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AN EXPIREMENTAL STUDY OF POLYPROPYLENE FIBER AS AN ADDITIVE IN CEMENT CONCRETE

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Abstract: India has a road network of more than 4.87 kilometers according to MORTH, Techier Research July 2015 and the second largest road network in the world. Road and highway development is the foundation of infrastructure improvement, enhancing the essential driver to deliver rapid and sustained economic growth in changing technological innovation. It is undoubtedly the lifeblood of the nation that is a never-ending litigation activity in India. Due to rising oil costs and a tighter monetary environment, cement is becoming a more attractive choice for a base company that completely contrasts with conventional bituminous asphalt. The Ministry of Road Transport and Highways in India noted that the advanced society cannot work properly without concrete roads.

Index Terms **-polypropylene, fibers,cement concrete pavement, rigid pavement.**

1. INTRODUCTION

1.1 General

Thousands of tons of waste are deposited on valuable land every year, resulting in the occupation and degradation of valuable land. Natural resource depletion is a common phenomenon in developing countries such as India due to rapid urbanization and infrastructure-building industrialization. Waste processing is currently a major problem. Therefore, many studies are being conducted to use industrial, architectural and household waste for concrete mix. A lot of research is being done on the use of rubber of tires, plastic waste, bottom ash, fly ash, copper slag, quarry dust, tile waste, recycled aggregate, glass waste etc.

1.2 Polypropylenefiber

Polypropylene is a thermoplastic. It is a linear structure of monomer CnH2n. It is made from propylene gas in the presence of titanium chloride. In addition to polypropylene, it is a by-product of the oil refining process.

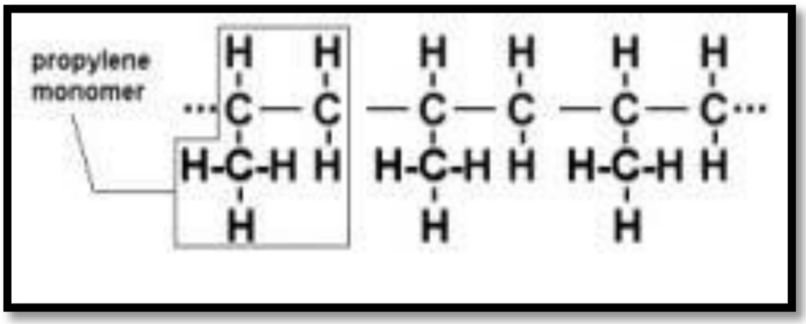


Figure 1.1-Chemical composition

1.3 Manufacturing process of polypropylenefiber.

Polypropylene chips can be converted into fibers / filaments by a melt spinning process. Spunbond and melt blown processes are also fiber producing techniques.

