EXPERIMENTAL INVESTIGATION ON POLYPROPYLENE FIBER REINFORCED CONCRETE FOR M40

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Abstract –*The use of fiber as a secondary reinforcement has been increasing in the recent years. This paper was conducted to compare the properties of fiber reinforced concrete with conventional concrete for M40 mix. An experimental program was conducted to determine the various effects on addition of polypropylene fiber into the concrete mix. The paper shows the experimental results of compressive strength, Split tensile strength, Flexural strength with the addition of 0.5%, 1%, 1.5%, and 2% of polypropylene fiber by replacement of cement by weight. It is observed that use of polypropylene fiber reduces the shrinkage and control cracks. It is seen that when fiber percentage is increased there is an increase in the strength up to 1.5% of fiber. However when the fiber content is increased beyond this value, a downward slope of the graph is observed.*

***Key Words*: Polypropylene, Fiber reinforced, Compressive Strength, Split Tensile Strength, and Flexural Strength.**

1. INTRODUCTION

Plain concrete possesses a very low tensile strength, limited ductility and very little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete. Cracks form a conduit for permeability of water and chloride ions present in permeated water and cause corrosion of steel present inside concrete, and over a period of time affects the durability of structure. It is a fact that addition of fibers has had an excellent effect in preventing / controlling micro shrinkage cracks as well as prevents ingress of water into concrete member and considerably preventing corrosion of rebar's from occurring in the first place. This enhances durability of concrete and the structure on the long run. In coastal areas, saline water ingress is more pronounced which accelerates corrosion of steel in concrete through capillary action and presence of fibers help in checking the same to a great extent. Fibers also enhance other mechanical properties such as tensile & flexural strengths, impact & abrasion resistance and improve seismic resistance of concrete by increase in concrete's energy absorption characteristics.

Polypropylene is 100% synthetic fiber which is transformed 85% propylene is composed crystalline and non-crystalline in nature. Polypropylene is the first stero-regular polymer to have achieved industrial importance and was first introduce in 1970s. Polypropylene fiber is third widely used fiber polypropylene fiber do no absorb moisture and it is a light fiber. Due to increase in temperature there are possibilities of shrinkage and development of cracks which can be reduced by the use of polypropylene fiber. After addition it improves toughness flexural strength tensile strength as well as failure mode of concrete polypropylene is used as retrofitting and repairing the concrete structure, tunnel, etc. It is used for pavement, slab flooring system precast pile short-Crete for tunnel lining canal and reservoir.

2. LITERATURE REVIEW

1. Saman khan *et.al* [1] this paper represents comparative experimental study on mechanical performance of polypropylene fibre reinforced concrete M25 and M30 grades of concrete mixes and polypropylene monofilaments micro fibres of length 35mm at volume fractions of 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3% Were used in the research. The samples with added polypropylene fibre of 1% and 1.5% showed better results in comparison with the others.

2. A.P.Sathe*et.al* [2] the paper presents research work of experimental investigation on polypropylene fibre reinforced concrete by replacing river sand without any admixture. This paper presents the effect of polypropylene fiber on various properties of concrete such as compressive strength, tensile strength, workability and fractures properties of fibers as 0-1.5 percentages. This paper investigation indicates that, by adding of 0.5% of polypropylene fiber show maximum compressive and tensile strength.

3. Milind V. Mohod [3] the paper deals with the effect of addition of various proportions of polypropylene fibers on the properties of high strength concrete. The main aim of the investigation program is to study the effect of polypropylene fiber mix by varying content such as 0% to 2% and finding the optimum polypropylene fiber content.

3. OBJECTIVES

The objectives of this research are

- To conduct experimental investigation for measurement of compressive strength, split tensile

strength and flexural strength of polypropylene fiber reinforced concrete.

- To investigate and compare the properties of hardened concrete and various PFRC mixes.

For mechanical properties, the following tests are conducted to study the effect with varying fiber content on following,

1. Compressive strength on concrete cubes
2. Split tensile strength on concrete cylinder
3. Flexural strength on concrete beam

4. METHODOLOGY

As in the literature review we have used the polypropylene fiber for the concrete mix and we have selected various proportions of polypropylene fiber for calculating the variation in strength i.e. 0.5%, 1%, 1.5% and 2%. The materials used for polypropylene fiber reinforced concrete are as follows.

