

An Experimental Study on Mechanical Properties of Concrete by using Polypropylene Fibers

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ABSTRACT:The present study was to evaluate the mechanical properties of concrete by using Polypropylene fibers as admixture for M₂₀ in FRC concrete. Specimens were prepared with various combinations of 0.6%, 0.8 %, 1.0 %, 1.2 %, Polypropylene fibers by volume fraction for all proportions. This project presents the experimental methodology and experimental result related to Compressive strength of cubes for 3 days, 7 days, and 28 days. Split tensile strength of Concrete at 28 days of curing was evaluated. The result shows The Compressive strength of concrete is increased by 61.53 % with PP fibers at 7 days and 70.00 % increase with PP fibers at 14 days, 76.36 % increase with PP fibers at 28 days when compare with controlled concrete. The Tensile strength of concrete is increased by 93.872 % with PP fibers when compare with controlled concrete. The use of polymer fibers has shown noticeable increase in Tensile strength of concrete.

KEYWORDS:PP fibers,FRC,Compressive strength,Split tensile strength.

I. INTRODUCTION

Concrete is artificial rock, and it is most widely used construction material. Fiber-reinforced concrete (FRC) is containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. While concrete brittleness to a large extent can be compensated with steel reinforcements on a structural scale in Fiber Reinforced Concrete resulting in improved structural durability, safety as well as improved performance in infrastructure sustainability

Fibers are usually 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. FRP reinforcements offer a number of advantages such as corrosion resistance, non-magnetic properties, high tensile strength, lightweight and ease of handling. "Through microstructure tailoring, we're able to design FRC with a combination of materials such that the capacity of the fibers that bridge the cracks is greater than the capacity of the matrix to resist cracking."

II. LITERATURE REVIEW

1. The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. **Historically, horse hair** was used in mortar and **straw in mud bricks**. In the **1900s, asbestos fibers** were used in concrete.
2. In 1909, official right was granted to L.H. Backland of United States to use polymer in Portland cement concrete.
3. By the 1960s, steel, glass, and synthetic fibers such as polypropylene fibers were used in concrete.
4. Polymers have been circulating in construction industry for a long period of time with the first being **Babylonians** building their clay brick walls using the **natural polymer asphalt** in the mortar back in the **fourth millennium B.C, temple of Ur-Nina, the walls of Jericho**.
5. This is due to the fact that they can provide inexpensive reinforcement for concrete and if the fibres are further optimized, greater improvements can be gained without increasing the **reinforcement costs (Li et al. 1991; Wang et al. 1989)**.
6. From among mentioned properties, elastic modulus of the fibre is investigated to be more important in the **reinforcing effect of fibre in the matrix (Beaudoin 1990)**.
7. It has been investigated (**Li & Wu 1992**) that in a brittle composite which is subjected to **uniaxial tensile loading**, the first macroscopic crack forms when applied load reaches the first cracking load capacity (**cracking strength**) of the material.



8. Fibres can only increase the strength of their composites when they have **greater modulus of elasticity** than that of the matrix (Zheng & Feldman 1995).
9. Polymer fibers act differently in a cement based matrix due to their **surface formation and high strength** (Li et al. 2001).
10. (Li et al. 2002) improved the performance of ECC by using **Polymer fibres** with proper adjusted surface properties in a suitable matrix.
11. Fibres are added in to a brittle-matrix composite to help improve three major aspects; **toughness, ductility and strength (tensile)** (Arisoy 2002).
12. Hence, these composites are recognized as extraordinary **high performance materials against durability** related problems because of their **ability in crack resisting** and crack width minimizing performance (Kendall et al. 2008).
13. The optimum performance of the composite highly depends on the compatibility of the fibre and matrix in terms of **strength, elasticity and surface adhesion** leading to an adequate **load transfer mechanism** (Felekoğlu et al. 2009).

III. METHODOLOGY

3.1. Polypropylene Fiber :

Polypropylene Fiber Reinforced Concrete is an embryonic construction material By utilization of Polypropylene fibers in concrete not only optimum utilization of materials is achieved but also the cost reduction is achieved. Addition of polypropylene fibers decreases the unit weight of concrete and increases its strength.

