

Flexural Behavior of RC Beams Using Polypropylene Fiber

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Abstract—In the use of fibers reinforcement of composites has increased in the last several years. The experimental investigation conducted on the use of polypropylene fibre of length 12mm having an aspect ratio of around 500. It was employed in equal percentages of 0.5 percentages by weight of cast concrete and tests like compressive strength, flexural strength and split tensile strength. Conventional concrete has very low tensile strength and low resistance to cracking. Internal cracks were inherently present in concrete and its poor tensile strength is due to the propagation of such micro cracks. Fibres added to a certain percentage of the concrete improve the strain value as well as crack resistance and flexure strength of the concrete.

Index Terms—Polypropylene Fiber, Compressive strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Polypropylene fibre has been improved further used as short discontinuous fibrillated material for production of fibre reinforced concrete or a continuous mat for production of thin sheet components. The application of the fibres in construction increased largely because addition of fibres in concrete improves the split tensile strength, flexural strength, toughness, impact strength and the failure mode of concrete. Polypropylene fibre is a fibre and it can be divided into small particles then formed into continuous fibres. Polypropylene fibres were first suggested for use in 1956 as an admixture in concrete for construction of basalt resistant buildings meant for the US Corps of engineers. Polypropylene fibre has a good resistance to chemical attack, impact load and fire. Some useful applications of these polypropylene composites are: bridges and highways, soil strengthening, industrial floors, industrial buildings, bullet proof vests and retrofitting and rehabilitation of structures. Polypropylene fibre has fine-grained, extrusive composed of with or without and containing not more than 53 Weight percentages of SiO₂ and less than 5 weight percentages of total alkalis. The many types of polypropylene fibre are monofilament polypropylene fibre, fibrillated polypropylene fibre and microfilament polypropylene fibre. In the production of polypropylene fibres gives more significant than any other synthetic fibres. Addition of polypropylene fibres decreases the unit weight of concrete and increase its strength. Polypropylene fibres were formerly known as stealth. This is macro reinforcement fibre and are 100% virgin homopolymer polypropylene graded monofilament fibres. They contain no reprocessed Olifin materials. The raw material of polypropylene is derived from monomeric C₃H₆ which a hydrocarbon is purely.

Study of literature

- The heating duration of 4.5 hours, the residual ultimate strength is larger than the corresponding strength of beams without polypropylene fibres by more than 60 %.
- Wear resistance of PFRC has not been widely studied, but one study was found an increase in the wear resistance with increasing fibre contents.
- Compressive strength enhancement ranges from 8% to 16% for PFRC. Strength enhancement in splitting tensile strength due to polypropylene fibre addition varies from 5% to 23%. The maximum increase in flexural strength of PFRC is 36%.
- The presence of fibres in concrete alters the failure mode of the material. It is found that the failure mode of plain concrete is mainly due to spalling, while the failure mode of fibre concrete is bulging in a transverse direction.
- The use of polypropylene fibre will enhance strength and behaviour of reinforced concrete also improves resistance against impact loading and fire. Polypropylene fibres have a positive impact test.

II. METHODOLOGY

The concrete mix was made as dry with OPC and fine aggregate (River Sand). The materials were properly mixed in dry condition and polypropylene fiber were taken to the weight of concrete as 0.5%. The water cement ratio of 0.4 was used to prepare the concrete mix. Totally 3 number of specimens were casted and cured for 28 days. After the curing period the specimens were subjected to testing using loading frame setup.

III. MATERIALS

1. Cement

An OPC 33 grade sample was tested to obtain the Specific Gravity 3.1. The Standard consistency is 32%.

2. Coarse Aggregate

In the present investigation, locally available crushed stone aggregate of size 20 mm was used and the various tests, carried out on the aggregates in the test value on Specific gravity 2.76, Water absorption 1.23% and Fineness modulus 2.265.

3. Fine Aggregate

In the present investigation, the river sand, which was available at Hosur, was used as fine aggregate and the test value on Specific gravity 2.631, Water absorption 1.84% and Fineness modulus 3.662.

4. Properties of polypropylene Fibre

- Length of fiber – 12mm
- Elongation – 1.1
- Tensile strength - 1500 Mpa
- Specific gravity – 0.91
- Resistance to alkali - Excellent
- Water absorption - 3 %
- UV resistance – High

IV. EXPERIMENTAL PROGRAM

It is well known that fibres usually have effect on compressive strength, which slightly increases the test results. In the cube results it was found that compressive strength of the cubes on increasing with the 0.5 percentage of polypropylene fiber will be added up.

