Experimental Study on Strength Properties of Polypropylene Fiber Reinforced Concrete

R Ajeethkumar[1], A Vishvasenan[2], G Chandru[3]
[1,2,3] UG Students
Department of Civil Engineering,
Ramco Institute of Technology, Rajapalayam,
Virudhunagar

J Ram Prashath[4]
[4] Project Guide,
Department of Civil Engineering,
Ramco Institute of Technology, Rajapalayam,
Virudhunagar

***Abstract*:- This paper focuses on experimental study in the behaviour of polypropylene fibre reinforced concrete. The polypropylene fibres were mixed into the concrete in the form of reinforcement into the concrete with uniform orientation of the fibres. The tests on the concrete were conducted before and after by adding polypropylene fibres into the concrete in different contents, i.e.; 1.6%, 1.7%, 1.8% of the cement mass. It was observed that the composite with 1.6% of polypropylene fibre demonstrated the highest compressive, flexural and split tensile strengths when compared to the other contents of fibres. The optimum result acquired Fibre reinforced concrete is fixed to accomplish additional flexure strength in the concrete beam.**

Keywords*: *Polypropylene fibre, Tensile Strength, Flexural behaviour, Fibre reinforced Concrete.

1. INTRODUCTION

Recent studies are being made in the field of Fibre reinforced concrete in order to improve the property of concrete. In general various types of fibres like steel fibres, carbon fibres, and glass fibres are being used. Natural fibres such as coconut, flax, hemp, jute and linen are used as reinforcement in the concrete. Synthetic fabrics include polypropylene, polyester, acrylic, nylon, rayon, acetate, spandex, lastex, orlon and Kevlar. Generally Synthetic fibres are more durable than most natural fibres and will readily pick-up different dyes. In addition, many synthetic fibres offer consumer-friendly functions such as stretching, waterproofing and stain resistance. Sunlight, moisture, and oils from human skin cause all fibres to break down and wear away. Compared to other types of fibres such as steel, natural or glass fibres these synthetic fibres i.e., fibre are cheap, they do not shrink, they last longer than natural fibres, they dry quickly, they need little or no ironing, they are resistant to chemicals. Synthetic fibres are more durable than natural fibres. Synthetic fibres are less expensive and readily available. Fibre content can be part of total weight/mass of composite or the percentage of any ingredient of the concrete. Synthetic fibres benefit the concrete in both plastic and hardened state. Some of the benefits include;

- Reduced plastic settlement cracks.
- Reduced plastic shrinkage cracks.
- Lowered permeability.
- Increased impact and abrasion resistance.
- Reduced plastic Shattering problems.

2. MATERIALS USED CEMENT

Cement used in this investigation was 53 Grade Ordinary Portland cement confirming to IS: 12269 [18]. The specific gravity of cement was 3.2. Initial and final setting time for the was 35 minutes and 560 minutes.

COURSE AND FINE AGGREGATE

Aggregates are inert mineral material used as filler in concrete which occupies 70% to 85 % volume. Sand passing through 4.75mm IS sieve conforming to grading zone III of IS 383:1970 was used. Its specific gravity is 2.74. Locally available stone aggregate of size 20 mm passing and retained in 19 mm, was used and the specific gravity and fineness modulus for the same are 2.74 and 2.47as per IS: 2386- 1968 Part
III. Both the Aggregates compiled with the requirements of IS: 383-1970.

Coarse and fine aggregates

POLYPROPYLENE FIBRE

Used as secondary reinforcement, polypropylene fibres help reduce shrinkage and control cracking. To use these fibres, concrete mix design does not have to be altered, and no special equipment or slump modifications are required, even for pumping. Only two things must be

determined: how much fibre to add and what length of fibre to use. Polypropylene fibres are manufactured in small bundles. During the mixing operation, the movement of aggregate shears these bundles into smaller bundles and individual fibres. If the jobsite is more than a 30- minute drive, the fibres should be added at the site.

Polypropylene fibre

FIBRE LENGTH

In fibre-reinforced concrete, cracks can open only if the tensile stresses in the concrete exceed the tensile strength or the pull-out strength of the fibres. The longer the fibres are, the stronger the bond between fibres and paste is and thus the greater the fibre pull-out strength is. If fibres are too long, uniform distribution of the fibres becomes difficult. Longer fibres can be used when larger aggregates are present to shear the bundles of fibre apart. Short fibres are used with small or lightweight aggregate.

Polypropylene fibres tend to hold the concrete mix together.In hardened concrete, polypropylene fibres act as crack arresters. Like any secondary reinforcement, the fibres tend to stop cracks from propagating by holding the concrete together so cracks cannot spread wider or grow longer. However, since polypropylene fibres are distributed throughout the concrete, they are effective close to where cracks start at the aggregate-paste interface. The length of pp fibre has *12*mm, density as *0.91*g/cm^3 ,Tensile strength as *360*MPa and *6*denier thick fibre.

