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Experimental study on concrete with addition of polypropylene fiber

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ABSTRACT

Concrete is a fundamental unit for the infrastructural development of an entire world and is a most commonly used building material for its sustainability, versatility, durability and economy. Concrete is a mixture of cement, sand and aggregate with water. To meet the requirements for new construction, the current trend in concrete technology is to increase the strength and durability of concrete. Research is very concerned with laboratory work to see how including polypropylene fibers improves material durability. Polypropylene fibres will be adding in various proportions (0.75% and 1.5% by weight of cement) the increase compressive strength, Tensile strength for M30 grade of concrete. With the inclusion of a limited number of polypropylene threads aged 7, 14, and 28 days, our project demonstrates the proven strength results of the FRC.

INTRODUCTION

Concrete creates small cracks in the treatment and this crack spreads rapidly under the applied pressure resulting in decreased strength of concrete. Thus the addition of fibers improves the strength of concrete and these problems can be overcome by the use of Polypropylene cables in concrete. Use of polypropylene
fibers provide strength to the concrete while the matrix protects the fibers. The main role of cables in cementitious bonding is to control cracks, increase strength, durability and improve the properties of the bonding structure. FRC performance depends on the type of wires used. The insertion of polypropylene fibers reduces water penetration, increases flexural strength due to its high-strength module. In the cracking phase, as the fibers are removed, the force enters and the crack is reduced.

OBJECTIVE OF PRESENT STUDY

1. To determine the optimum percentage of polypropylene fiber.
2. The main objective of present investigation is to study the properties of concrete with addition of polypropylene fibres. The study was carried out on M30 grade concrete.
3. To compare the strength of concrete cube containing polypropylene fiber with 1.5% proportions of volume of the cement and normal concrete.

LITERATURE COLLECTION

Nivedhan et al Normal or conventional concrete uses more of the raw material like sand, gravels, fly ash etc. its usage has been increased to an enormous amount where there are likely chances of meeting with the demand of such construction materials. It may also lead to increase the cost of the materials drastically. Other building materials were built to deal with those problems. This study was conducted in an effort to improve the state of the art by building with recycled materials. Weld slag and fibers, which are readily available, were chosen to insert a concrete component. Weld slag, which is a residual product, is used in concrete in various quantities to incorporate the dreaded component into 10%, 20%, and 30% by weight.
Prabhakaran et al The use of Fiber-reinforced concrete (FRC) in many engineering applications is undeniable. Reinforced fiber concrete was previously used to build slabs, bridges, industrial buildings, footings, hydraulic structures, and various other structures. This paper provides a state-of-the-art review of experimental studies performed with a reinforced polypropylene fiber machine instead of cement with silica smoke, rice straw, and fly ash, including compression, strength and durability. The effect of different concentrations of polypropylene fibers with mineral admixtures is studied in this system, which uses M30 grade concrete. The various types of concrete have been tested on mechanical properties in various years, as well as the testing of cement, fine-grained, composite, and mineral mixing to learn more about their properties.

