



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

[ijrset@gmail.com](mailto:ijrset@gmail.com)

[www.ijrset.com](http://www.ijrset.com)

# Assessment of Effectiveness of Polypropylene Fibers in Crack Reduction of Concrete Structural Element

Soundarya. M<sup>1</sup>, Aishwarya. S. N<sup>1</sup>, Tharun Tej. S. V<sup>1</sup>, Dr. K N Vishwanath<sup>2</sup>

<sup>1</sup>Student, Department of Civil Engineering, Dayananda Sagar Academy of Technology & Management, Bangalore, India

<sup>2</sup>Professor and Head of the Dept, Department of Civil Engineering Dayananda Sagar Academy of Technology & Management Bangalore, India

**ABSTRACT:** The study examines the impact of polypropylene fibres on recycled aggregate concrete. Basically Recycled aggregates are gathered from building waste, and the reuse of concrete as aggregate will have positive effects on the environment and the economy. To study the parameters such as tensile strength, compressive strength, and flexural strength, experimental experiments including the addition of PPF to natural aggregate concrete and recycled aggregate concrete are conducted. Recycled aggregates have an impact on how concrete behaves, and PPF with the right amount of fibre enhances the characteristics of recycled coarse aggregate. In natural aggregate concrete, PP fibres reduce cracking. This study examines the impact of polypropylene fibre inclusion on various concrete characteristics.

## I.INTRODUCTION

Concrete is a synthetic building material created by combining binding components (cement, water, and perhaps additional inert components). For more than a century, concrete has been proven to be one of the best and most important building materials. and other part instead of polluting the environment by throwing the plastic to ocean or anywhere here we are using them(fibers) as construction material in construction industry. And also plastic fibers place an important role in concrete as crack reduction agent and also combination of recycled aggregates with calculated amount of fibers will give more strength to concrete. This type of fiber reinforced concrete is used in structures for slabs, pavements, floors etc.,

## II.MATERIALS

Fibre reinforcement concrete is made out of recycled coarse material, fine aggregate, cement, polypropylene fibres, and water. The combination produces a surface that leads to reduced breaking of cement concrete.

### Polypropylene fibers

- polypropylene fiber has excellent chemical resistance to acids and alkalis, high abrasion resistance and resistance to insects and pests. PP fiber is also easy to process and inexpensive compared to other synthetic fibers. Its low moisture absorption helps aid the quick transport of moisture.
- Polypropylene is a light fiber, its density (.91 gm/cm<sup>3</sup>) is the lowest of all synthetic fibres.
- It does not absorb moisture. This means the wet and dry properties of the fibre are identical. Low moisture regain is not considered a disadvantage because it helps in quick transport of moisture as is required in special applications like babies' ever-dry nappies.
- It has excellent chemical resistance. PP fibres are very resistant to most acids and alkalis.
- The thermal conductivity of PP fibre is lower than that of other fibres and may be used in applications as thermal wear.

### Recycled coarse aggregates

Crushing demolition trash from concrete structures yields recycled coarse aggregate (RCA). The regenerated coarse aggregate incorporates original aggregate that has been mortared together. The mortar that is applied is light and porous in nature. As a result, the specific gravity and density of recycled aggregate are obviously lower when compared to natural aggregate. The maximum aggregate size is 16mm.



**Cementitious materials**

The Ordinary Portland Cement ASTM Type 1 of Grade: 42.5 with 60 % consistency was used. The coarse aggregate which used were passing from 12.70 mm sieve and retained on 9.52 mm sieve.

**Water**

Water-to-cement ratios between 0.27 and 0.30 are used routinely with proper inclusion of chemical admixtures, and those as high as 0.34 to 0.40 have been used successfully. The relation between strength and water-to-cement ratio is not clear for pervious concrete, because unlike conventional concrete, the total paste content is less than the voids content between the aggregates. Therefore, making the paste stronger may not always lead to increased overall strength. Water content should be tightly controlled. The correct water content has been described as giving the mixture a sheen, without flowing off of the aggregate. A handful of pervious concrete formed into a ball will not crumble or lose its void structure as the paste flows into the spaces between the aggregates.

