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Study of Strength of Polypropylene Fiber Reinforced Concrete

Archana P[1], Ashwini N Nayak[2],
Sanjana R Nayak[3], Harshita Vaddar[4],
[1, 2, 3, 4] Students
Civil Engineering Department,
Stj Institute of Technology,
Ranebennur.

Dinesh S Magnur[5]
[5] Assistant Professor,
Head of Department,
Civil Engineering, Stj Institute of Technology,
Ranebennur.

***Abstract* - 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 volume fraction v ranges from 0%,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.**

Keywords: Plain Cement Concrete, Polypropylene Fibre Reinforced Concrete, Compressive Strength, Split Tensile Strength, Flexural Strength.

I INTRODUCTION

Concrete is one of the most important materials among the building materials in all types of civil engineering works. Since the adaptation of concrete as a building material, lot of researches and studies has been made to improve the quality, strength and durability of it. By the same time efforts are also being made to economize concrete construction compared to other materials.

Plain concrete is good in compression but weak in tensile strength with very limited ductility and little resistance to cracking. Internal micro cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro cracks, eventually leading to brittle fracture of concrete. Generally in case of rigid pavements cracks are formed due to the variation in temperature, shrinkage and heavy moving loads.

Attempts have been made to reduce the cracks and impart improvements in tensile property of concrete members using conventionally reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength to concrete members, they however do not increase the tensile strength of concrete itself. In plain concrete and similar brittle materials, structural micro cracks develop even before loading due to drying and shrinkage or other causes of volume changes. When loaded these micro cracks propagate and open up owing to effect of stress concentration.

It has been recognized that the addition of small closely spaced and uniformly dispersed fibres to concrete would act as crack resistance and substantially improve its static and dynamic properties. This type of concrete is known as fibre reinforced concrete. In these dissertations an attempt will be made to view the behavior of concrete mixed fibre with polymer fibre reinforced concrete in comparison with plain concrete.

1.10 Polypropylene Fibre:

Polypropylene is an economical material that offers a combination of outstanding physical, mechanical, thermal and electrical properties not found in any other synthetic fibres. There are two general types of fibres currently available in the market. These are referred to as fibrillated and monofilament.

1.11 Specifications and Physical Properties of Polypropylene Fibre:

1.11.1 Specifications Polypropylene Fibre:

Diameter	33-35 micron
cut length	6mm, 12mm, 24mm
tensile strength	6000kg/cm^2
Melting point	>250^{0}C
Dispersion	Excellent
Acid Resistance	Excellent
Alkaline resistance	Good
Elongation	45-55%
Moisture	<1%

Fig 1.1 Polypropylene Fibre

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1.11.2 Physical Properties Of Polypropylene Fibre:

Thermal shrinkage cracks	Significant Reduction
Water Penetration	Significant Reduction
Abrasion resistance	Over 40% improvement over normal concrete
Impact strength shatter resistance	Improves significantly
Flexural strength & compressive strength	Results show from 10-30% increase over normal concrete allowing smart mix design
Mortar cubes	Normal mortar shatters, with Recron 3s doesn't cracks easily under load
Rebound loss	Reduced up to 70% resulting in saving in labour, raw material and faster pace of work

1.12 Charecteristics Of Polypropylene Fibre:

a) Polypropylene comes in two forms – straight and special crimped, unlike other manmade fibres. Crimped fibre allows improved interlocking.
b) Polypropylene disperses in water within seconds, their by allowing the uniformity in application and properties.
c) Polypropylene is produced in fine controlled dimension and gives very high matrix (6-7 times). Such fine fibre and dispersion ensures uniform three dimensional micro reinforcement.
d) In construction industry, these fine fibres help the structure take-up thermal expansion and contractions. In RCC and plastering, the fine fibres checks micro cracks. They are also used in cement mix.
e) It has excellent UV stability as compared to the Polyester polymer fibres.
f) The alkali stability of the fibre in the 2% cement slurry alkalinity shows excellent stability over a period of time.

1.13 Advantages

a) Increases tensile strength.
b) Greater impact resistance of fibre reinforced concrete.
c) Reduces permeability.
d) Arrest drying shrinkage.
e) Easy to use and mix.
f) Controls cracking.
g) Reduces rebound loss-Brings direct savings and gains.
h) Increases flexibility and abrasion resistance.
i) Chemically very inert and highly integral product.
j) Minimize steel reinforcement in industrial floors.
k) Compactable to all type of fibre's.
l) Rust and alkaline proof material.
m) Suitable for pumped concrete and shotcreting.

1.14 Disadvantages

a) The fibres form very small lumps while mixing.
b) The fibres appearing on the surface of the concrete and are not recommended from the aesthetic views.
c)

1.15APPLICATIONS

a) Plain concrete and wall plastering.
b) Used in footings, foundations and tanks.
c) Pipes, burial vaults, pre-stressed beams etc.
d) Roads and pavements.
e) Bridges and dams.