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ChaitraPatil et al Concrete is a fundamental unit for the infrastructural development of an entire world and is a most commonly used building material for its sustainability, versatility, durability and economy. Concrete is a mixture of cement, sand and aggregate with water. In present situation the availability of natural sand is being decreasing day by day due to its high consumption. Scarcity of natural sand has uplifted the need for its substitute. Manufactured sand is one such excellent alternative material to replace natural sand. Manufactured sand is purpose made crushed aggregate processed by separation, washing, crushing and srubbing. Polypropylene fibres are used in a concrete to enrich the resistance against cracks and to strengthen the concrete. This paper enhances the experimental results of compressive strength, split tensile strength and flexural strength of fiber reinforced concrete with a partial replacement of manufactured sand with variant proprotions (0%, 20%, 40%, 60%, 80% and 100%) and addition of fixed proportion (1% of weight of cement) of polypropylene fibers.
Baswa Raghav Reddy et al In the following experiment, the study of influence of polypropylene fibers in reinforced High-Performance concrete (HPC) beams was done. 200 * 300 * 2100mm were the dimensions of the sample beam specimens cast in this study. The beam was loaded with two points under the loading frame 28 days after it was cured. Curve of deflection, flexural stiffness, and energy absorption are all investigated. HPC and PFRC had stiffness features of 9.55x10-3 and 11.79x10-3, respectively. High-performance concrete (HPC), reinforced polypropylene fiber (PFRC), load deviation, flexural strength, and energy absorption capacity are some of the terms used in this study.
Syed Zaheer Ahmed et al In this experimental study to effort using polypropylene fiber with different mix proportion of fusion ratio to form the fusion reinforced concrete. Polypropylene fibers have modified properties, which will improve flexural concrete strength, break strength, and compression strength. By this strength parameter also increases. In this effort has been approved for M30 and M40 grade concrete according to IS 10262:2009 with five various proportions are added with concrete ingredient. The proportion of polypropylene fiber is varying with different fusion fiber amount varies from i.e. 0%0.5%, 1.0 %, 1.5% 2.0%. Polypropylene fiber is added by the weight of cement. These tests were done to analyze the hardened properties of concrete for - & 28-days curing specimens. Investigation of strength parameter on different tests is evaluated and results are tabulated. From experimental study and results it can be notify that the sample of added polypropylene fiber1% & 1.5% determined better results.

Material collection

Cement

Ordinary Portland cement has been used in this project (OPC 53). IS 12269 - 1987 used to inspect all concrete structures. Cement has a gravitational force of 3.15. 55 minutes and 258 minutes were considered the first and last times, respectively. The cement has an average accuracy of 30%.
Cement is one of the binding products of the project. In today's world of construction, cement is one of the most important building materials. Ordinary Portland Cement (OPC) grade 53, according to IS: 8112-1989. Table 3.1 gives the cement structures used.

Table 3.1 Properties of cement

S.No	Description of test	Test results obtained
1	Initial setting time	65 minutes
2	Final setting time	270 minutes
3	Fineness (specific surface by Blaine's air permeability test)	412.92 m^2/kg

Coarse aggregate

Weighed 20mm large sized granular aggregates, with a gravitational force of 2.78 and 7 modulus of fineness. Sources for the collection area were available. The stones compliant with IS: 383 - 1970 is compacted with a scale of 20 mm.
Both specimens will be cast with aggregate with a maximum strength of 2.77 and passed through a filter of 4.75 mm. Many studies have concluded that the total size of coarse aggregate in composite should be limited. The composite form, in addition to the adhesive rate of the cement, has a significant impact on the consistency of the concrete surface.

Table 3.2 Test results of coarse aggregate

S.NO	Description	Values
1	Specific gravity	2.68
2	Bulk density	1642.45
3	Surface moisture	0.08%
4	Water absorption	1%
5	Fineness modulus	6.98

Fine aggregate

Sand was used locally and passed through a 4.75mm IS filter. Fine aggregate had a gravitational force of 2.60. Local river sand meets IS: 383 –1970 Grading Zone I can be used to obtain clean and dry river sand. All types will be cast with sand past with an IS 4.75mm filter.

Table 3.3 Property of Fine Aggregate

S.NO	PROPERTIES	VALUE
1	Specific Gravity	2.65
2	Fineness Modulus	2.25
3	Water absorption	1.5%

Polypropylene fibres

Monofilament fibers and film fibers are two types of polypropylene. The insertion into the orifices in the spinneret produces the strands of the monofilament, and is then cut to the desired value. After that each film is made in the same way, except that the polypropylene is removed from the sofa, resulting in a corrugated or flat film. The video is then cut to tapes and expanded separately. These tapes are then extended over specially designed roller pin systems, resulting in longitudinal cracks that can be cut or bent to create a variety of shapes.