3. TESTS CONDUCTED

A. *COMPRESSIVE STRENGTH*

The cube specimens were tested in the compression testing machine with the capacity of 200 tonnes. The upper / bearing surface of the machine is cleaned and kept free from the other loose particles and the; load is applied constantly at increased rate until the specimen got broken. The 7 & 28 days strength of cubes with various proportions of polypropylene fibre is compared below for M25 grade concrete.

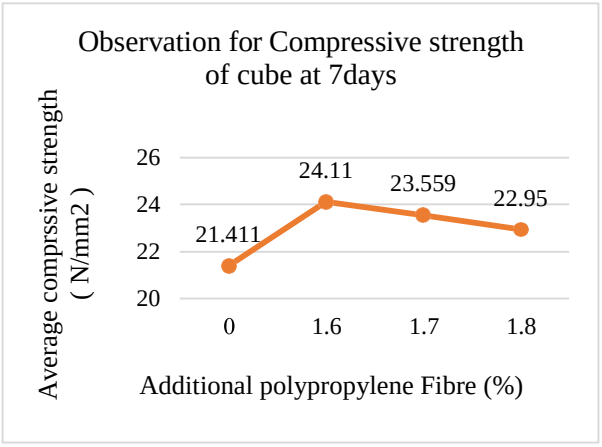
Calculations:

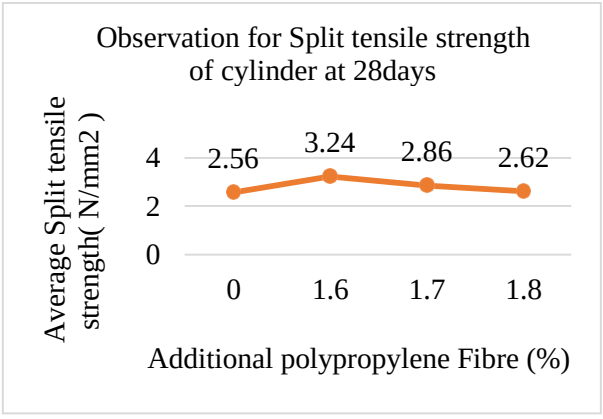
Compressive strength = Maximum load/ Area

= P/A

Compressive testing on cube

Split tensile Strength (N/mm^2)	
	28days
Conventional	2.56
1.6% of polypropylene fibre	3.24
1.7% of polypropylene fibre	2.86
1.8% of polypropylene fibre	2.62





B. SPLIT TENSILE STRENGTH TEST

Split tensile strength was evaluated as per the test procedure given in Indian Standards IS.5816. In order to evaluate the splitting tensile strength of polypropylene fibre reinforced concrete, all the cylinder specimens were subjected to split tensile strength test in a 2000 kN digital compression testing machine. Specimens of 150 mm diameter, 300 mm height were placed in the machine in a horizontal manner in between the two parallel steel strips one at top and another at the bottom such that the load shall be applied along 300 mm length. The load was applied without shock and increased continuously at a nominal rate within the range of 1.2 N/mm^2/min to 2.4N/mm^2/min until the specimen failed. The maximum load applied to the specimen was recorded and the split tensile strength of the specimen was calculated at 28 days for M25 grade concrete.

Calculations:

The split tensile strength of the specimen calculated from the following formula

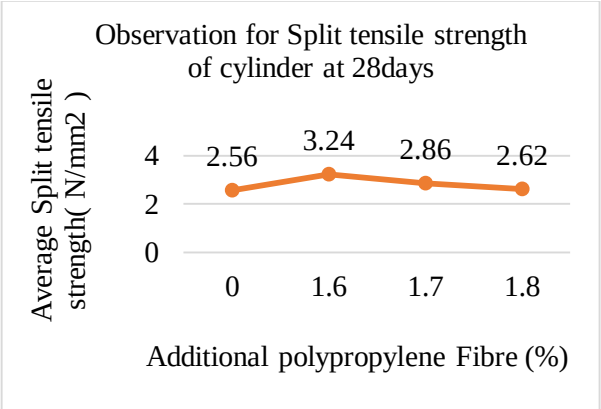
$$T_{sp} = (2P/ (\pi dL))$$

Where

P = maximum load in tonne
L = length of the specimen
D = dia of the specimen

Split tensile testing on cylinder

Split tensile Strength (N/mm^2)	
	28days
Conventional	2.56
1.6% of polypropylene fibre	3.24
1.7% of polypropylene fibre	2.86
1.8% of polypropylene fibre	2.62