II SCOPE AND OBJECTIVES

2.1 Scope of the Work:

The properties of polymer fibre reinforced concrete mixes and various factors such as w/c ratio, type of fibre, volume, aspect ratio and its effect on strength has now been well established and much research has been carried up to date. The improvement in strength of polymer fibre reinforced concrete is accompanied by a relatively greater increase in flexural toughness & impact resistance, which are important factors. The structural behavior of polymer fibre reinforced concrete needs to be examined

2.2 Objective of the Study:

The following are the main objective of study:

a) Compare the crushing strength of plain cement concrete with fibre reinforced concrete.
b) To evaluate flexural strength of plain cement concrete and fibre reinforced concrete.
c) Evaluate split tensile strength of plain cement concrete with fibre reinforced concrete.

III. TESTS ON FRC

3.1 Compresion Test
3.2 Split Tensile Test
3.3 Flexural Strength Test

3.1 Compressive Strength Test

The following procedure is adopted to conduct the compressive strength test

- Size of the specimen is 150×150×150mm cubes determined by averaging perpendicular dimensions at least at two places.
- Place the specimen centrally on the compression testing machine and load is applied continuously and uniformly on the surface parallel to the direction of tamping.
- The load is increased until the specimen fails and record the maximum load carried by each specimen during the test as shown in figure
- Compressive strength was calculated as follows
  Compressive strength = P/A×1000
  Where ,
  P= Load in KN
  A=Area of cube surface=150×150mm^2

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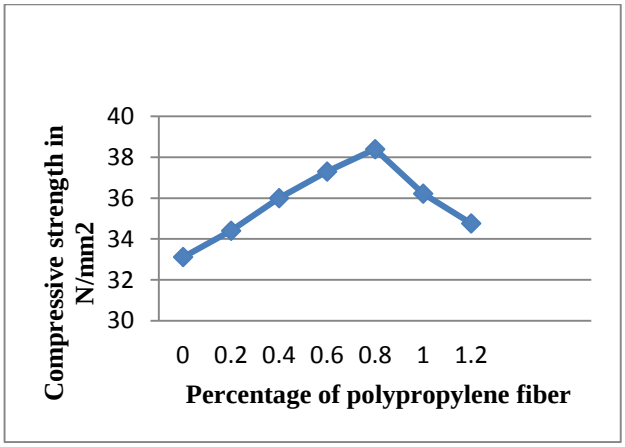
Table 3.1 Compressive Strength Of Concrete

%Of Polypropylene fibre used	Trials	Load at failure in 'KN'	Average load in 'N'	Compressive strength in N/mm^2
0%	1 2 3	743 744 748	745000	33.11
0.2%	1 2 3	771 773 778	774000	34.4
0.4%	1 2 3	812 813 813	813000	36.11
0.6%	1 2 3	838 839 843	840000	37.3
0.8%	1 2 3	865 860 867	864000	38.4
1%	1 2 3	814 819 818	817000	36.11
1.2%	1 2 3	760 764 765	763000	33.91

From the above test result of polypropylene fibre 0.8% is maximum.



Graph 3.1: Compressive Strength At 28 Days Of Curing.

3.2 Split Tensile strength Test

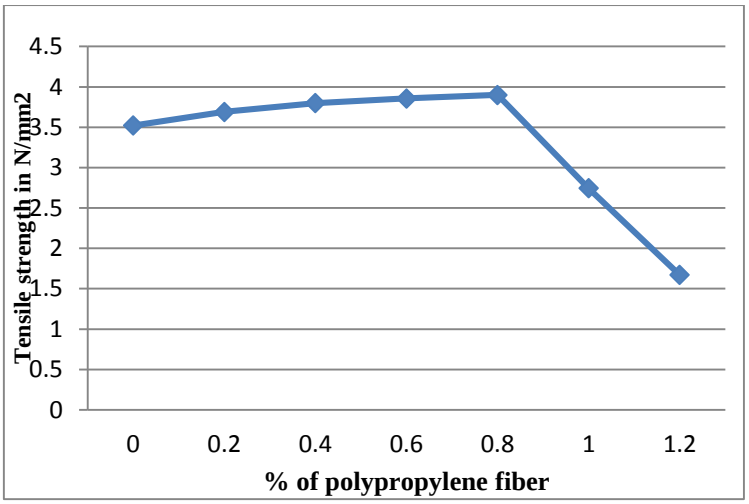
The fallowing procedure is adopted to conduct the tensile strength test.