Table 3.4 Properties Of Polypropylene Fibres

Properties	Test data
Diameter(D).mm	0.0445
Length(l).mm	6.2
Aspect Ratio(l/D)	139.33
Tensile strength Mpa	308
Specific gravity	1.33

Experimental setup

Compressive strength test

When a specimen of material is loaded in such a way that it extends it is said to be in tension. The content, on the other hand, is said to be in compression if it compresses and shortens. When molecules or atoms are in tension, they are pulled apart, and when they are in confinement, they are forced together. Since atoms in solids are constantly trying to reach an equilibrium position and distance from other atoms, stress and compression forces emerge in the substance. As a result, the processes at the atomic level are similar. All types must be stored on an integrated testing machine during the testing process. The maximum load on which a concrete block can break will be registered. The compression strength can be determined using the formula below according to the recognized values.

Load / Area = Compression Capacity of the sample sample is 150mm x 150mm x 150mm in size.

Fig 4.1 Compression Test

Split tensile test

The diameter of the cylinders, the cubes are cast through a process of 300 mm long and 150 mm wide, and the load is added to the opposite side of the cubes. The load can be felt before the sample template breaks after proper alignment. The formula used in the measurement.

Split tensile strength = 2P/ µdl

Fig 4.2 Split Tensile Test

The tensile strength is one of the basic and important properties of the concrete. Because of their strong durability and bold appearance, concrete often cannot withstand direct tension pressure. The strength of the concrete, on the other hand, should be determined in order to determine which pressure the concrete members can break from. The cracking happens through failure posed by tension.

Flexural strength test

During the experiment, 7000mmx150mmx150mm testing pieces were used. Specimens dried in the open air after 7 days of healing and tested for flexural test strength under flexural test assembly. Load with a scale that always increases the pressure until it explodes. The fragmentation indicates an inconsistency of the space within a third of the length of the space. Flexural strength is obtained using the formula (R).

R = Pl/bd^2

Where,

R = Modulus of rupture (N/mm^2)

P = Maximum applied load (N/mm^2)

l = Length of specimen (mm)

b = Width of specimen (mm)

d = Depth of specimen (mm)

Fig 4.3 Flexural Strength Test

Flexural force, also known as the modulus of rupture, bending force, or force of fracture, the optical device parameter, is defined as the ability of an object to withstand a load under external pressure. Flexural force represents the maximum pressure that occurs within an object during its rupture. Flexural force would be the same as tensile force if that content were the same. In fact, many things have a small or large defect in them that creates a pressure point in the area, which effectively creates local weakness. When the tool is bent only the excess fibers are still under the greatest pressure, therefore, if those fibers have no defects, the flexural strength will be controlled by the strength of those strong 'fibers'.

RESULTS & DISCUSSION

Compressive strength of cube

Table 5.1 Compression Test Result

Days	% replacement	Compressive strength in N/mm^2			Average Strength
		S1	S2	S3	
7	0	17.50	17.4	17.30	17.4
	0.75	18.50	18.6	18.70	18.6
	1.50	20.20	20.4	20.50	20.3
28	0	24.5	24.2	23.8	24.2
	0.75	26.2	25.8	26.5	26.20
	1.50	28.3	27.9	28.6	28.30

Model Calculation

STRENGTH $= \frac{Load}{Area}$ N/mm^2
$= 393.75 \times 10^3 / 150 \times 150$
$= 17.5$ N/mm^2

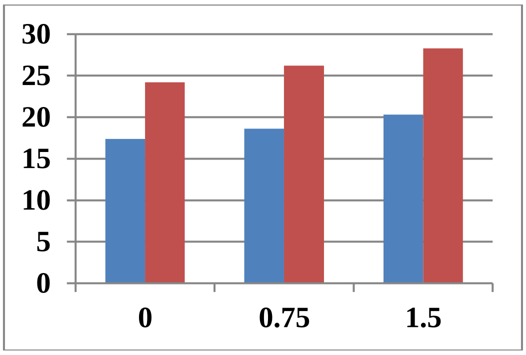

Fig 5.1 Compression Test Graph Result

Split tensile test for cylinder

Table 5.2 Split Tensile Test Result

Curing Days	% replacement	Split Tensile strength in N/mm^2			Average Strength
		S_1	S_2	S_3	
7	0	2.92	2.91	2.91	2.91
	0.75	3.01	3.01	3.02	3.01
	1.50	3.14	3.16	3.16	3.15
28	0	3.52	3.48	3.5	3.5
	0.75	3.78	3.68	3.7	3.72
	1.50	4.4	4.2	4.15	4.25

