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## Polypropylene Concrete

Zakerullah khan R.<sup>1</sup>, Mohommed Anwaruddin M. A.<sup>2</sup>

Head of Department of Civil Engineering, Gramin Polytechnic Vishnupuri,, Nanded, Maharashtra, India<sup>1</sup>

Assistant Professor, Department of Civil Engineering, Gramin College of Engineering (GRACE), Vishnupuri Nanded,  
Maharashtra, India<sup>2</sup>

**ABSTRACT:** The main purpose of this investigation is to study the effects of polypropylene fibre on the compressive and flexural strength of normal weight concrete. Polypropylene is a synthetic hydrocarbon polymer, the fibre of which is made using extrusion process by hot drawing the material through a die. Its use enables reliable and effective utilization of utilization of intrinsic tensile and flexural strength of the material along with significant reduction of plastic shrinkage cracking and minimizing of thermal cracking. Effect of these fibres on various strengths of concrete are studied. Firstly 0.1% Fibre content is used and after that varied from 0.1 to 0.175 % at an interval of 0.2 by weight of cement. Various strengths considered for investigation are compressive strength, split tensile, bond strength and shear strength for Polypropylene fibre reinforced concrete. A cube of 150mm is made by polypropylene concrete. The specimen was cured for 7 to 28 days and after that they are tested consequently. The workability was tested by slump cone test. The test results showed that the increase of mechanical properties (compressive and flexural strength) resulting from added of polypropylene fibre was relatively high.

**KEYWORDS:** Polypropylene, Strength, Fibre reinforced concrete, synthetic fibre, workability.

### I. INTRODUCTION

Concrete is widely used in structural engineering with its high compressive strength, low cost and abundant raw material, but common concrete has some shortcomings, for example, low tensile and flexural strength, poor toughness, high brittleness, and so on that restrict its application. To overcome these deficiencies, additional materials are added to improve the performance of concrete. Fibre reinforced concrete is a composite material that has been developed in recent years. It has been successfully used in construction with its excellent flexural tensile strength, permeability ...and so on. Short fibres have been known and used for centuries to reinforced brittle material like cement or masonry bricks. At that time, fibres were natural fibres, such as horse hair, straw, etc. Now, days numerous fibre types are available for commercial uses, the basic types begin steel, glass, synthetic materials and some natural fibres. Extensive research on fibre reinforced began in 1960 and since then a substation amount of researches development, applications and commercialization have occurred. Two kinds of polypropylene fibres with different fibre contents (0.2%, 0.5%, 1.0% and 1.5%) by volume were used in the beam. It was found that the strength of the reinforced concrete beams was significantly increased, the flexural toughness was also improved, compared to those unreinforced concrete beams. Ali investigated the effects of steel fibres and polypropylene (PP) fibres on the splitting tensile, compressive strength, stress-strain relationship (stiffness) and energy absorption capacities (toughness) of concretes. Steel or polypropylene fibres are used to enhance the ductility/toughness of the hardened concrete. Concrete mixtures comprised a concrete mix, prepared without any fibres, and concrete mixes reinforced with either or both steel fibres and polypropylene (PP) fibres. Obtained results show that polypropylene (PP) fibres reinforced has high compressive and tensile strength. Polypropylene fibre is a synthetic fibre with low density, fine diameter and low modulus of elasticity. It has some special characteristics such as high strength, ductility and durability, abundant resources, low cost, and easily physical and chemical reformations according to certain demands. Thus it can be widely utilized in the field of concrete products. This study will discuss the compressive and flexural strength of polypropylene fibre reinforced concrete beams. This study was performed by test cube specimen and two point load beam.

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## II. NECESSITY OF WORK

Portland cement concrete is considered to be a relatively brittle material. When subjected to tensile stresses, non-reinforced concrete will crack and fail. Since mid 1800's steel reinforcing has been used to overcome this problem. As a composite system, the reinforcing steel is assumed to carry all tensile loads. The problem with employing steel in concrete is that over time steel corrodes due to the ingress of chloride ions. In the northeast, where sodium chloride deicing salts are commonly used and a large amount of coastal area exists, chlorides are readily available for penetration into concrete to promote corrosion, which favors the formation of rust. Rust has a volume between four to ten times the iron, which dissolves to form it. The volume expansion produces large tensile stresses in the concrete, which initiates cracks and results in concrete spalling from the surface. A better and permanent solution may be to replace the steel with a reinforcement that is less environmentally sensitive,