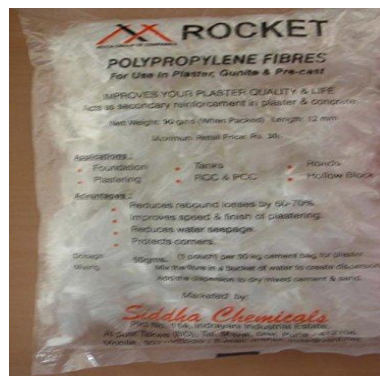


FIGURE NO:3.1.POLYPROPYLENE FIBERS

Poly propylene is a 100 % synthetic textile fiber. It is formed by about 85 % propylene. The monomer of polypropylene is propylene. Improve mix cohesion, improving pump ability over long distances, Improve freeze-thaw resistance, Improve resistance to explosive spalling in case of a severe fire. Improve impact resistance Increase resistance to plastic shrinkage during curing

FIBRE LENGTH	6 MM
DENSITY	0.91 GM/CC
MELTING POINT	160-170°C
RESISTANCE TO ACID & ALKALI	94.4%
FIBRE TYPE	MONOFILAMENT
CRACK ELONGATION	15%
YOUNG'S MODULUS	5 GPA
TENSILE STRENGTH	600 MPA

Table No: 3.1.POLYPROPYLENE FIBERS PROPERTIES

3.2. Cement :

SL NO	Characteristics	
1	Fineness of cement	$F.C = \frac{\text{wt of sample left}}{\text{wt of sample}} \times 100\%$ $= \frac{5}{100} \times 100\%$ $= 5\%$
2	Setting time	
	a) Initial setting time	18 Minutes
	b) Final setting time	560 minutes
3	Normal consistency	32%
4	Specific gravity of cement	Sp gravity = 3.15

Table No: 3.2.POLYPROPYLENE FIBERS PROPERTIES



FIGURE NO:3.2.NORMAL CONSISTENCY&FINENESS TESTING

3.3.Fine Aggregate:

- Fine aggregate used in concrete mixture, for conforming the zone-iii.
- Specific gravity of fine aggregate is 2.59.
- code book- IS 10262.

3.4. Coarse Aggregate:

- Coarse aggregate used in this study are the crushed aggregate, this are commonly used stones are quarried, crushed and graded.
- The sizes are 20mm are used in this project.
- The specific gravity are water absorption tests is give code book is IS 10262.

PHYSICAL PROPERTIES	20MM
Specific gravity of coarse aggregate	2.69
Water absorption for coarse aggregate	0.84

Table No: 3.3.Coarse Aggregate properties

IV. EXPERIMENTAL METHODOLOGY

4.1.MIX DESIGN

MEAN STRENGTH (F_{ck}') = $F_{ck} + 1.65 \times S$

WHERE,

F_{ck}' = TARGET MEAN STRENGTH.

F_{ck} = COMPRESSION STRENGTH@28DAYS.

S = STANDARD DEVIATION.(IS CODE 10262 IN TABLE 1)

F_{ck}' = $20 + 1.65 \times 4$

= 26.66kg/m^3

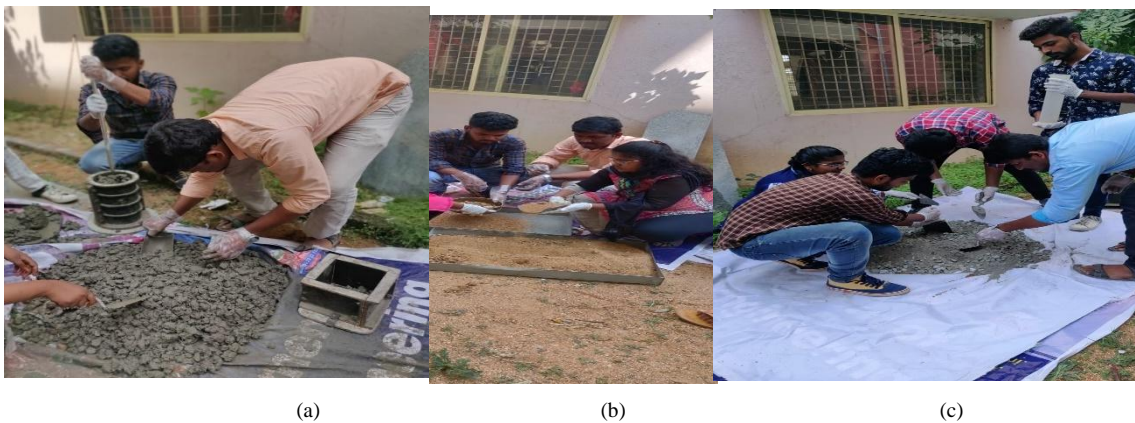


Fig. 4.1. (a)(b)(c)Mixing of concrete



Fig.4.2.(a)(b).slump cone test &Curing Tank

S.NO	Water	Cement	Fine aggregate	Coarse aggregate
1	186 litres	400	683.034	1157.453