Model Calculation

STRENGTH $= \frac{2P}{\pi dl}$N/mm^2
$= 2 \times 206.20 \times 10^3 / (\pi x 150 \times 300)$
$= 2.92$ N/mm^2

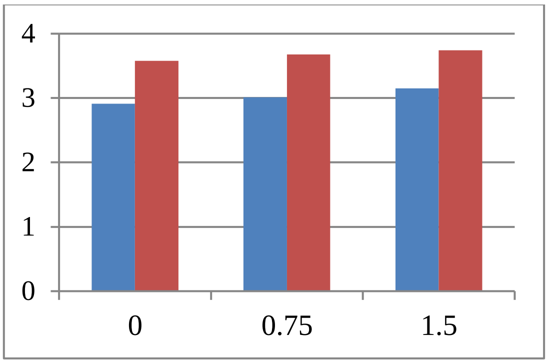

Fig 5.2 Split Tensile Graph Result

Flexural strength test for beam

Curing Days	% replacement	Flexural strength in N/mm²			Average Strength
		S1	S2	S3	
7	0	2.45	2.43	2.42	2.43
	0.75	2.77	2.79	2.80	2.78
	1.50	2.82	2.85	2.87	2.84
28	0	3.8	3.75	3.86	3.80
	0.75	4.2	4.26	4.30	4.25
	1.50	4.85	4.90	4.82	4.85

Table 5.3 Flexural Strength Test Result

Model Calculation

Flexural strength R = Pl/bd^2
$= 11800 \times 700 / (150 \times 150^2)$
$= 2.45$ N/mm^2

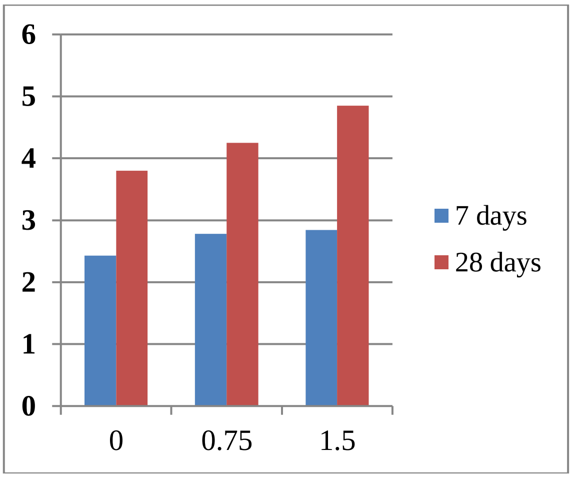

Fig 5.3 Flexural Strength Graph Result

CONCLUSION

From the above investigations, the following conclusions are made from the experimental results indicated following: By using of polypropylene fibre the specimens will be cast in different volume i.e. 0%, 0.75% and 1.5% in concrete.

- The compressive strength is increases with increase in quantity of polypropylene fibre.
- The compressive strength of the concrete with 1.5% polypropylene fibre is attaining 28.3N/mm^2 at 28 days curing.
- The split tensile strength of the concrete with polypropylene fibre is high when compared to conventional concrete.
- The flexural strength of conventional concrete is 4.85 N/mm^2. It is high when comparing to conventional concrete.

- Addition of polypropylene fibre increases the split tensile strength increasing when comparing to conventional concrete results.
- Therefore, the PP 1.5% gives maximum compressive strength, split tensile strength and flexural strength.
- Finally conclude the result of experimental work proves that addition of polypropylene fibres to increase the strength and mechanical characteristics of concrete.

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