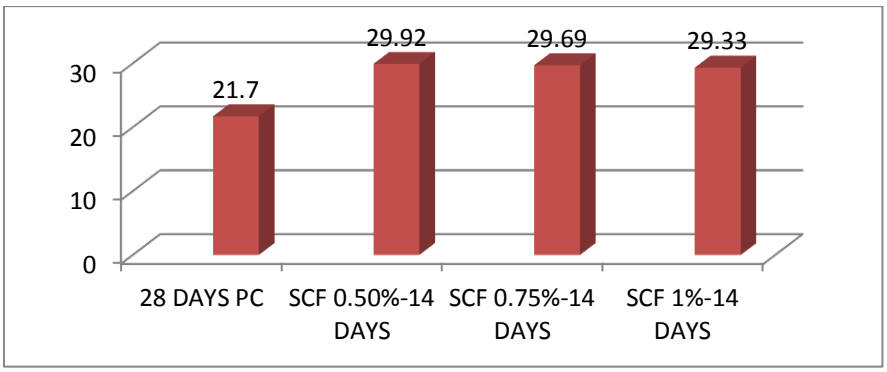



Chart.9- PC+SCF

G. Comparison of 28 days' plain concrete to 14 days of PPF + SCF Fiber concrete

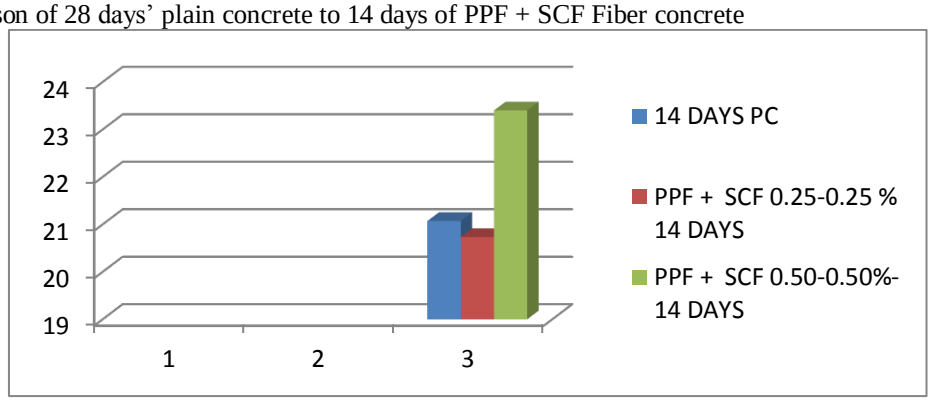



Chart.10 – PPF+SCF

I. All test results of cubes

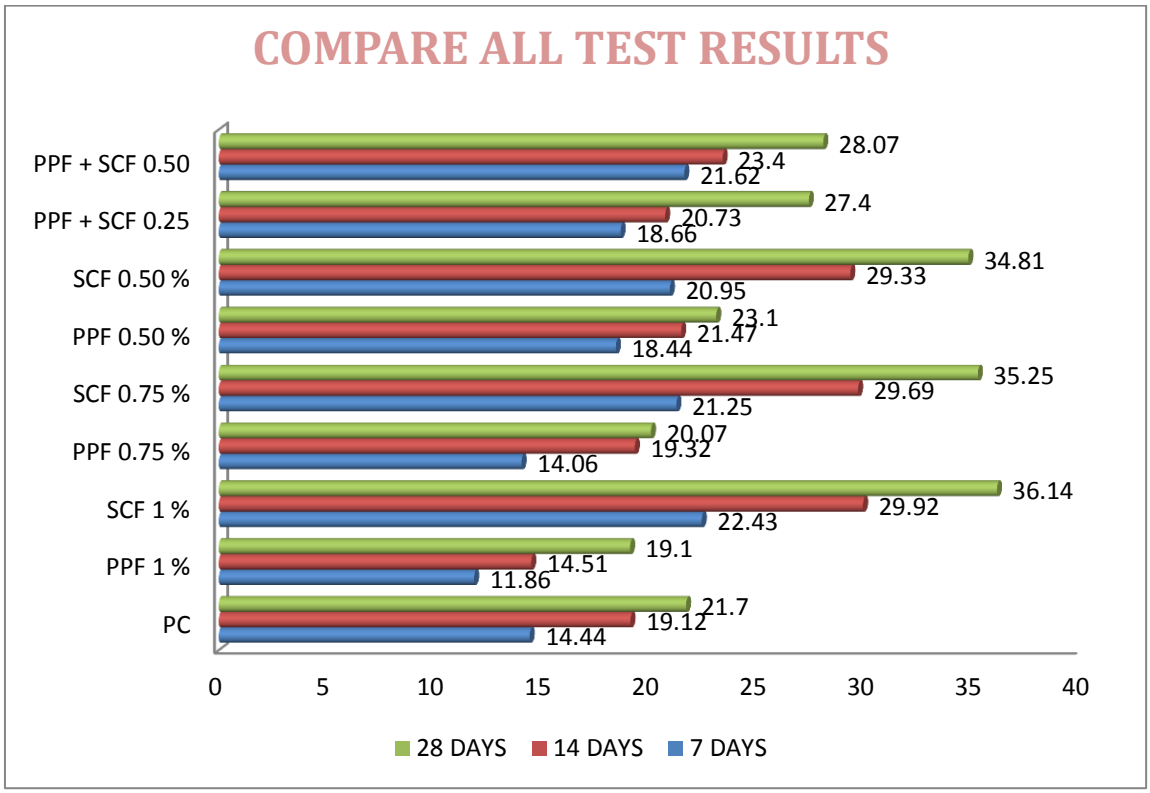



Chart.11- All test results of cubes

## V. CONCLUSION

Workability of concrete decreases with increase in polypropylene fiber volume fraction. The failure is gradual and ductile in polypropylene fiber reinforced concrete. The durability of concrete improves and accumulation of polypropylene fibers significantly improves the fracture parameters of concrete. The compressive strength and modulus of elasticity increase with the addition of polypropylene & steel fiber content as accompanying with conventional concrete. Accumulation of steel fibers to a concrete will improve its compressive strength. The strengths increase expressively with fiber content. Maximum compressive strength for M20 grade of concrete was gained by accumulation of 1% hook end steel fibers.

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