1 : 1.7 : 3

Table No:4.1. Mix proportions

4.2.Compressive Strength of Concrete

1. Cubes with dimension of 150mm×150mm×150mm were used for Compression test .
2. All these specimens were casted in cast iron moulds confirming to relevant codes of Indian standards.
3. Prior to casting of specimen, moulds were cleaned, lubricated with oil and all the bolts are fastened tightly so that there is no leakages in the mould.
4. The curing was done by immersing concrete specimens in a tank containing water.

5. The concrete specimens were cured for specified number of days (3, 7, 28, 56 and 90 days) in water at $25 \pm 2^\circ\text{C}$ and later specimens are taken out of water for testing.
6. The specimens after subjected to curing drying for 1 day are loaded in compressive strength testing machine.
7. When tested concrete cubes should fail by developing of a crack in body of cubes.

COMPRESSIVE STRENGTH = LOAD / AREA



Fig.4.3.Compressive Strength test

4.3.Tensile Strength of Concrete

1. As per IS specifications IS 5816:1999 Split tensile test is to be conducted.
2. The cylinder of size is 150 mm diameter and 300 mm length are taken and cylinders were placed horizontally between the loading plate surfaces of a compression testing machine.
3. Then the load was applied to the cylinder until failure of the vertical diameter along the cylinder length.
4. The maximum load on the cylinder was to be observed.

$$\text{Split Tensile Strength} = \frac{\text{LOAD}}{\text{AREA}}$$
$$= \frac{2P}{\text{Pd}}$$