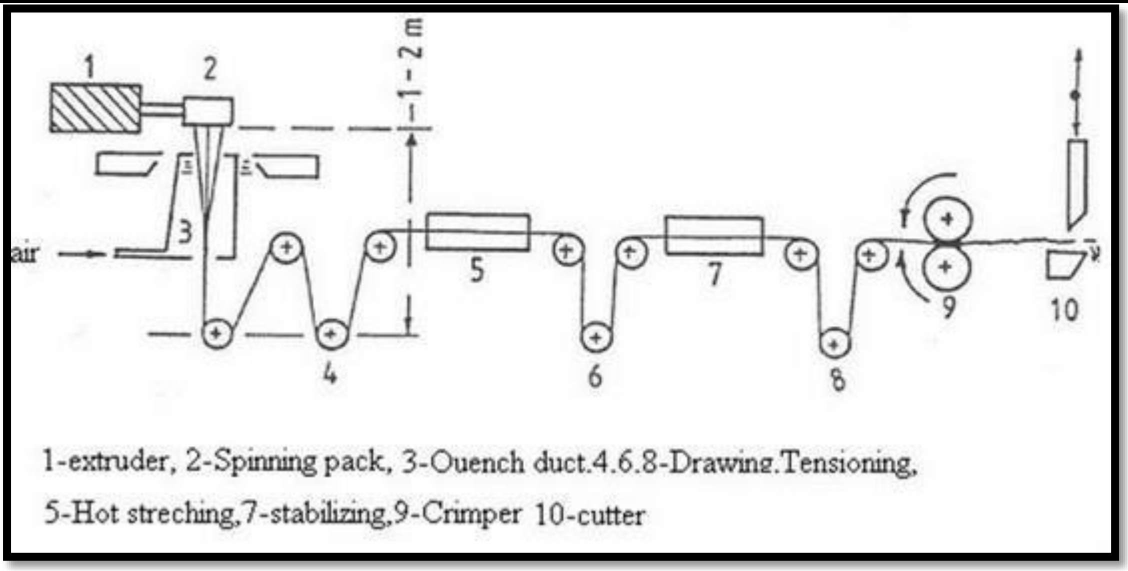


Figure 1.2-Fiber Production process

- **Extrusion:** L / D = 30, compression ratio = 1: 3.5
- **Dosage:** One or more rotary gear pumps pick up the molten polymer and pass it through the rotating package to homogenize the product, feed the rotating package at a constant speed, and prevent fluctuations from a screw extruder.
- **Spinning:** The spinning package consists of three part filters and the die. The diameter of the die varies from 0.5 - 1.5 mm, depending on the denier required.
- **Quenching:** Newly extruded filaments are cooled in a good "box" that will distribute 3 m3 / min of cool air without damaging the filaments.
- **Finish:** to improve antistatic and reduce wear.
- **Hot stretching:** to improve physio-mechanical properties.
- **Shrink:** to improve bulk.
- **Thermo setting:** It is a treatment in hot air or steam that removes internal stress and relaxes the fibers. The resulting fibers are heat cured with a larger denier.

1.3 Advantages of Polypropylenefibers

• Polypropylene fibers are non-magnetic, stainless, alkali resistant, safe and easy to use. Polypropylene yarn is inexpensive, abundantly available and of consistent quality.

• Polypropylene fibers are also compatible with all chemical concrete mixes and can be easily processed. The high molecular weight of polypropylene gives it many useful properties.

1.4 Disadvantages of Polypropylenefibers.

• Low melting temperature so it cannot be ironed like cotton, wool etc.

• Hard to paint after production.

• High crystalline and low thermal conductivity.

1.6 Need of study

Polypropylene fiber deserves special attention that gets many benefits in industrial and everyday life. Significant studies and studies have been conducted in some countries, such as the US and the UK, on the worldwide use of polypropylene fibers.However, there are very limited studies in India on the use of polypropylene fibers, but no research has yet been conducted on the use of polypropylene fibers. polypropylene fiber in rigid pavement. This study presents the information on the civil engineering applications of industrial by-products such as polypropylene, which is technically sound and environmentally friendly.

2. BASIC OF POLYPROPYLENEFIBERS

2.1 General

All fibers are categorized as macro or microfibers. The term structural fibers is often used for macro fibers with a length between 19-60 mm. These fibers are expected to bridge cracks and provide structural support for the paved condition of concrete. Microfibre, on the other hand, is included in a mix to help improve the fresh and early tensile and flexural strength of concrete. These fibers offer the necessary resistance to tensile forces developed by both dry shrinkage - 2 - and plastic shrinkage. Microfibers have a length of 2-10 mm and a nominal diameter of 0.1-1 mm (Concrete Society UK TR 63, 2007).

2.2 Properties of polypropylenefibers

Chemical properties:-

Formule Chemical formula of polypropylene fiber (C3H6) n

Acids: - Acid has no effect on polypropylene. It has an excellent protesting ability against acids.

Basic: - Basic does not affect the base.

Effect of bleaching: -It has enough power to prevent the harmful effect of bleach under 65

Organic solvent: - Organic solvent does not damage polypropylene during action.

Protective ability against light: -It loses energy from sunlight.

Vermogen Protective ability against mold: - Good

Insecten Insect protection: - It does not affect insects.

Table 2.1-Physical Properties of Polypropylene fiber

Fiber Type	Length (mm)	Diameter (mm)	Tensile Strength (MPa)	Modulus of elasticity (GPa)	Specific surface (m^2/kg)	Density (kg/cm^3)
Monofilament	30-50	0.30-0.35	547-658	3.50-7.50	91	0.9
Microfilament	12-20	0.05-0.20	330-414	3.70-5.50	225	0.91
Fibrillated	19-40	0.20-0.30	500-750	5.00-10.00	58	0.95

3.LITERATUREREVIEW

3.1 Literaturereview

A literature study is a text written by someone to consider the critical points of current knowledge, including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources and as such do not report new or original experimental work. A literature search can also be interpreted as an overview of an abstract achievement.