Compression Test

The compression test was conducted on cube specimens properly cured for 28 days. The top and bottom bearing plates of the compression testing machine were wiped and cleaned before the placement of the cube specimen. Cube moulds of size 150 x 150 x 150 mm were casted and allowed for curing tank for 28 days. These cubes were tested on compression testing machine as per I.S.516-1959. The compressive strength was calculated as follows: Compressive strength (MPa) = Failure load / cross sectional area.

Table:1 Compression Test 0.5% polypropylene fibre added mix

Type of concrete	Specimen	Initial load(KN)	crack	Compressive strength(N/mm ²)	Average compression strength(N/mm ²)
Conventional concrete	1	850		37.77	38.81
	2	880		39.11	
	3	890		39.55	
0.5% Polypropylene fiber	1	920		40.88	41.77
	2	940		41.77	
	3	960		42.66	

Split Tensile Strength Test

For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were de-molded after 24 hours of casting and were transferred to curing on curing tank to cure for 7, 14 and 28 days. These specimens were tested under compression testing machine. In the three cylinders were tested and their average value is reported. Tensile strength was calculated as follows as split tensile strength:

Tensile strength (MPa) = $2P / \pi DL$, Where, P = failure load, D = diameter of cylinder, L = length of cylinder

Table:2 Split Tensile Strength

Age of concrete	Split tensile strength(MPa)
7 days	1.05
14 days	1.28
28days	1.49

Flexural Strength Test

The flexural strength of concrete beam was determined based on IS: 516 –1959. Beam specimens size of 1200 mm x 120 mm x 150 mm were casted and curing. The samples de-moulded after 24 h from casting and taking to water tank for 28 days curing. The

specimens were placed in loading frame and tested for flexural strength. The strain behaviour of the specimens containing polypropylene fibre up to 0.5% behavior in a similar trend to conventional specimen. In these cases which contain 0.5% polypropylene fibre behaves like a brittle material of which the total energy is generated is elastic energy. There is significant change in strain of the concrete due to addition of fibres. Descending portion of the curve becomes more and more flatten as the fibre volume fraction increases. The relationship with different volume fraction of nylon fibre is shown in Fig. 8. Two different behavior patterns are obtained as shown in stress strain curve. However, non-linear behavior is seen for the other specimens which contains more than 0.5% of polypropylene strands fibre. Here, once the peak stress is reached the specimen continues to yield.

V. RESULT

LOAD VS DEFLECTION CHARACTERISTICS

The behavior of load and deflection is the principle constituent of the flexural behaviour of the beam, as the load increases the deflection also increases up to a particular limit. The load will partially increase to compare conventional beam with 0.5% polypropylene fiber mix specimen.