Where

P is the compressive load on the cylinder

L is the length of the cylinder

D is its diameter

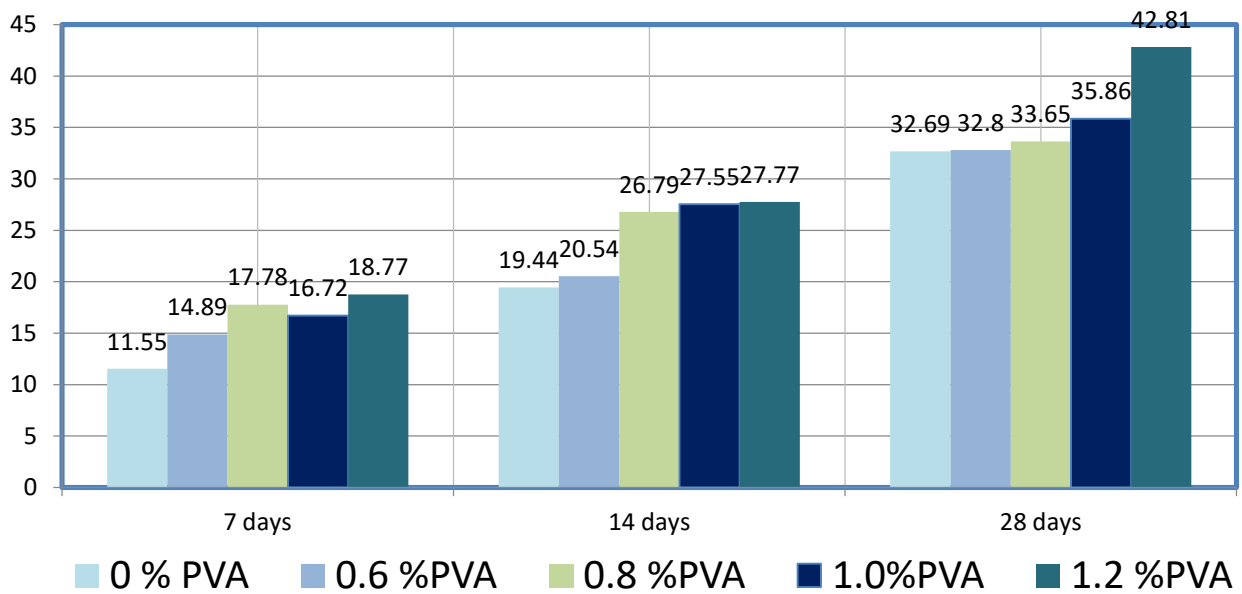
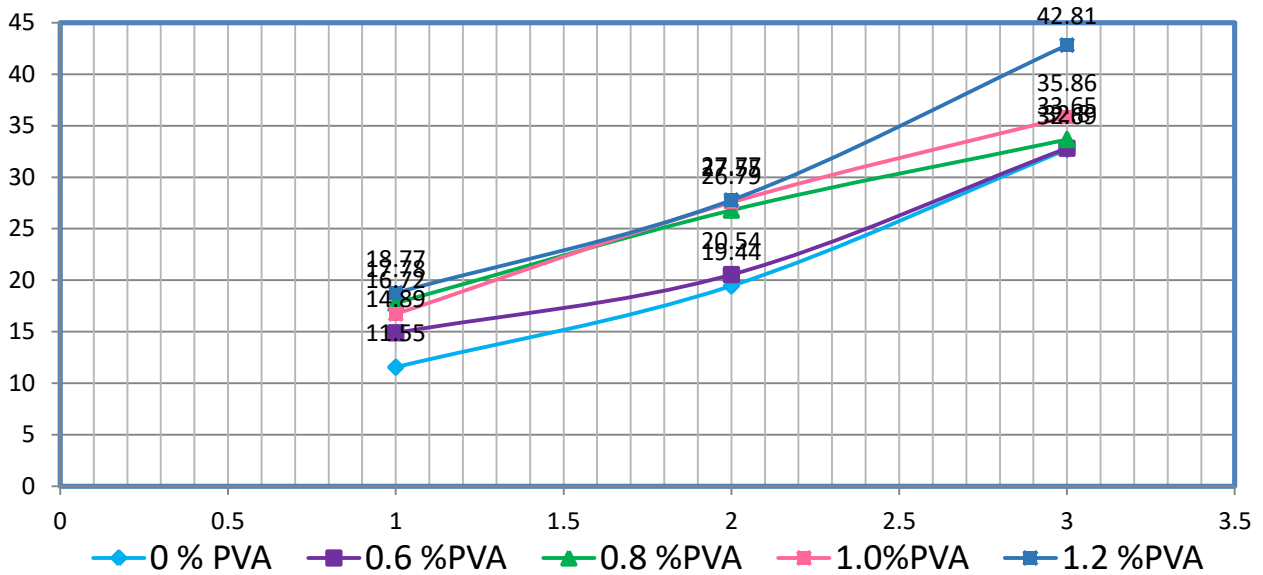


