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The Strength Properties of Concrete Integrated with Polypropylene Fiber Reinforced Concrete

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ABSTRACT:

Concrete Containing Fibrous Material Which Increases Its Structural Integrity, Concrete is an artificial material in which the arrangements both fine and coarse aggregate are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent characteristics and advantages either when green or hardened. The use of reinforcement in concrete brought a revolution in application of concrete. Concrete has unlimited opportunities for innovative application, design and construction techniques. Its great versatility and relative economy in filling wide range of needs has made it a very competitive building material.

It has been found that different type of fibers added in specific percentage to concrete Improves the strength properties of the structure. It is now established that one of the important properties of polypropylene Fiber Reinforced Concrete (PPFRC).

In this project effect of fibers on the strength of concrete for M 30grade have been studied by varying the percentage of fibers in concrete. Fiber content were add varied by 0 %, 1%, 2%, 3% and 4% by weight of cement. Cubes of size 150mmx150mmx150mm and cylinder size 150 mm in diameter and 300mm long 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 7, 14 and 28 days before testing.

Keywords: Mechanical properties; Concrete; polypropylene Fiber reinforcement; Compressive strength cubes and cylinders: flexural strength.

1. INTRODUCTION

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibers. Fiber reinforced concrete is of different types and properties with many advantages.

Fiber is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. Typical aspect ratio ranges from 30 to 150.Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. The fiber is often described by a convenient parameter called "aspect ratio". The aspect ratio of the fiber is the ratio of its length to its diameter.

It contains short discrete fibers that are uniformly distributed and randomly

oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Within these different fibers that character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities.

Fiber-reinforcement is mainly used in concrete, but can also be used in normal concrete. Fiber-reinforced normal concrete are mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, pliers, foundations etc) either alone or with hand-tied rebar's.

Polypropylene fibers have some unique properties that make them suitable for reinforcement in concrete. The fibers have a low density, are chemically inert and non corrosive. The primary objectives of this investigation were to determine the benefits of using polypropylene fiber reinforced concrete (PFRC).

2. LITERATURE REVIEW

1.Dr.T.Ch.Madhavi1, L. Swamy Raju2, Deepak Mathur1 Professor and Head, Department of Civil Engineering, SRM University, Ramapuram, [1]

1. Polypropylene fibers reduce the water permeability, plastic, shrinkage and settlement and carbonation depth.
2. Workability of concrete decreases with increase in polypropylene fiber volume fraction. However, higher workability can be achieved with the addition of HRWR admixtures even with w/c ratio of 0.3.
3. Polypropylene fibers enhance the strength of concrete, without causing the well known problems, normally associated with steel fibers.
4. The problem of low tensile strength of concrete can be overcome by addition of polypropylene fibers to concrete.
5. Notable increase in compressive strength is reported with addition of polypropylene fibers.
6. The failure is gradual and ductile in polypropylene fiber reinforced concrete.

2.**Saeid Kakooei a, Hazizan Md Akil b,⇑, Morteza Jamshidi c,e, Jalal Rouhi d,** [2]

i. From this study, it could be clearly seen that coral aggregate was not a suitable component for concrete structure because of its high electrical resistivity and low compressive strength.
ii. According to the results of compressive strength tests, the concrete compressive strength increased proportionately with the increase in volume ratios of propylene fibers, the highest strength values were seen in the volume ratios of 1.5 kg m 3 and 2 kg m 3.
iii. The presence of polypropylene fibers had caused delay in starting the degradation process by reducing permeability, reducing the amount of shrinkage and expansion of concrete that can significantly affect the lifespan of the structure.
iv. Electrical resistivity of concrete samples with fibers ratios of 1 and 1.5 kg m 3 had higher values in comparison with other samples. It has direct effect on the corrosion reduction ofrebar.
v. In general, the samples with fibers content of 1.5 kg m 3showed optimum results in comparison with other samples in this study.

3. Archana P1, Ashwini N Nayak2, Sanjana R Nayak3, Harshita Vaddar4 [3]

Conventional concrete has two major drawbacks:

Low tensile strength and a destructive and brittle failure. Concrete (PFRC) has been introduced. In a attempt to increase concrete ductility and energy absorption, polypropylene fiber reinforced.

This study is part of research program on evaluating the performance of polypropylene fiber reinforced
Concrete.
An experimental investigation explored properties
such as compressive strength, flexural strength, split tensile strength and shear strength and shear strength of polypropylene fiber reinforced concrete. The fiber volumefractionvrangesfrom0%,0.2%,0.4%, 0.6%,0.8%,1%, to 2%.
Significant change is found for compressive strength, flexural, split tensile and shear improves greatly, when compare to the plain concrete.