**BASIC TEST DATA FOR MATERIALS**

**For cement**

TESTS	VALUES
Specific gravity	3.12 [(IS 2720 Part 3) -3.15g/cc]
Normal Consistency	30% of water [(IS 4031 Part 4)-5 to 7mm]
Initial settings Time	35min [(IS 12269)- not less than 30 min]
Final Setting Time	340 min [(IS 12269)- not greater than 600 min]
Fineness	3.38% [(IS 460 part 1 1985)- 2 to 4%]

**Chemical composition of cement**

Constituent	wt. (%)
SiO <sub>2</sub>	19.92
Fe <sub>2</sub> O <sub>3</sub>	2.09
Al <sub>2</sub> O <sub>3</sub>	6.54
CaO	64.70
Na <sub>2</sub> O	0.28
K <sub>2</sub> O	0.84
MgO	1.84



**Basic Tests For Recycled aggregates**

TESTS	VALUES
Sieve Analysis	5.96% (fines modulus)
Water Absorption (BS 6349)- 0.2 to 1%	1)10 mm=0.2 % 2)12.5mm= 0.2%
Specific gravity (IS 2386-3 1963)-2.5 to 3%	1)10 mm = 2.6 2) 12.5mm =2.75
Shape Test	1)Flakiness = 12.4% passing 2)Elongation=9.9% Retained

**Basic Test for polypropylene fibers**

TESTS	VALUES
Diameter of polypropylene fibers	230nm approx.
Specific gravity	0.9

**Concrete mix design – M20 Grade**

**IS-456 : 2000 and IS-10262 : 2019**

**Data required for proportioning:**

1. Great designation- M20
2. Type of cement and grade of cement OPC 53 grade
3. Max nominal size of aggregate 20 mm
4. Explosive condition : mild (IS-456 2000, Table-3)
5. Minimum cement content : 30 kg per metre cube
6. Workability in terms of slump
7. Water cement ratio : 0.5 (IS-456, Table-5)



**Steps involved in mix design**

<b>1) Target Strength</b>	<b><u>26.6 N/mm<sup>2</sup></u></b>
<b>2) Water cement ratio</b>	<b><u>0.5</u></b>
<b>3) Water content</b>	<b><u>186 kg(for 50mm slump)</u></b>
<b>4) Calculation of cement content</b>	<b><u>&gt;300kg/m<sup>3</sup></u></b>

**III.REVIEW OF PROPERTIES**

**Compressive strength**

**Scope:** The capacity of a material or structure to carry stresses on its surface without cracking or deflection is referred to as compressive strength. When a material is compressed, its size decreases, and when it is tensioned, its size increases. Many factors influence this, including the water-cement ratio, cement strength, concrete material quality, quality control during the manufacturing process, and so on.

**Specimen details:**

Specimen Type	Dimension(mm)
Natural aggregate concrete cube	150x150x150
Recycled aggregate concrete cube	150x150x150

**Apparatus:** Compression testing machine, Cube of size 150x150x150mm, Scale.

**Test procedure:**

- Remove the cube from the water on the 14th and 28th days and clean with a dry towel. Take measurements of the surface where the weight will be applied. Let's call them 'L' and 'B', respectively.
- Place the cube in the compressive testing machine and apply a consistent force of 14N/mm<sup>2</sup> per minute.
- Keep track of the load at which the cube fails. Let's go with 'P'.
- Using the P/A formula, determine the compressive strength of the cube. Where A is the loaded surface area (i.e. LB).
- Repeat the process with the remaining cubes.

**Split Tensile strength**

**Scope:**In general, splitting tensile strength is stronger than direct tensile strength and lower than flexural strength (modulus of rupture). In the design of structural light weight concrete elements, splitting tensile strength is utilised to evaluate the shear resistance supplied by concrete and to calculate the development length of the reinforcement.

**5.3.2 Specimen details:**

Specimen Type	Dimension(mm)
Natural concrete aggregate cylinder	150(dia) & 300(ht)
Recycled concrete aggregate cylinder	150(dia) & 300(ht)

**Apparatus:** Cylindrical mould conforming to IS: 10086-1982 for splitting tensile strength, tamping rod, metallic sheet, universal testing machine.