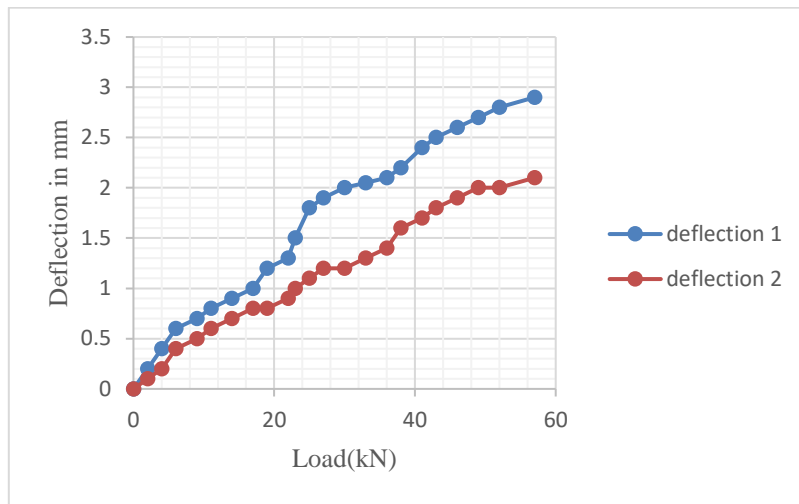


Figure 1: Load vs Deflection Curve for Conventional Beam

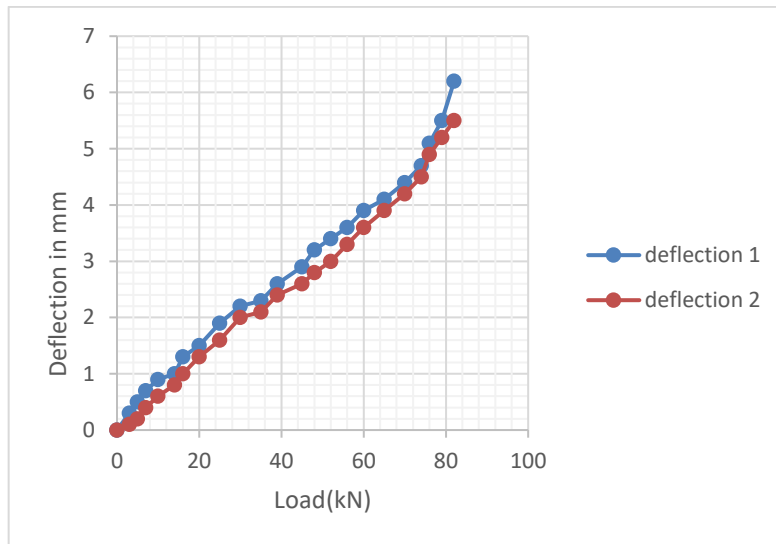


Figure 2: Load Vs Deflection Curve For 0.5% Polypropylene Fibre Mix Specimen Beam

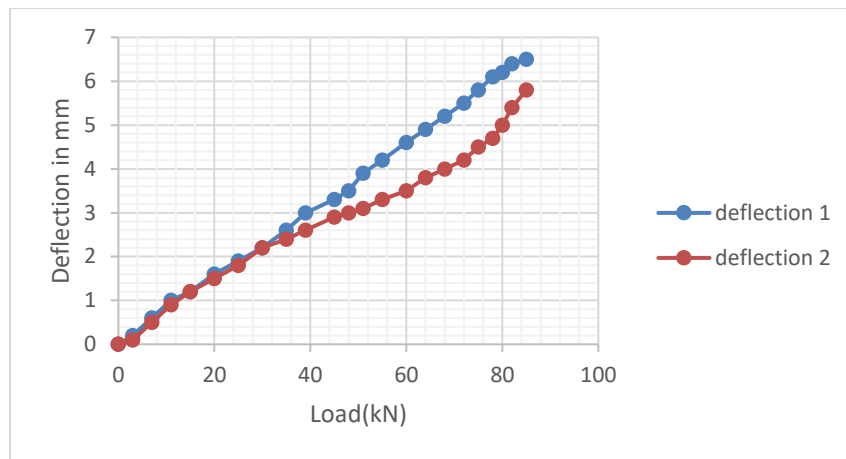


Figure 3: Load vs Deflection 0.5% Polypropylene Fibre Mix Specimen Beam

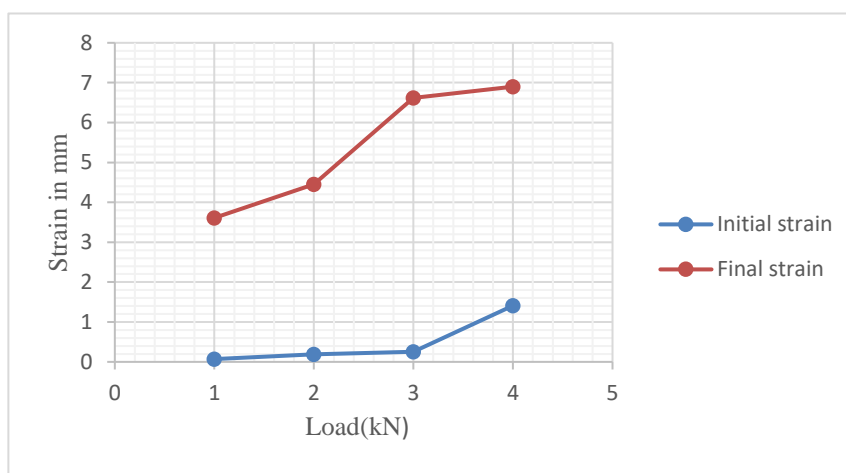


Figure 4: Strain Behaviour 0.5% Polypropylene Fibre Mix Specimen Beam

VI. CONCLUSION

The investigation of this papers from some mechanical behavior of concrete with polypropylene fibres. The experiments were done on compressive, tensile and Flexural behavior of polypropylene fiber reinforced concrete. Hence the conclusions summarized as: From the result, given below

- Polypropylene fibre reinforced concrete gives a more strength to compare the normal concrete. The following quantity of fibre 0.5% was added in concrete and their strength was compared with normal mix concrete specimens and hence found that the concrete with polypropylene added is stronger than normal mix concrete specimens.
- The compressive strength was increased when adding the polypropylene fiber.
- The addition of polypropylene fibres to concrete will increasing the tensile strength compared to plain concrete.
- The addition of fibres to increase the flexural strength of concrete. The fibre reinforced concrete has controlled the cracks and resist the beam.
- In the modern world concrete is the fundamental material in the construction field. To improving the mechanical properties of concrete by adding this fibers to composite material to increase strength and durable on future

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