Fig.4.4.Tensile Strength of Concrete

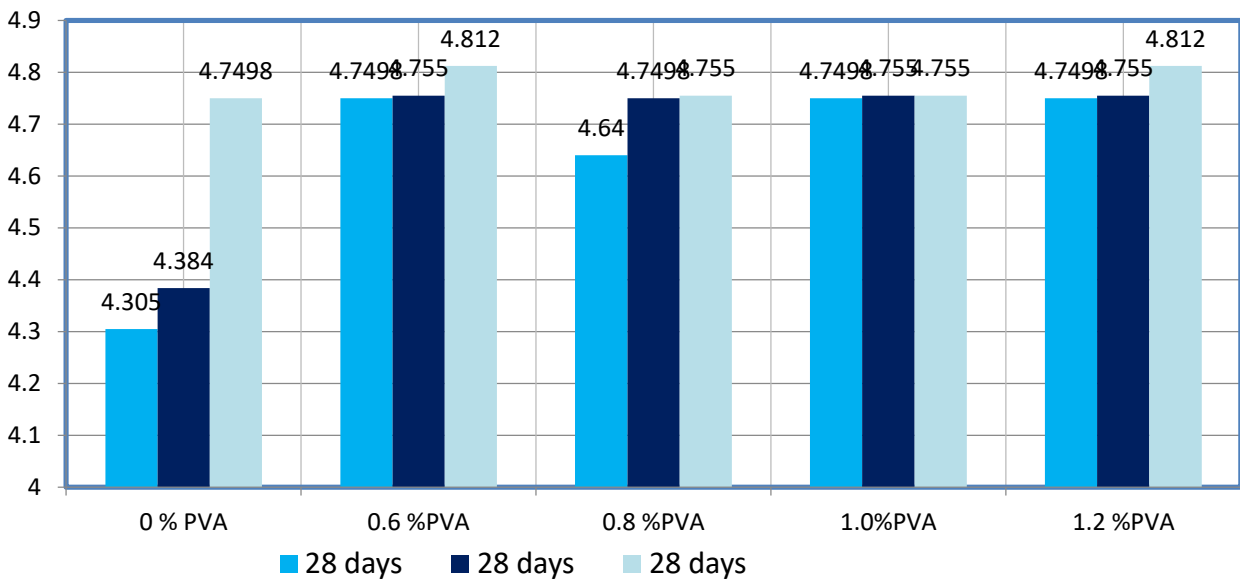
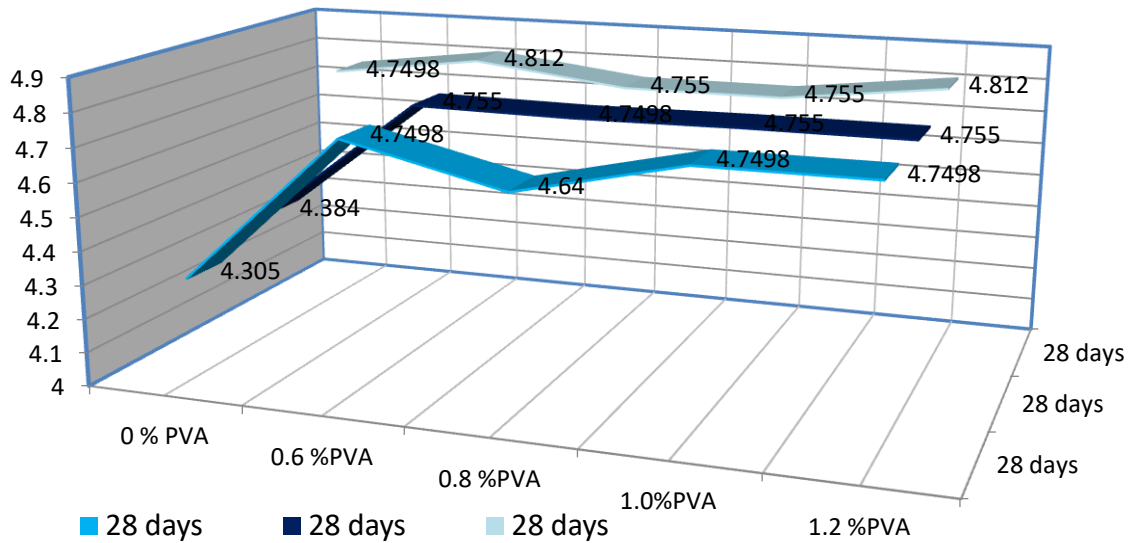


V. RESULTS

5.1. Compressive strength of concrete using PP fibers



5.2.Comparison of Tensile strength Polypropylene fiber concrete & Normal concrete



VI. CONCLUSION

1. The durability of concrete improves and addition of polypropylene fibres greatly improves the fracture parameters of concrete. Polypropylene fibre is Reduce number of joints And Reduce repair due to subsequent damage.
2. The Compressive strength of concrete is increased by 61.53 % with PP fibers at 7 days and 70.00 % increase with PP fibers at 14 days, 76.36 % increase with PP fibers at 28 days when compare with controlled concrete.
3. The Tensile strength of concrete is increased by 93.872 % with PP fibers when compare with controlled concrete.
4. The compressive strength, split tensile strength increase with the addition of fibre content as compared with conventional concrete.
5. The workability of Polypropylene fibre concrete has been found to decrease with increase in Polypropylene fibre content replacement.
6. Bond strength between polymer fibers and concrete is high.
7. Polymer fiber reinforced concrete is the most effective type of concrete withstands the adverse environmental conditions such as corrosion and other distress due to poor quality, execution and maintenance works.

8. Use of polymer fiber concrete composites increases the structural stability of a structure due to better flexural, tensile, bond, and compressive strengths.

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