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Effect of volume fraction of Polypropylene Fiber on Mechanical Properties of Concrete

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Abstract
In this study, the result of polypropylene fiber on mechanical properties of concrete is studied. Polypropylene fibers of 12mm cut length and 6 denier were added at volume fraction of 0%, 0.25%, 0.50%, 0.75% & 1 %.The cube, cylinder and beams wear tested under two point loads on UTM. The results showed that the addition of polypropylene fiber significantly improved the compressive strength, split tensile strength, flexural strength, reserve strength and ductility of fiber reinforced concrete.
Keyword: compressive strength, split tensile strength, flexural strength, reserve strength and ductility

I. Introduction

An attempt has been made through this work to understand the flexural strength response of beams under fibrous matrix. A very little work has been reported on flexural deformational behavior of fibrous Reinforced Cement Concrete beams.

Concrete has disadvantage that it fails in brittle manner. The fibers can make failure mode more ductile by increasing the tensile strength of concrete. As a result a structural performance can be improved. The addition of polypropylene fibers to a concrete beam is known to increase its flexural strength, reserve strength and ductility. Many researchers like Vinu R. Patel, Ankur Rana and I. I. Pandya have confirmed addition of polypropylene fiber show enhanced shear strength and energy distribution capacity. There are only few studies reporting results on the behavior of beams reinforced with a new type of polypropylene fibrillated mesh fibers. This fiber has a higher modulus of elasticity and an optimized geometry to enhance the bond between the fiber and the concrete matrix, which leads to an increase in the toughness properties of concrete. If sufficient fibers are added, a brittle failure can be suppressed in favor of more ductile behavior. The increased strength and ductility of fiber-reinforced beams.

II. RESERCH SIGNIFICANCE

This paper will provide data about use of polypropylene fibers in the concrete, where it increase the compressive strength, split tensile strength, flexural strength, reserve strength and ductility.

III. EXPERIMENTAL PROGRAMME

Test Materials

Ordinary Portland Cement (OPC) of 43 grade, natural river sand of fineness modulus 4.175 and 20 mm coarse aggregate were used. The concrete mix was in proportion of 1: 1.272: 2.766 by weight and water cement ratio of 0.43 kept constant for all beam. Polypropylene fibers of 12 mm cut length and 6 denier wear used. The workability of polypropylene fiber reinforced concrete mixtures was maintained by adjusting the dosage of super plasticizer admixture to offset the possible reduction in slump. For each beams, three cubes (150mmX150mmX150mm) and three cylinders (150mm diameter, 300mm high) as control specimen were cast. Cubes were tested for crushing strength at 28 days and cylinder were tested for splitting tensile strength at 28 days.

Specimen Details

Tests were carried out on fifteen beams, simply supported on constant effective span of 600mm, depth of 150mm and width of 150mm under two point concentrated symmetrical loading.
Polypropylene fibers wear added at volume fraction of 0%, 0.25%, 0.50%, 0.75% & 1

Testing Procedure

The beams were tested under two point concentrated loading at their mid span in a universal testing machine. A dial gauge was fixed at bottom of beam to measure mid span deflection at interval of 0.5mm and corresponding load were noted. The loading at which first crack and ultimate crack appeared was noted. The pattern and propagation of cracks was noted, up to failure of beam.

IV.RESULTS AND DISCUSSIONS

Table 1 Compressive strength and split tensile strength

Fiber volume fraction (%)	Average compressive strength (N/mm^2)	Average split tensile strength (N/mm^2)
0	33.55	2.78
0.25	34.44	2.97
0.50	34.81	3.06
0.75	35.18	3.19
1	36.00	3.30

Table 2 Flexural strength of beam

% Fiber volume fraction (Vf)	Average flexural strength (N/mm^2)	Average shear stress (N/mm^2)
0	15.13	2.83
0.25	15.87	2.97
0.50	17.23	3.21
0.75	17.56	3.33
1	17.85	3.35

Table 3 Reserve strength of beam

% Fiber Volume Fraction(Vf)	First Crack Load Wc, (kN)	Ultimate Crack Load Wu, (kN)	Reserve Strength (Wu-Wc/Wc) X100, %
0	50.240	85.120	69.42
0.25	51.973	89.300	71.81
0.50	55.940	96.290	72.13
0.75	57.682	99.850	72.48
1	58.180	100.447	72.64

Table 4 Ductility of beam

% Fiber Volume Fraction (Vf)	Deflection at First Crack Load Dc, (kN)	Deflection at Ultimate Crack Load Du, (kN)	Ductility M = (Du/Dc)
0	2.20	4.20	1.90
0.25	2.00	4.50	2.25
0.50	2.15	4.63	2.15
0.75	1.92	4.60	2.39
1	1.76	4.50	2.55

V. DISCUSSION OF CRACK PATTERNS AND MODE OF FAILURE

Flexure cracks developed at the region of maximum moment. in all the beam flexural cracks were observed in the lower half depth of the beam. Flexural cracks were few and were very fine and hardly reached up to the mid-height of the beam. All the flexural cracks were almost vertical. These cracks were found to have little effect either on the mode of failure or on the ultimate load. There were two types of diagonal tension cracks observed in test specimens. The first type of diagonal tension cracks originated from the inner edge of the support to the outer edge of the loading plate. These cracks were either the immediate cause of failure of the beam or else they brought the beam to its eventual collapse. The other type of diagonal cracks opened at a distance of D/2 to D/4 from the soffit. With load increment, the rate of progress of these cracks was as gradual as the diagonal cracks which originated in the vicinity of inner edge of the support. The beams were collapsed by flexure with a flexural crack near to mid-span.

VI.CONCLUSIONS

Following conclusion are drawn on the result discussed in the previous chapter,

1) The increase in average compressive strength for PPFC is found 6.80 %. Compared to PCC. The maximum compressive strength is achieved with 1% fiber volume fraction.

2) The increase in split tensile strength is found 15.75 %. The maximum split tensile strength achieved with polypropylene fibers having volume fraction 1 %.

3) The increase in flexural strength and shear stress is found 15.23 % and 15.52 % respectively by inclusion of 1% polypropylene fiber.

4) The increase in reserve strength and ductility is found 4.43 % and 25.49% respectively by inclusion of 1% polypropylene fiber.

VII. FUTURE SCOPE

1. The present study can be verified for different grades of concrete.
2. Workability, strength in compression and tension can be verified by varying the aspect ratio of fiber.
3. Comparison study can be made by using various substitutes to cement such as fly ash, micro silica, rise husk ash etc.
4. This study can be extended by using combination of different types of fibers to understand the behavior of hybrid fiber reinforced concrete.

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