1) Gopi J. Sutaria, Prof. dr. C.B. Mishra, Prof. N.F. Umrigar (2015), "Diagnosis of polypropylene fiber performance in concrete mix design for rigid paving" SSRG International Journal of Civil Engineering (SSRG-IJCE)

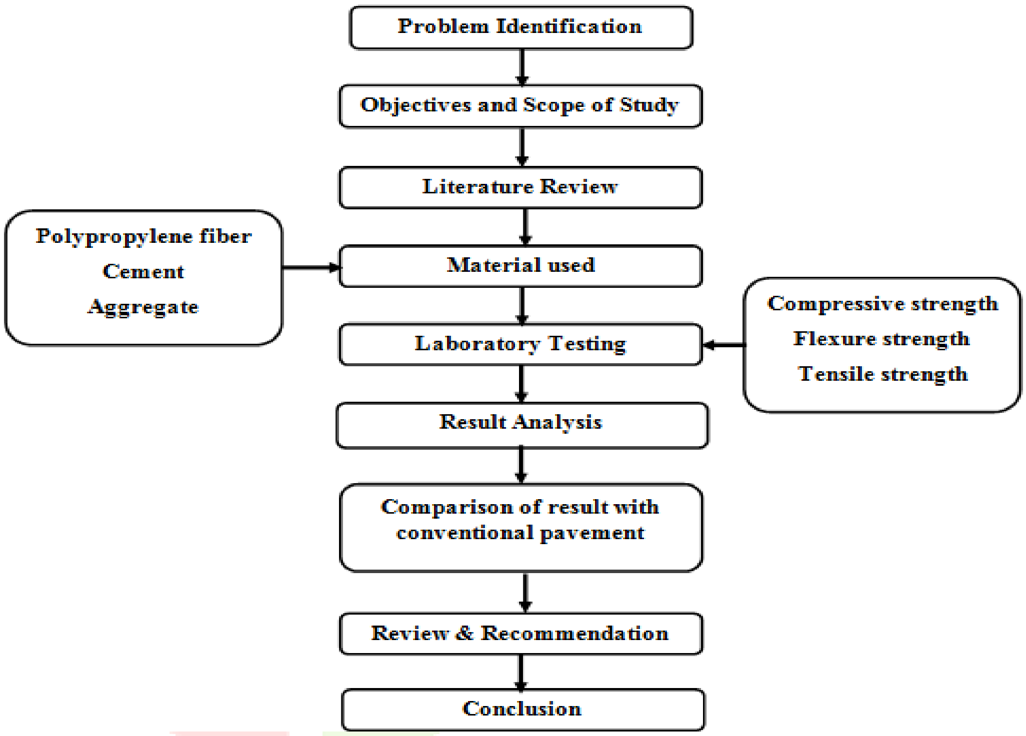
A study has been conducted to diagnose the performance of a conventional concrete admixture design test containing admixtures to concentrate the compressive and flexural strength of the concrete form with a typical mixture after 7 days and 28 days. The correlation between concrete mix with and without polypropylene added in dosages of 0.6%, 0.8% and 1.0% instead of cement is worked out to concentrate compressive strength and flexural strength, which is of paramount importance to highway specialists. And found that up to 0.6% including concrete with polypropylene fiber 12mm length, there is an ideal speed to increase the improved compressive strength and bending strength, which can reduce the slab thickness in the wear surface of cement concrete pavements and because of the higher bending strength, reduces material usage.

Cengiz, O. Turanli, L. (2004), "Durability of polypropylene fibers in Portland cement based composites".

Alhozaimy, A. M. Soroushiad, P. MirzaC, F. (1995),*"Mechanical Properties of Polypropylene Fiber Reinforced Concrete and the Effects of PozzolanicMaterials"*

4. METHODOLOGY

4.1 Methodology Flowchart



4.2 Experimental of RawMaterials.

4.2.1 BasicMaterials

In this chapter, the basic properties of different materials used in experimental work are identified. Some basic tests have been carried out on this material to check their physical properties and the chemical properties of quartz sand. The basic properties of materials used in the experimental work are as follows:

i) Cement
ii) CoarseAggregates
iii) Sand (fineaggregate)
iv) Polypropylenefiber

4.3 LaboratoryTest

4.3.1 CompressiveStrength

The compressive strength of concrete is the most important characteristic of concrete, which is measured by engineers when designing structures. Compressive strength is the most common test performed on hardened concrete. It is very easy and simple to perform and in part because many of the desirable properties of concrete are qualitatively related to compressive strength. Compression test samples are used: cubes, cylinder and prisms. Take the required amounts of material and mix by hand or machine. Concrete must be filled into the mold in three equal layers. Each layer must be compacted 25 times with a diameter of 16 mm. fishing rod. After curing, the samples are taken out and cured in clean, fresh water. Curing takes place until the required test days.