Sr.No	Description of Test	Results
1	Fineness	6.10
2	Specific Gravity	3.15
3	Consistency	29%
4	Initial setting time	40 min
5	Final setting time	370 min
6	Soundness	1.5mm

## III. PREPARATION OF TEST SPECIMENS

Aggregate and cement were first mixed, and water was progressively added until a homogeneous concrete was obtained. Then, the fibres were added, and concrete was mixed for at least 3 minutes in order to allow a sufficient time for fibre even distribution in the mixture. For each mixture six concrete cubes with dimensions of 150x150x150 mm and three beams with dimensions 100 x100x100 mm were cast into moulds consolidated by vibration to decrease the amount of air bubbles. The specimens were remodelled after 24 hours and then placed in a curing tank under laboratory conditions for 14 days for compressive concrete strength at age 14 days and 28 days for compressive strength of concrete and flexural strength at age 28 days.

## IV. TESTS ON MATERIALS

### A. Water

Potable water available in laboratory was used for mixing and curing of concrete.

### B. Test On Cement

The cement used in this experimental work is 53 grade Portland Pozzolana cement. All properties of cement are tested by referring IS 1489 (part 1) 1991 [42] PPC specification. Test results are presented in Table.

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### C. Tests On Aggregates:

Natural sand from Paithan (Godavari) river is used conforming to IS 383-1970. Various tests such as specific gravity, water absorption, impact strength, crushing strength, sieve analysis etc. have been conducted on CA and FA to know their quality and grading. All the tests have been carried and are shown in tables 3.2 to 3.5. Crushed black trap basalt rock of aggregate size 20mm down and 10mm down were used conforming to IS 383-1970.

#### Physical Properties Of Fine Aggregate:

Sr.No.	Properties	Results
1	Particle shape, size	Round, 4.7mm down
2	Fineness modulus	3.42
3	Silt content	2%
4	Specific gravity	2.63
5	Bulking of sand	4.16%
6	Bulk density	1793 Kg/m <sup>3</sup>
7	Surface moisture	2%
8	Fineness modulus	4.16

#### Physical Properties Of Coarse Aggregate :

Sr. No	Property	Results
1	Particle Size	Angular, 20mm
2	Fineness modulus of 20mm aggregates	6.97
3	Specific gravity	2.77
4	Water absorption	1.02%
5	Bulk density of 20mm aggregates	1603 Kg/mm <sup>3</sup>
6	Surface moisture	Nil
7	Fineness modulus	6.90

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Physical properties of Polypropylene fibres.

Sr. No.	Property	Polypropylene
1.	Material	100% virgin synthetic fiber
2.	Cross section	Triangular
3.	Fiber length	3,4,8,6,12, 24mm
4.	Dispersion	Excellent
5.	Sp. Gravity	1.36
6.	Colour	Brilliant white
7.	Melt point	240 <sup>o</sup> C
8.	Alkali resistance	Good
9.	UV stability	Very good
10.	Tensile strength (Mpa)	897-1104
11.	Young's modulus(10 <sup>3</sup> Mpa)	17.25
12.	Ultimate elongation (%)	50-70

D. Dosages Used:

Firstly 0.1% fiber volume fraction is used and after that varied from 0.1 to 0.175 % at an interval of 0.025 by weight of cement.

Weight Of Concrete Ingredients Used For A Single Batch For M45 (Cylinders) :

FIBRE (%)	CEMENT (KG)	PPF	F.A (KG)	C.A (KG)	WATER (KG)
0.000	17.273	000	24.182	34.546	6.564
0.100	17.273	017	24.182	34.546	6.564
0.125	17.273	022	24.182	34.546	6.564
0.150	17.273	026	24.182	34.546	6.564
0.175	17.273	031	24.182	34.546	6.564

Schedule Of Specimen Preparation:

Mix Grade	PPF content (%)	W/C ratio	Comp. Test		Split Tensile Test	
			7 days	28 days	7 days	28 days
M45	0.00	0.38	3	3	3	3
M45	0.25	0.38	3	3	3	3

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M45	0.50	0.38	3	3	3	3
M45	0.75	0.38	3	3	3	3
M45	1.00	0.38	3	3	3	3

### E. Compressive Strength

Compressive strength values obtained after 14 and 28 days are summarized. the 28 days compressive strength for fibrous concrete increase from 39 mpa for 0.0 % fibre weight content to 43.3, 48.5, 57.0, and 61 MPa for 0.4%, 0.8%, 1.0%,and 1.5% fibre weight contents, respectively. the increase in the compressive strengths for fibrous concrete compared to non-fibrous concrete is 11%, 24.35%, 46.0%, and 56.4% for 0.4%, 0.8%, 1.0%, and 1.5% fibre content, respectively.