4.1 Materials

Cement

Ordinary Portland cement with the specific gravity of 2.98 was used with initial and final setting time 52 min and 186 min respectively. The cement was tested as per IS: 8112-1989.

Aggregates

The size of coarse aggregate depends upon the nature of work. The coarse aggregates used in this experimental investigation are of 10mm and 20mm size crushed and angular in shape. The aggregates were tested as per IS: 2386-(1963). The aggregates are free from dust before used in the concrete.

Polypropylene fiber

Use of polypropylene fiber reduces the shrinkage and control cracks. In this experimental investigation, Fiber of length 20mm is used. The polypropylene fiber was collected from Siddha Chemicals, Pune. The polypropylene fiber was replaced by weight of cement.

5. MIX DESIGN

The mix design was calculated using the IS: 10262:2009.

Mix Proportion:

Cement	465 kg/cum
Water	186 kg/cum
Fine Aggregate	661.078 kg
Coarse Aggregate	1218.57 kg
Chemical Admixture	4.92 kg
Water-Cement ratio	0.40

6. EXPERIMENTAL RESULTS AND DISSCUSSION

6.1 Compressive Strength Test on Cubes

Compressive strength of concrete is tested on cubes at various percentage of polypropylene fiber content in concrete. The strength of concrete was tested on cubes at 7 days and 28 days of curing respectively. For the calculation of the compressive strength, the compression testing machine was used. The highest strength was achieved at 1.5% of fiber content. The results obtained in this experimental program are as follow.

Table 1: Compressive Strength Results

SPECIMEN	PERCENTAGE OF FIBER	COMPRESSIVE STRENGTH	
		7 DAYS	28 DAYS
1	0	22.16	35.12
2	0.5	24.65	39.20
3	1	28.77	42.73
4	1.5	33.65	45.92
5	2	29.20	41.20

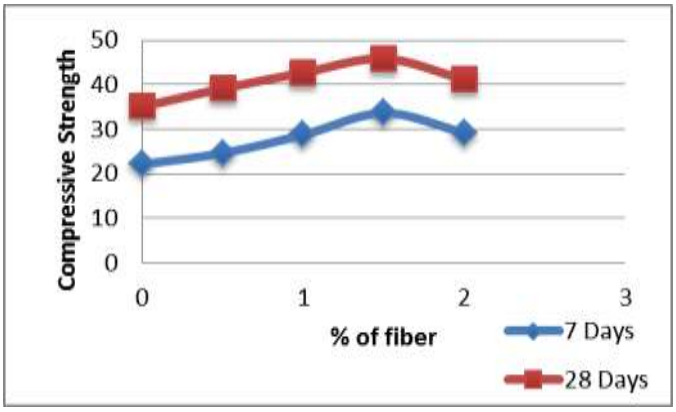

Figure 1: Graph showing results of compressive strength

We have done linear regression analysis on the graph of compressive strength vs. percentage of fiber. From this analysis we have derived a linear equation from which we can calculate a compressive strength for any percentage of fiber. This linear equation is as follows,

Compressive strength = $-4.88x^3 + 9.52x^2 + 3.52x + 35.23$

Where, x = percentage of fiber.

6.2 Split Tensile Strength Test on Cylinder

Split tensile strength of concrete is tested on cylinder at various percentage of polypropylene fiber content in concrete. The split tensile strength of concrete was tested on cylinder at 7 days and 28 days of curing respectively. For the calculation of the split tensile strength, the compression testing machine was used. The highest strength was achieved at 1.5% of fiber content. The results obtained in this experimental program are as follow.