Figure 4.2-Flexural strength machine

4.3.2 TensileStrength

Tensile stress is likely to develop in concrete due to drying, shrinkage, corrosion of steel reinforcement or temperature gradients. The determination of the bending tensile strength is essential to be able to estimate the load at which the concrete elements can crack. Narrow plywood or rubber gasket is used to reduce the magnitude of high compressive stress directly under load. If such strips are not supplied, the perceived tension is reduced by up to 8%.

Horizontal Tensile Stress $= \frac{2P}{\pi LD}$

Where,

P = Compressive load on the cylinder L = Length of cylinder

D = Diameter of cylinder

(IS: 516-1959 – Methods of tests for strength of concrete)

Figure 4.3-Tensile strength machine

5. MIX DESIGN &EXPERIMENTS

5.1 MixDesign

➢ *Designstipulations*

- Compressive strength required for 28 days = 38 N/mm^2 (Tb-2, Pg-16, IS456:2000)
- Max size of aggregate = 20mm (cl 5.3.3 IS456:2000)
- Degree of workability = 0.80 compacting factor (cl 7.1.1 IS456:2000)

➢ *Test data for materials*

- Sp. gravity of cement = 3.07
- Sp. gravity of fine agg. =2.60
- Sp. gravity of coarse agg. =2.7

Targetstrengthofconcretemeanstrength=38+(1.65*5)=46.25 (Tb-1,Pg-20IS: 10262 2009)

- Water cementratio

Adopt cement water ratio = 0.4 (Tb-5, Pg20: IS 456:2000)

➢ *Water content*

From IS 10262-(table 4), for 20mm aggregate, sand conforming to grading is 186 kg sand content of total aggregate by absolute volume = 35 %

Therefore required sand content = 33%

Required water content = 186+3/100 = 5.58 L

➢ *Cement content*

Water cement ratio = 0.40 Water = 5.58 L

Therefore, cement = 186+5.58/C =0.4

C = 479 kg/ m^3

➢ *Coarse aggregate and fine aggregate contents*

As per clause 3.5.1 on Pg. 11 of IS 10262 fine aggregate is obtained from the equation. Putting the values in this equation, wehave

As per clause 3.5.1 on Pg. 11 of IS 10262 fine aggregate is obtained from the equation. Putting the values in this equation, wehave

Fine Aggregates and Course Aggregates:

Total Volume = Cement+Water+Aggregate

1=0.156+0.191+Aggregate

Aggregate =0.653

For 20mm Course aggregates =Fine Aggregate is zone 3

Total Volume = Course Aggregate + Fine Aggregate

1=0.65+ Fine Aggregate

Fine Aggregate =0.35

Mass of Fine Aggregate =0.653*0.64*2.7*1000

=1128 Kg/m^3

Mass of Course Aggregate =0.653*0.36*2.6*1000

=611.2 Kg/m^3

CEMENT: WATER: FINE AGGREGATE; COURSE AGGREGATE

479/479:191/479;611.2/479:1128.3/479

FINAL MIX PROPORTION

1:0.384:1.27:2.35

5.2 TESTING OFMATERIALS

5.2.1 Cement

Table 5.2-Ultratech-53 grade ordinary Portland cement

Initial setting time	26 min
Final setting time	600 min
Normal consistency	28%
W.C plunger	32mm
Sp.gravity	3.07
Fineness (90 um sieve)	4 %
Standard consistency	31.5%

Table 5.4-Test value of coarse aggregate

Coarse aggregate	Aggregate Impact value	12.4
	Aggregate Crusher Value	14.3
	Aggregate Abrasion Value	16.3
	Specific Gravity	2.79
	Water Absorption	0.94%
	Gradation	Falls in 20 mm size
	Combined Flakiness Index, Elongation Index	22.9 %