Compressive Strength Of Concrete, Mpa For M45 Grade Of Concrete.

Sr. no.	Mix	Fiber Content (%)	Compressive strength (N/mm <sup>2</sup> )		% Increase in compressive strength of concrete	
			7 Days	28 Days	7 Days	28 Days
1	M45	0.000	34.71	51.10	—	—
2	M45	0.100	35.70	52.66	2.84	3.05
3	M45	0.125	36.18	53.10	4.23	3.91
4	M45	0.150	36.43	53.83	4.95	5.34
5	M45	0.175	32.54	48.17	-6.25	-5.73

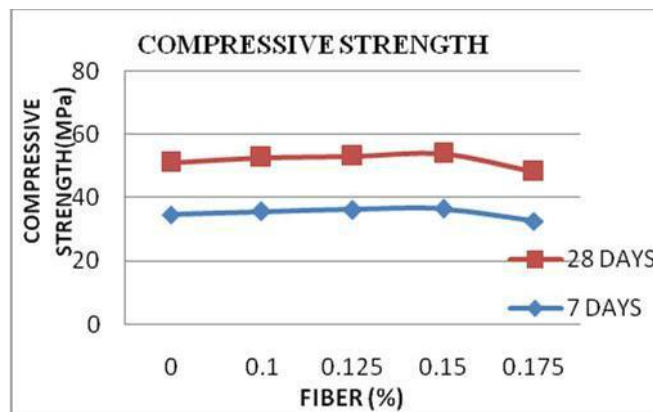


Fig. Variation of compressive strength at the age of 7 & 28 days with respect to percentage fiber volume fraction.

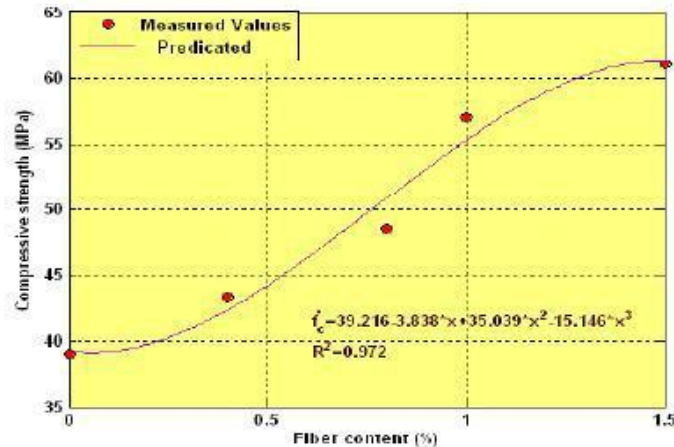
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Compressive strength after 14 and 28 day



Effect of fiber contain on compressive strength

## F. Split Tensile Strength of Concrete, Mpa for M45 Grade of Concrete

This test method covers the determination of the splitting tensile strength of cylindrical of size 150 X 300 mm cylinders concrete specimens, such as molded cylinders and drilled cores. This test method consists of applying a diametral compressive force along the length of a cylindrical concrete specimen at a rate that is within a prescribed range until failure occurs. This loading induces tensile stresses on the plane containing the applied load and relatively high compressive stresses in the area immediately around the applied load. Tensile failure occurs rather than compressive failure because the areas of load application are in a state of triaxial compression, thereby allowing them to withstand much higher compressive stresses than would be indicated by a uniaxial compressive strength test result.

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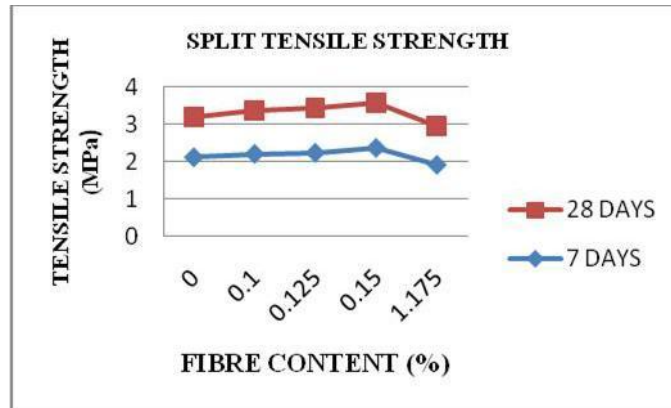
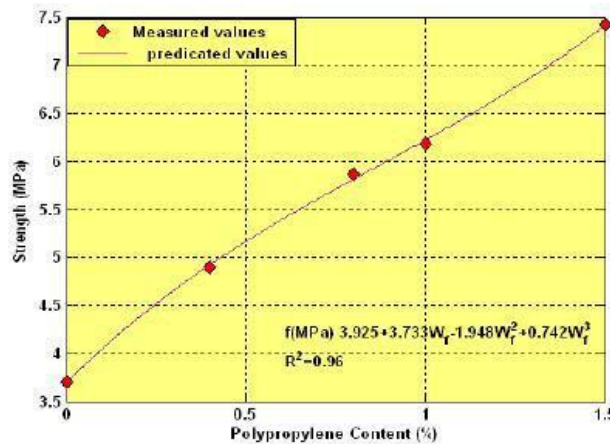