Table 2: Split tensile Strength Results

SPECIMEN	PERCENTAGE OF FIBER	SPLIT TENSILE STRENGTH	
		7 DAYS	28 DAYS
1	0	2.12	3.98
2	0.5	2.90	4.78
3	1	3.12	5.45
4	1.5	3.30	5.89
5	2	2.75	5.24

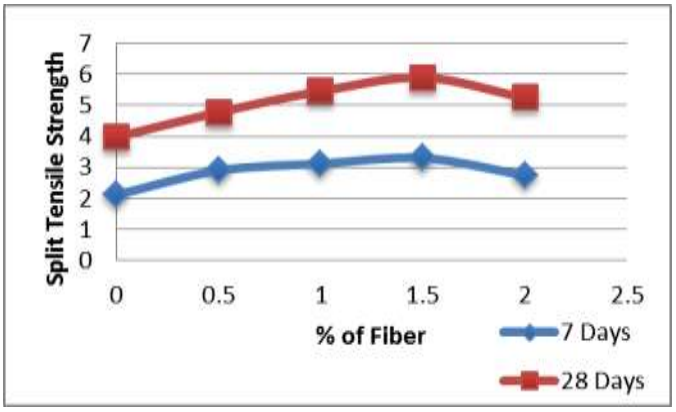

Figure 1: Graph showing results of Split tensile Strength

We have done linear regression analysis on the graph of split tensile strength vs. percentage of fiber. From this analysis we have derived a linear equation from which we can calculate a split tensile strength for any percentage of fiber. This linear equation is as follows,

Split tensile Strength = $-0.64x^3 + 0.974x^2 + 1.241x + 3.983$

Where, x = percentage of fiber.

6.3 Flexural Strength Test on Cylinder

Flexural strength of concrete is tested on beams at various percentage of polypropylene fiber content in concrete. The flexural strength of concrete was tested on beam at 7 days and 28 days of curing respectively. For the calculation of the flexural strength, the universal testing machine was used. The highest strength was achieved at 1.5% of fiber content. The results obtained in this experimental program are as follow.

Table 3: Flexural Strength Results

SPECIMEN	PERCENTAGE OF FIBER	FLEXURAL STRENGTH	
		7 DAYS	28 DAYS
1	0	4.45	7.05
2	0.5	4.98	7.53
3	1	5.55	7.85
4	1.5	6.10	8.55
5	2	5.23	7.15

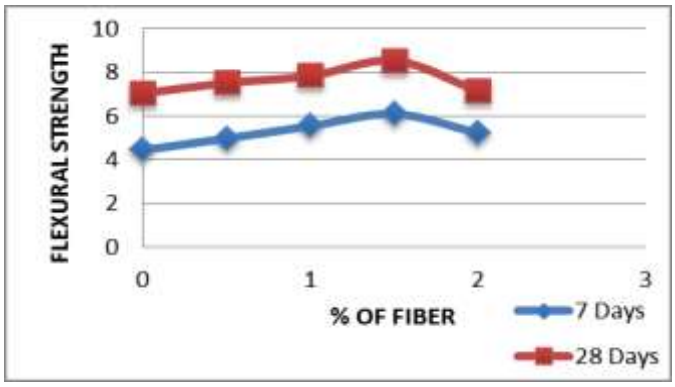

Figure 1: Graph showing results of flexural strength

We have done linear regression analysis on the graph of flexural strength vs. percentage of fiber. From this analysis we have derived a linear equation from which we can calculate a flexural strength for any percentage of fiber. This linear equation is as follows,

Flexural Strength = $-0.64x^3 + 0.974x^2 + 1.241x + 3.983$

Where, x = percentage of fiber.

7. CONCLUSION

1. In this investigation program we conclude that there was increase in compressive strength, split tensile strength, and flexural strength up-to 1.5% of fiber content and thereafter there was decrease in strength on further increase in fiber content.

2. On using polypropylene fiber in M40 mix there was low shrinkage, creep cracks also reduce in comparison with conventional concrete.

3. It is easier to find the compressive strength, split tensile strength, and flexural strength up to 2% of fiber by using the formula given below.

Compressive strength = $-4.88x^3 + 9.52x^2 + 3.52x + 35.23$

Split tensile Strength = $-0.64x^3 + 0.974x^2 + 1.241x + 3.983$

Flexural Strength = $-0.64x^3 + 0.974x^2 + 1.241x + 3.983$

Where, x = percentage of fiber.

8. REFERENCE

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