5.2.3 Fineaggregate:

Table 5.5-Sieve analysis of fine aggregate

Sieve size (mm)	Weight retain (gms)	Cumulative weight retain (gms)	Cumulative percentage weight retain (%)	Cumulative percentage weight passing
10	0	0	0	100
4.75	0	0	0	100
2.36	2	2	0.2	99.8
1.18	31	33	3.3	96.7
600 micron	634	667	66.7	33.3
300 micron	198	865	86.5	13.5
75 micron	134	999	99.9	0.1
150 micron	1	1000	100	0

6. EXPERIMENTALINVESTIGATION

6.1 General

This chapter explains the process of pouring concrete. The curing and storage of concrete samples is also briefly explained. During this experimental work, various tests were performed on both fresh and hardened concrete. The tests performed are explained in detail using the observations made during experimental work in this chapter.

6.2 Casting ofConcrete

6.2.1 Batching and preparation ofmound

The first step in making concrete is to collect the correct material, such as cement, fine aggregate, coarse aggregate, water, and also collect other material that requires similar additives. The different material was weighed according to the mix design of the concrete. The different material can be weighed by simple weighing machine or electric weighing machine, we were weighed by electric weighing machine. The electric weighing machine used in experimental work had a maximum capacity of 50 kg and the minimum size of 50 grams.

Figure 6.1-Batching and preparation of mound

6.2.2 Mixing

- In the first step, coarse aggregate, fine aggregate and silica sand were added to the mixing drum and then the drum is rotated for 1 to 1.5 minutes.
- • Ordinary Portland cement was added to the drum of the mixing machine and then the drum is rotated for 1 to 1.5 minutes.
- • Water is added to the drum and then the rotation of the drum is started and rotated for 3 to 5 minutes.

Figure 6.2-Mixing

Casting andcuring

Correctly mixing silica sand into concrete, the second step is to install concrete. The concrete was immediately poured into molds in three layers, all layers were manually compacted with a 16 mm rod.

Figure6.4-Casting

Figure 6.3-Curing

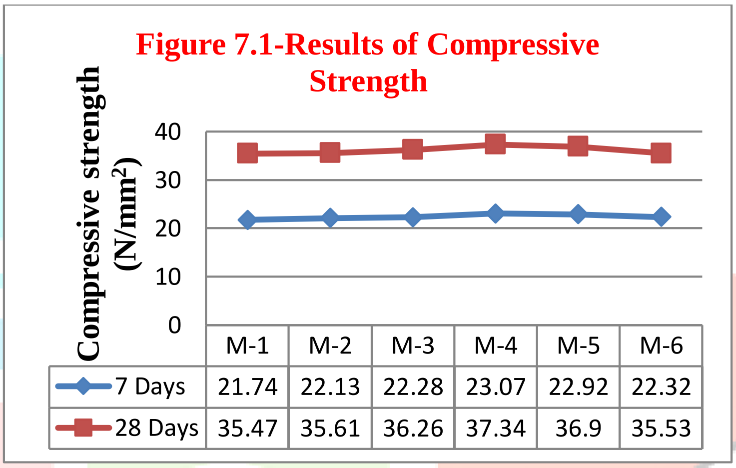
7.Results

7.1 Results of CompressiveStrength

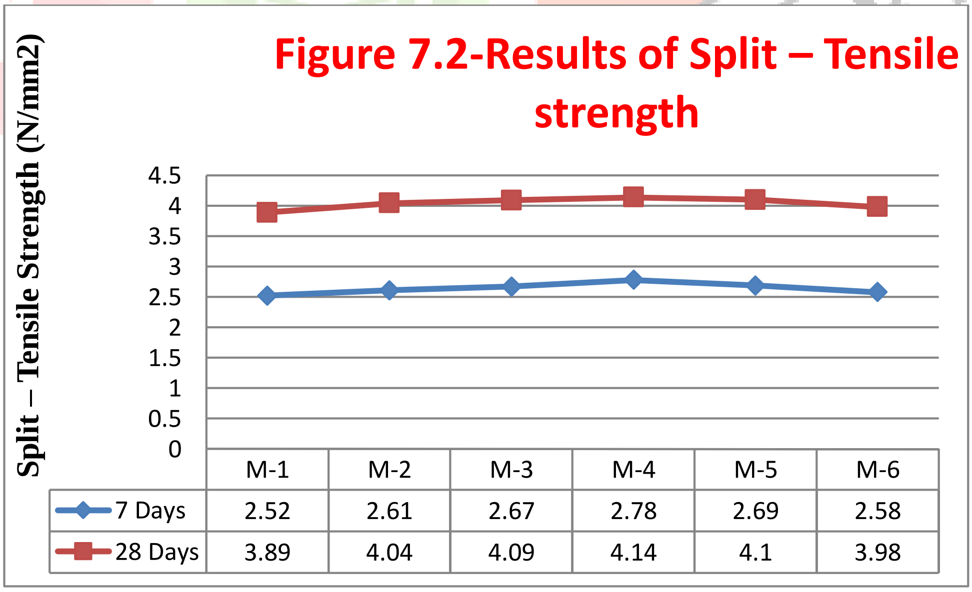
By replacing polypropylene fiber in concrete, the compressive strength was increased to 1.5% replacement and then after start to 2% replacement to 2.5% replacement. Compressive strength increases to 5.56% by replacing 1.5% polypropylene fiber with cement.