Fig. Variation of tensile strength with respect to the varying fiber percentage

### G. Flexural Strength

It can be seen that the 28- days flexural strength measured for fibrous content increase from 3.925 MPa for 0.0% fibre content to 4.9% MPa, 5.87 MPa, 6.18 MPa, and 7.27 MPa for 0.4%, 0.8%, 1.0%, and 1.5% fibre weight contents, respectively. These values represent percentage increase of 24.6%, 49.36%, 57%, and 85% for 0.4%, 0.8%, 1.0%, and 1.5% fibre weight contents, respectively. The magnitudes of this increase are some what higher than these in compressive strength.



Effect of Fiber Contain Flexural Strength

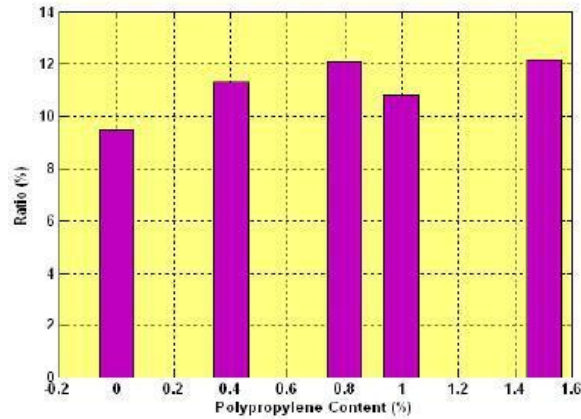
Sr. no.	Mix Grade	Fiber Content (%)	Split tensile strength (N/mm <sup>2</sup> )		%Increase in split tensile strength of concrete	
			7 Days	28 Days	7 Days	28 Days
1	M45	0.000	2.10	3.20	—	—
2	M45	0.100	2.19	3.36	4.28	5.00
3	M45	0.125	2.22	3.44	5.71	7.50
4	M45	0.150	2.35	3.58	11.90	11.87
5	M45	0.175	1.90	2.95	9.52 (d)	7.81 (d)

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Ratio of Flexural Strength to Compressive Strength

Optimum Fibre Content Maximum Compressive Strength For M45

Strength MPa	PPFRC	
	Fibre content (%)	Max. value of strength, MPa
Compressive strength	0.15	53.83

Optimum Fibre Content Maximum Split Tensile Strength For M45

Strength MPa	PPFRC	
	Fibre content (%)	Max. value of strength, MPa
Split tensile	0.15	3.58

## V. RESULTS

Results of compressive strength are shown in table initially the value of compressive strength of M45 get increased up to 0.75% of Polypropylene at the age of 7 days and 28 days by 9.38% and 5.48% respectively over normal concrete and then it goes on decreasing. It indicates that there is an increase in compressive strength when adding the fibre content up-to certain limit after that the strength goes on reducing.

## VI. CONCLUSION

Following conclusion are drawn based on the result;

1. The wet and dry density (7 and 28 Days) goes on increasing as the percentage fibre volume fraction increases.



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2. The maximum Compressive Strength, achieved is 53.83 MPa at 0.15% of fibre volume fractions respectively.
3. Significant improvement in various strengths is observed with the inclusion of Polypropylene fibres in the plain concrete. Maximum gain in strength of concrete is found to depend upon the amount of fibre content. The optimum fibre content to impart maximum gain in strength varies with different type of strength tests.
4. While testing plain cement concrete cube spalling of concrete is observed. However it is not observed in PPFRC cubes due to randomly distributed fibres.
5. In all fibre content mode of failure was changed from brittle to ductile failure when subjected to compression and bending.
6. The maximum split Tensile strength of concrete was observed to be 3.58 MPa at 0.15% of fibre volume fractions respectively.
7. Optimum fibre content for all strength observed at 0.15%.

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