**Test procedure:**

- a) Material Sampling: Aggregate samples for each batch of concrete must be of the appropriate grade and must be air-dried. When the cement samples arrive at the laboratory, they must be properly mixed dry, either by hand or in a suitable mixer, to guarantee the best possible blending and consistency in the material.
- b) Proportioning: The proportions of the components, including water, in concrete mixes used to determine the appropriateness of the available materials must be identical in all respects to those used in the job.
- c) Weighing: The amounts of cement, aggregate size, and water for each batch must be calculated by weight, with an accuracy of 0.1 percent of the total The batch's total weight.
- d) Concrete mixing: The concrete must be mixed by hand, or better in a laboratory batch mixer, in order to minimise water or other material loss. Each batch of concrete must be large enough to allow around 10% surplus after shaping the required number of test specimens.
- e) Mould: The cylindrical mould must be 150 mm in diameter and 300 mm in height, in accordance with IS: 10086-1982.
- f) Compacting: The test specimens must be created as soon as possible after mixing and in such a way that the concrete is fully compacted with no segregation or undue laitance.
- g) Curing: The test specimens must be stored in a clean, dry environment vibration, in moist air with at least 90% relative humidity, and at a temperature of 27° 2° C for 24 hours 12 hours from the time the water was added to the dry components.
- h) Inserting the specimen into the testing machine: Wipe clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other debris from the surfaces of the specimen that will come into contact with the rollers.
- i) For each specimen, two bearing strips of nominal (1/8 in i.e. 3.175mm) thick plywood, free of defects, roughly (25mm) broad, and equal to or slightly longer in length than the specimen should be given.
- j) The bearing strips are inserted between the specimen and the base Both the top and lower bearing blocks of the testing equipment, as well as the specimen and the supplemental bars or plates, must be used.
- k) Using an appropriate instrument, draw diametric lines on either end of the specimen to confirm that they are in the same axial plane. Canter a plywood strip down the centre of the bottom bearing block.
- l) Align the specimen on the plywood strip such that the lines drawn on the ends of the specimen are vertical and in the centre of the plywood strip.
- m) Centre a second plywood strip lengthwise on the cylinder, on the lines marked on the ends. Apply the load constantly and without interruption, at a consistent rate within the 689 range to 1380 kPa/min splitting tensile stress until failure of the specimen.
- n) At failure, record the maximum applied load given by the testing equipment. Take note of the sort of failure and appearance of fracture.

**Split Tensile strength =  $2P/\pi dl$**

Where,

- P = Load at failure in N
- d = Diameter of cylinder mould in mm
- l = Length of the cylindrical mould in mm

**IV.RESULTS AND DISCUSSION**

1. SPECIMEN : Cubical concrete specimens.

DIMENSIONS : 150\*150\*150mm

TYPE OF TEST : Compressive strength

TEST RESULTS :