- Draw diametrical lines on two ends of the specimen so that they are in the same axial plane. Diameter of specimen is 150mm and length 300mm.
- Determine the diameter of specimen to the nearest 0.2 mm by averaging the diameters of the specimen lying in the plane of pre marked lines measured near the ends and the middle of the specimen. The length of specimen also shall be taken be nearest 0.2 mm by averaging the two lengths measured in the plane containing pre marked lines.
- Centre one of the plywood strips along the centre of the lower pattern. Place the specimen on the plywood strip and align it so that the lines marked on the end of the specimen are vertical and cantered over the plywood strip. The second plywood strip is placed length wise on the cylinder cantered on the lines marked on the ends of the cylinder.
- Apply the load without shock and increase it continuously at the rate to produce a split tensile stress of approximately 1.4 to 2.1 N/mm^2/min, until no greater load can be sustained. Record the maximum load applied to specimen as shown in fig
- Computation of the split tensile strength was as follows.
  Split tensile strength = 2P/πdL×1000
  where,
  P = Load in KN and π = 3.142
  d = Diameter of cylinder = 150 mm
  L = Length of cylinder = 300 mm

Table 3.2: Split Tensile Strength Of Concrete

%Of Polypropylene fibre used	Trials	Load at failure in 'N'	Average load in 'N'	Split tensile strength in N/mm^2
0%	1 2 3	246 246 255	249000	3.522
0.2%	1 2 3	260 262 261	261000	3.69
0.4%	1 2 3	266 275 266	269000	3.80
0.6%	1 2 3	266 267 285	273000	3.856
0.8%	1 2 3	271 274 285	277000	3.90
1%	1 2 3	192 196 194	194000	2.744
1.2%	1 2 3	113 119 122	118000	1.67

From the above test result of polypropylene fibre 0.8% is maximu



Graph 3.2: Split tensile strength at 28 days of curing (N/mm^2)

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3.3 Flexural Strength Test

The fallowing procedure is adopted to conduct the flexural strength test.

- Brush the beam clean. Turn the beam on it side, with respect to its position as moulded, and place it in the breaking machine.
- Set the bearing plates with the beam and adjust for distance by means of the guide plates furnished with the machine.
- Place a strip if leather or similar material under the upper bearing plate to assist in distributing the load.
- Bring the plunger of the jack into contact with the ball on the bearing bar by turning the screw in the end of the plunger.
- After contact is made and when only firm finger pressure has been applied, adjust the needle on the dial gauge to "0".
- Here we are applying two point loading on the beam specimen, apply load till it breaks and note that as failure load as shwon in fig.

  Flexural Strength =PL/BD^2×1000

  Where,

  P=Load in KN

  L= Effective length of beam=400 mm

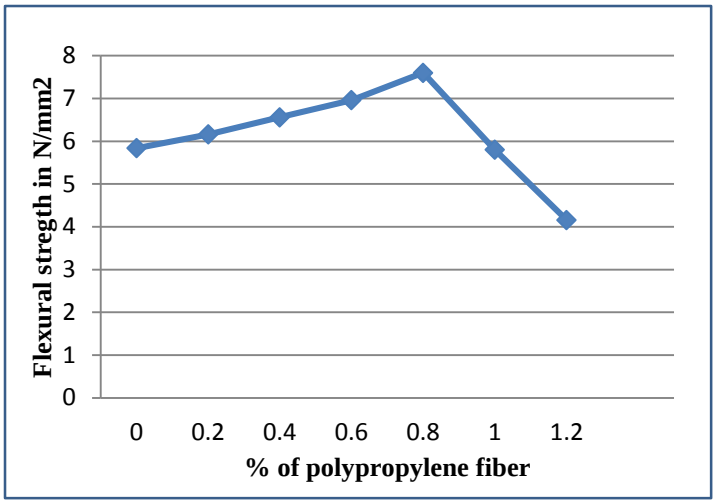
  b=Width of the beam= 100 mm

  d=Depth of beam =100 mm

Table 5.3: Flexural strength of concrete

%Of Polypropylene fibre used	Trials	Load at failure in 'N'	Average load in 'N'	Compressive strength in N/mm^2
0%	1 2 3	142 144 152	14600	5.84
0.2%	1 2 3	151 153 158	15400	6.16
0.4%	1 2 3	163 164 164	16400	6.56
0.6%	1 2 3	175 174 173	17400	6.96
0.8%	1 2 3	192 193 185	19000	7.6
1%	1 2 3	141 144 150	14500	5.8
1.2%	1 2 3	100 105 107	10400	4.16

From the above test result of polypropylene fibre 0.8% is maximum.



Graph 3.3: flexural strength at 28 days of curing.

IV. CONCLUSION

Based on the experiment conducted the following observation were made hence some conclusion.

a) Compressive strength properties of polypropylene fibre reinforced concrete increase as the percentage of polypropylene fibre increase up to 0.8% increasing strength and therefore at 1.2% shows decreasing strength.

b) Tensile strength properties of polypropylene fibre reinforced concrete increase as the percentage of polypropylene fibre increase up to 0.8% increasing strength and therefore at 1.2% shows decreasing strength.

c) Flexural strength properties of polypropylene fibre reinforced concrete increase as the percentage of polypropylene fibre increase up to 0.8% increasing strength and therefore at 1.2% shows decreasing strength.

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