4. Arumugam .V1, Dr.T.Bhagavathi Pushpa2, K.M.Basanth Babu3 ME Student1, [4]
Construction is an everlasting activity and is one of the main contributors to the growth of an economy of a country. Due to growing environmental concerns of the cement industry, alternatives like Geopolymer Concrete (GPC) have become indispensable for environmental and durability performance. Fly ash can be used as a substitute for OPC to manufacture concrete due to its abundant availability. To improve the mechanical properties of GPC, polypropylene fibers were added to GPC in various percentages in this study. Geopolymer Concrete (GPC) is manufactured by alkali activation on dry mix which contains fly ash, coarse and fine aggregates. Sodium hydroxide and Sodium silicate were used as an alkali activator solution. Super plasticizer is added to improve the workability of GPC. GGBS, a by-product from steel industries, is used to replace flash at the rate of 10% to avoid heat curing of Geopolymer concrete in this study. Based on the various literature reviews, the effect of polypropylene fibers in various proportions viz., 0.5% to 5% in geopolymer concrete was tested in this study. For this, the basic properties of geopolymer concrete like compressive strength, split tensile strength and flexural strength were carried out. Test results shown that PP fibers at 2.5% resulted in 73.47% increase in compressive strength, 13.40% increase split tensile and 44.24% increase flexural strength compared to other combinations. Hence it is concluded that the polypropylene fibers at 2.5% can be used as a promising additive to the geopolymer concrete to enhance the properties of geopolymer concrete.

5. P.S. Songa,*, S. Hwangb, B.C. Sheub[5]
The strength potential of nylon-fiber-reinforced concrete was investigated versus that of the polypropylene-fiber-reinforced concrete, at a Fiber content of 0.6 kg/m3. The compressive and splitting tensile strengths and modulus of rupture (MOR) of the nylon fiber concrete Improved by 6.3%, 6.7%, and 4.3%, respectively, over those of the polypropylene fiber concrete. On the impact resistance, the first-crack and Failure strengths and the percentage increase in the post first-crack blows improved more for the nylon fiber concrete than for its Polypropylene counterpart. In addition, the shrinkage crack reduction potential also improved more for the nylon-fiber-reinforced mortar. The
Above-listed improvements stemmed from the nylon fibers registering a higher tensile strength and possibly due to its better distribution in Concrete.

6. Preetha V1, Belarmin Xavier2, K P Narayanan3, [6] Concrete is most widely used construction material in the world. Fibre reinforced concrete (FRC) is a concrete in which small and discontinuous fibers are dispersed uniformly. The addition of fibres can dramatically increase the compressive strength, tensile strength and flexural strength of concrete. In this paper effect of fibers on the strength of concrete

for M25 grade have been studied by varying the percentages of fibers in concrete. 0.5%, 0.75% and 1% volume Fraction of steel fiber and glass fibers of 0.15%, 0.2% and 0.25% weight of cement were used without any admixtures.

3.2EXPERIMENTAL INVESTIGATION

3.2.1 Experimental Program

In order to study the interaction of polypropylene fiber with concrete under compression, flexure, 15 cubes and 15 cylinders were casted respectively. The experimental program was divided into four groups.

Each group consists of 3 cubes, 3 cylinders and 3 beams, of Cubes of size 150mmx150mmx150mm and cylinder size 150 mm in diameter and 300mm long to check the compressive strength and beams of size 500mmx100mmx100mm for checking flexural strength respectively.

A. The first group is the control (Plain) concrete with 0% fiber (PCC)
B. The second group consisted of 1% of polypropylene fiber with Aspect ratio 80, by volume.
C. The third group consisted of 2% of polypropylene fiber with aspect ratio 80, by volume.
D. The fourth group consisted of 3% of polypropylene fiber with aspect ratio 80, by volume.
E. The fourth group consisted of 4% of polypropylene fiber with aspect ratio 80, by volume.

3.2.2 Materials Used

The materials used in the experimental investigation are locally available Cement, sand, coarse aggregate, mineral and fibers. The fibers used in the present investigation are of commercial grade.

3.2.3 List of Experiment as per Concrete Technology Lab

1. Testing of cement: Consistency, fineness, setting time, Specific Gravity.
2. Testing of fine aggregate: Specific Gravity, sieve analysis and zoning, water absorption.
3. Testing of coarse aggregate: Specific Gravity, sieve analysis, water absorption & moisture content of aggregate.
4. Concrete Mix design by IS code method as per 10262-2007 & 456-2000
5. Tests on Concrete- Slump cone test, strength tests- compressive strength cubes and cylinders, Flexural strength.
6. Effects of fibers – strength of concrete.