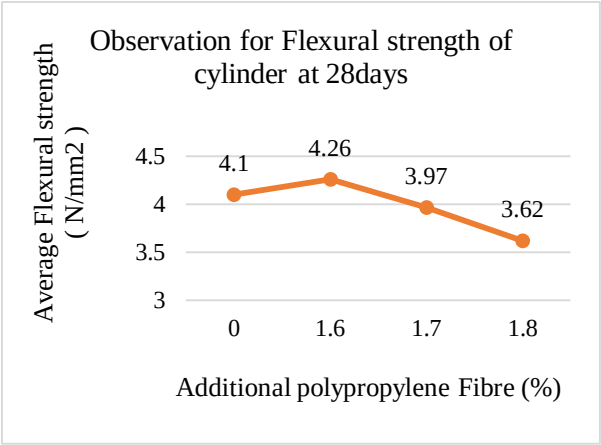
C. FLEXURAL STRENGTH TEST

The beam specimens were tested in the universal resting machine to obtain the flexural strength of the beam casted with the polypropylene fibre reinforcement. The 28 days flexural strength of beams at M25 grade concrete with various proportions of polypropylene fibres, the flexural strength of the specimen was calculated using the bending equation.

$$\frac{M}{I} = \frac{f}{y} = \frac{E}{R}$$

Flexural test in UTM

Flexural Strength (N/mm^2)	
	28days
Conventional	4.10
1.6% of polypropylene fibre	4.26
1.7% of polypropylene fibre	3.97
1.8% of polypropylene fibre	3.73



4. CONCLUSION

Based on the experimental investigation, the following conclusions have been drawn;

Optimum result of high compressive strength, split tensile strength and flexural strength has been achieved in 1.6% of polypropylene fibre in the concrete and thus that fibre has ability to reduce the cracks, shrinkage in the concrete.

5. FUTURE WORK

- Effect of coated PP fibre of higher diameter and higher length.
- Will investigate the mechanical and structural properties of PP fibre reinforced self-compacting concrete.
- Incorporating higher amounts of supplementary cementitious materials such as fly ash and slag.
- Incorporating the nano particles with PP-FRC such as nano calcium carbonate and nano silica and study the mechanical properties and fracture.
- To be study the creep performance of PP-FRC.
- An investigation on fire exposed properties of PP-FRC including the effect of PP fibres on mitigating explosive spalling.

6. AREAS OF APPLICATION

- Pavements,
- Drive ways,
- Overlay patch repair,
- Thin concrete,
- Plastering,
- Renders

7. REFERENCE

- **"Strength Properties Of Polypropylene Fiber Reinforced Concrete",** Kolli.Ramujee Associate Professor, Department of Civil Engineering, VNR Vignana Jyothi Institute of Engineering & Technology, Hyderabad ,Andhra Pradesh ,India

- **"Behaviour Of Polypropylene Fibre Reinforced Fly Ash Concrete Deep Beams In Flexure And Shear"** M.V. Krishna Raoa, N.R. Dakhshina Murthyb and V. Santhosh Kumara Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, India. Department of Civil Engineering, Kakatiya Institute of Technology and Science, Warangal-506015, India.

- **"Effect Of Polypropylene Fiber Content On Flexural Strength Of Lightweight Foamed Concrete At Ambient And Elevated Temperatures",** Md Azree Othuman Mydin and Sara Soleimanzadeh School of Housing, Building and Planning, University Sains Malaysia, 11800, Penang, Malaysia.

- **"Evaluation of Shear Strain Distribution In Polypropylene Fiber Reinforced Cement Concrete Moderate Deep Beams",** Vinu R.Patel, Pandya.I.I - Assistant Professor in Applied Mechanics Department, Faculty of Tech. & Engg. ,M.S.Uni.,Vadodara Associate Professor in Applied Mechanics Department, Faculty of Tech. & Engg.,M.S.Uni.,Vadodara.

- **"Evaluation Of Composite Polypropylene Fibre Reinforced Concrete",** V.M. Sounthararajan1, Anshul Jain, Abhishek Kumar Singh, S. Thirumurugan and Dr. A. Sivakumar.

- **"Fracture Properties of Polypropylene Fiber Reinforced Concrete Containing Fly Ash and Silica Fume",**Peng Zhang and Qingfu Li School of Water Conservancy and Environment Engineering, Zhengzhou University ,Zhengzhou 450001, China.

- **"Effect Of Polypropylene Fiber Content On Flexural Strength Of Lightweight Foamed Concrete At Ambient And Elevated Temperatures",** Md Azree Othuman Mydin and Sara Soleimanzadeh School of Housing, Building and Planning, University Sains Malaysia, 11800, Penang, Malaysia.