Table 7.1-Results of Compressive Strength

Mix No.	7 days (N/mm^2)	28 days (N/mm^2)
M - 1	21.74	35.47
M – 2	22.13	35.61
M – 3	22.28	36.26
M – 4	23.07	37.34
M – 5	22.92	36.90
M – 6	22.32	35.53



Mix Numbers



Mix numbers

7.2 Results of Flexural strength

By replacing polypropylene fiber in concrete, the flexural strength increased to 1.5% replacement and then after start to 2% replacement to 2.5% replacement. The flexural strength increases to 21.15% by replacing 1.5% polypropylene fiber with cement.

Table 7.3-Results of Flexuralstrength

Mix No.	7 days (N/mm^2)	28 days (N/mm^2)
M - 1	3.87	5.19
M – 2	3.76	5.61
M – 3	3.91	5.92
M – 4	4.32	6.34
M – 5	4.08	6.12
M – 6	3.94	5.91

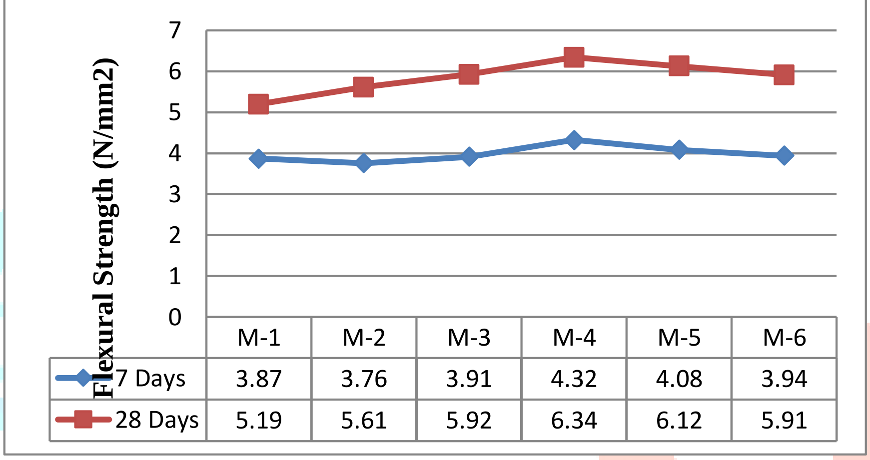


Figure 7.3-Results of Flexural strength

Conclusion

- Increase in compressive strength with an increase in the replacement of polypropylene fiber with cement and reaching the maximum value with replacement is 1.5% and then it starts to decrease.
- Compressive strength increases to 5.27% when replacing cement with polypropylene at 1.5%.
- Split tensile strength increase with increased replacement of polypropylene fibers with cement and reach maximum value when replacement is 1.5% and then the start decreases.
- The split strength increases to 6.42% when replacing cement with polypropylene at 1.5%.
- The flexural strength increases with an increase in the replacement of polypropylene fiber with cement and reaching a maximum value with replacement is 1.5% and then it starts to decrease.
- The flexural strength increases to 22.16% when replacing cement with polypropylene at 1.5%.
- The compressive split tensile strength, bending increase with the addition of polypropylene fiber content up to 1.5% compared to conventional concrete.
- By replacing cement with polypropylene fiber, Achieved increased strength at an optimal dosage of 1.5%, slightly reducing cement consumption.

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