MATERIALS AND THEIR PROPERTIES

Raw materials required for the concrete mix used in the present work are

- Cement OPC 53 Grade (Ultra tech super shakti)
- Fine aggregate: Natural river sand
- Coarse Aggregates:20mm and 10mm (Locally Quarried and Crushed)
- Water: Potable drinking water
- Admixtures-Nil
- Polypropylene fiber (1%,2%,3%,4%)

3.3 CEMENT: Ordinary Portland cement of grade 53 was used in this project to prepare the control specimen.

The Specific gravity is 3.01.

The Setting time, Initial setting time is 35 minutes

The Normal consistency is 37%

The Fineness of cement (by sieving test) is 3.60

FINE AGGREGATE: Fine aggregate which is free from debris, obtained from nearby river.

The Specific gravity is 2.46.

The Water absorption as 1.62%

The grading has zone-IV.

COURSE AGGREGATE: Course aggregate is commonly known as crushed aggregates. The nominal maximum size of 20mm and 10mm aggregate were used in this study.

The Specific gravity is 2.67.

The Water absorption as 0.21%

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The passing through max.25 mm sieve

POLYPROPYLENE FIBERS:

- Improve mix cohesion, improving Palpability over long distances
- Improve freeze-thaw resistance, Improve impact– and abrasion–resistance
- Improve resistance to explosive spelling in case of a severe fire
- Increase resistance to plastic shrinkage during curing
- Improve structural strength, Reduce steel reinforcement requirements
- Improve ductility
- Reduce crack widths and control the crack widths tightly, thus improving durability.

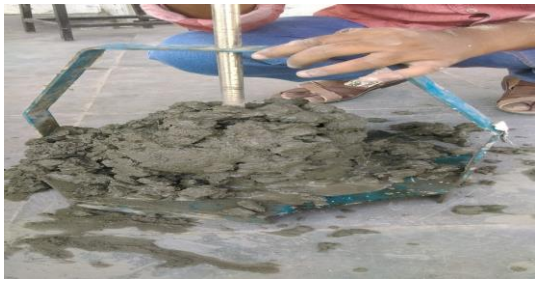
1.5.1 Specifications Polypropylene Fiber:

Diameter	33-35 micron
Cut length	6mm,12mm, 24mm
Tensile strength	6000kg/cm2
Melting point	>2500c
Dispersion	excellent
Acid resistance	excellent
Alkaline resistance	good
Elongation	45-55%
Moisture	<1%

Workability of fresh concrete by slump cone test

Slump test is the most commonly used method of measuring consistency of concrete.

The vertical difference between top of the mold and the displaces original center of the top surface of the specimen 100 mm



Slump Cone Test

MIXING AND CASTING

Weighing:

The quantities of cement, each size of aggregate, and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch

Apparatus: Drum type mixer in the laboratory, mould as cube, cylinder, beam, Weights and weighing device, Tamper (16 mm in diameter and 600 mm length), Tools and containers for mixing, or concrete mixer etc.

1.The cube sizes are 150mmx150mmx150mm.

2. Cylinder size 150 mm in diameter and 300mm long.

3. Beams of size 500mmx100mmx100mm

Estimated quantities in 1 m^3 of concrete:

Cement = 492.5 kg/m^3

Fine aggregates = 610.86 kg/m^3

Coarse aggregates= 1045.78 kg/m^3

Water = 197 kg/m^3

Water-cement ratio = 0.40

The ratio comes to be 1: 1.24: 2.12 @ 0.40 for M30 grade concrete.

The mix proportion used in the present study on each cubes is given in table.

s. no	%of add of pp fiber	Cement(in kgs)	Fine aggregate	Coarse Aggregate	Water	PPF (gms)
1	0%	1.65	2.32	3.94	0.4	0
2	1%	1.65	2.32	3.94	0.4	50
3	2%	1.65	2.32	3.94	0.4	99
4	3%	1.65	2.32	3.94	0.4	150
5	4%	1.65	2.32	3.94	0.4	198

6. RESULTS

TESTING OF SPECIMENS

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Different tests were conducted on the specimens to determine and compare the strength properties polypropylene fiber.

1. Compressive Strength
   a. Cubes
   b. cylinders

Tests were made at the ages of 7, 14 and 28 days. Specimens stored in water were tested immediately on removal from the water and while they were in the wet condition. The projecting fins were removed if found.