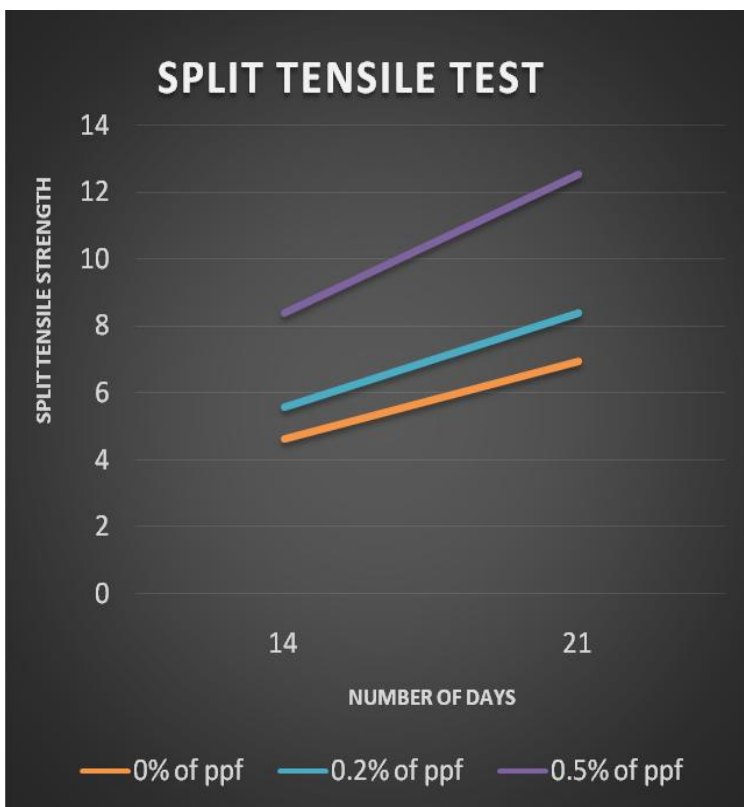
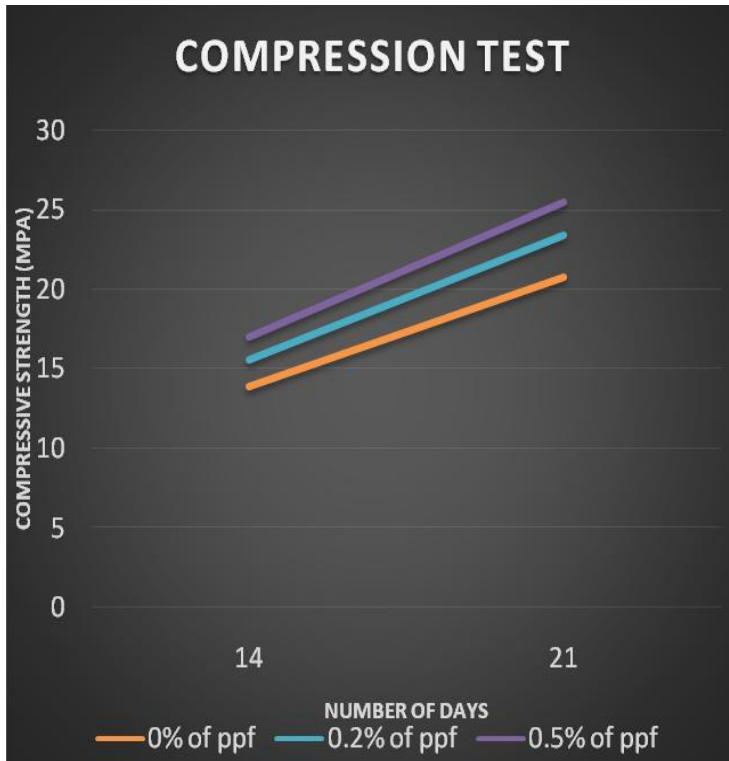
Specimen	Aggregates used	Percentage of fiber used	Load(KN)	Compressive strength(Mpa)
				14 DAYS 21 DAYS
Recycled aggregates with 0% PPF	12.5 And 10mm	0%	447	13.8620.79
Recycled aggregates with PPF	12.5mm and 10mm	0.2%	548.6	15.56 23.36
	12.5mm and 10mm	0.5%	17.01	17.01 25.51



2. SPECIMEN : Cylindrical concrete specimen  
DIMENSIONS : 300mm height and 150mm diameter  
TYPE OF TEST : Split tensile strength  
TEST RESULTS :

Specimen	Aggregates used	Percentage of fiber used	Load(KN)	Split tensile strength (Mpa)
				14 DAYS 21 DAYS
Recycled aggregates with 0% PPF	12.5 And 10mm	0%	447	4.63 6.94
Recycled aggregates with PPF	12.5mm and 10mm	0.2%	548.6	5.58 8.37
	12.5mm and 10mm	0.5%	17.01	8.36 12.54

GRAPHICAL REPRESENTATION





## V. CONCLUSION

The use of polypropylene fibers has increased in recent years due to the property of the fibers to eliminate some defects in concrete. The addition of PP fibers to concrete improves its mechanical properties.