6.1 COMPRESSIVE STRENGTH OF CUBES

Compressive Strength for cube

Compressive strength for cube = P/A×1000

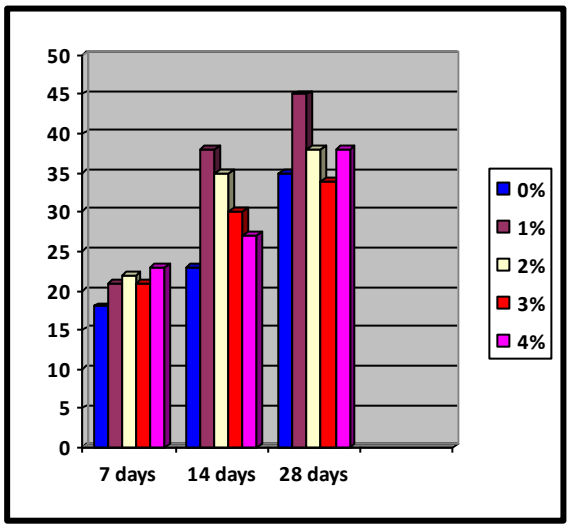
Where,

P= Failure Load in KN

A=Area of cube surface=150×150mm^2

Table 6.1 Compressive Strength of cubes Results

S. NO	MATERIAL %Of Polypropylene fiber used	CUBES UNDER COMPRESSIVE STRENGTH IN N/mm2 AGE IN(DAYS)		
		7days	14 days	28days
1	0%	18	23	35
2	1%	21	38	45
3	2%	22	35	38
4	3%	21	30	34
5	4%	23	27	38



Graph 6.1 Comparison of Compressive Strength of cubes

Compressive Strength at 7, 14, 28 Days of Curing

Discussion: Compressive Strength of cubes For 7 days curing period, the strength of the concrete is increased about 85.71%, 81.81% and 78.26 % increased for 4% of Polypropylene Fiber respectively when compared with that of conventional concrete. For 14 days curing period, the strength of the concrete increased about 60.52%, 65.71% and 76.66% for 1%, and decreases about 85.18% for 1% of Polypropylene Fiber respectively when compared with that of conventional concrete. At 28 days of the compressive strength of Polypropylene Fiber reinforced concrete was found to be more. From the results the optimum percent of Polypropylene Fiber was found to be 77.77% is highest at 1% of Polypropylene fiber used in concrete.

6.2 COMPRESSIVE STRENGTH OF CYLINDERS Compressive Strength for cylinders

Compressive strength for cylinders = P/A×1000

Where,

P=Failure Load in KN

A=Area of cube surface=150×300mm^2

Table 6.1 Compressive Strength of cylinders Results

S. NO	MATERIAL %Of Polypropylene fiber used	CYLINDERS UNDER COMPRESSIVE STRENGTH IN N/mm2 AGE IN(DAYS)		
		7days	14 days	28days
1	0%	9	10	12
2	1%	10	11	13
3	2%	11	13	15
4	3%	10	11	13
5	4%	11	14	14

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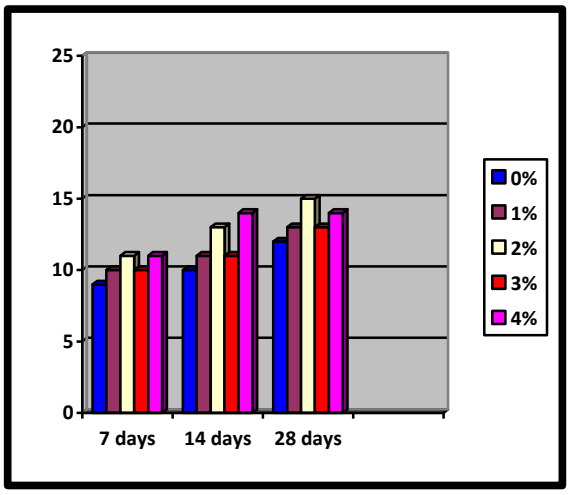

Graph 6.1 Comparison of Compressive Strength of cylinders

Compressive Strength at 7, 14, 28 Days of Curing

Discussion: Compressive Strength of cylinders For 7 days curing period, the strength of the concrete is increased about 81.81% increased for 4% of Polypropylene Fiber respectively when compared with that of conventional concrete. For 14 days curing period, the strength of the concrete increased about 71.42% for 4%. At 28 days of the compressive strength of Polypropylene Fiber reinforced concrete was found to be more. From the results the optimum percent of Polypropylene Fiber was found to be 80.00% is highest at 2% of Polypropylene fiber used in concrete.

CONCLUSION

1. In Construction Industry, These Fine Fibers Help the Structure Take-Up Thermal Expansion and Contractions. In RCC and Plastering.
2. The Fine Fibers Checks Micro Cracks. They Are Also Used In Cement Mix.
3. The Polypropylene Fiber is mostly used in industrial area for roads, pavements, parking flooring, etc...
4. This experimental to found strength of compressive strength for cubes is 78.26 % increased for 4% at 7 days of Polypropylene Fiber respectively.
5. Compressive strength for cubes is 77.77 % increased for 1% at 28 days of Polypropylene Fiber respectively.
6. Compressive strength for cylinders is 80.00 % increased for 2% at 28 days of Polypropylene Fiber respectively.

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