- From above results it is concluded that inclusion of polypropylene fibers to concrete mix increases the compressive strength by 10.92% and 11% at 14 and 21 days respectively.
- Split tensile strength is found to increase by 33.2% and 49.8% at 14 and 21 days respectively.
- The optimum percentage of polypropylene fibers is observed to be 0.5% for all the properties.
- It is observed that fibers have helped in arresting as well as stop propagating surface cracks.

## VI. FUTURE SCOPE

Fiber reinforced concrete (FRC) has been increasingly used in construction due to its superior properties compared to conventional concrete, such as increased durability, toughness, and crack resistance. The future scope of FRC is promising and includes the following potential developments:

1. Sustainable Construction: FRC can be used in sustainable construction practices as it can reduce the amount of steel required in construction, leading to a reduction in greenhouse gas emissions.
2. Infrastructure Rehabilitation: FRC can be used in infrastructure rehabilitation projects as it can extend the service life of existing structures by increasing their durability and strength.
3. Advanced Manufacturing: FRC can be produced using advanced manufacturing techniques such as 3D printing, leading to the creation of complex shapes and geometries.
4. New Materials: FRC can be combined with new materials such as carbon nanotubes or graphene to create materials with even greater strength and durability.
5. Construction Automation: FRC can be used in construction automation processes such as robotic assembly and prefabrication to reduce labor costs and improve efficiency.

Overall, the future scope of FRC is broad, and ongoing research and development efforts are likely to yield even more applications and benefits.

## REFERENCES

1. Ibrahim an Abbas, **“Mechanical Behavior of Recycled Self-Compacting Concrete Reinforced with Polypropylene Fibres”**, Journal of Architectural Engineering Technology, 2017 Vol 6(2): 207
2. Al- Tulian, **“Recycled Plastic Fibers for Minimizing Plastic Shrinkage Cracking of Cement Based Mortar.”**, The Science Direct , Volume 6 Issue 10 Pages PP 16-25,2017.
3. Marcin Małek Mateusz Jackowski Waldemar Łasica Marta Kadela **“Characteristics of Recycled Polypropylene Fibers as an Addition to Concrete Fabrication Based on Portland Cement”**, 2020 Vol(14).
4. Jahidul Islam & Shahjalal, **“Effect of polypropylene plastic on concrete properties as a partial replacement of stone and brick aggregate”**, December 2021, e00627 Volume 15
5. Wassila MOUATS , Assia ABDELOUAHED , Houria HEBHOUB , Wassila BOUGHAMSA **“The effect of plastic waste fibers on mortar performance”**,2021.
6. Julia Blazya , Rafał Blazya, **“Polypropylene fiber reinforced concrete and its application increasing architectural forms of public spaces”**, The Science Direct ,Vol 14, June 2021, e00549.
7. N. Sohaib, Seemab, Sana G R. Mamoon, **“Using Polypropylene Fibers in Concrete to achieve maximum strength”**, Institute of Research Engineers and Doctors, 2018.
8. Mujeeb Latifi , Ozgur Biricik , Ali Mardani , **“Effect of the addition of polypropylene fiber on concrete properties”**, Research Gate 2022.
9. G.M. Sadiqul Islam, Sristi Das Gupta, **“Evaluating plastic shrinkage and permeability of polypropylene fiber reinforced concrete”**, the science direct, Volume 5, Issue 2, December 2017, Pages 345-354.
10. Sivakumar Anandan , Majed Alsubih, **Mechanical Strength Characterization of Plastic Fiber Reinforced Cement Concrete Composites**, Research Gate, January 2021.
11. Ali Mardani, Metin İlhan, **The effect of shrinkage reducing admixture and polypropylene fibers on drying shrinkage behaviour of concrete**, Research Gate, 2019.



12. Paul Awoyera, Olalusi, Physical, strength, and microscale properties of plastic fiber-reinforced concrete containing fine ceramics particles, Research Gate, 2021
13. Danar, Mechanical Properties and Load Deflection Relationship of Polypropylene Fiber Reinforced Self-Compacting Lightweight Concrete, 2020



**INNO SPACE**  
SJIF Scientific Journal Impact Factor  
**Impact Factor: 8.423**



**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

**9940 572 462** **6381 907 438** **ijirset@gmail.com**



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details