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Study on Structural Behaviour of Synthetic Polymer Fiber in Concrete

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Abstract: Many studies are going on finding the optimum performance of reinforced concrete by adding fibers in it. Synthetic polymer fibers are used in this study. Synthetic polymer fibers are made from polymer based materials such as polypropylene, nylon or polyethylene. In different proportions these synthetic fibers are mixed with concrete, the compressive and flexural strength of reinforced concrete are tested and optimum mixing level of synthetic polymer fiber is analysed for better strength.

Key words: Synthetic polymer fiber, concrete reinforcing, structural behaviour, compressive strength, flexural strength, polymer

INTRODUCTION

The unreinforced concretes are easy brittle materials, because of their low tensile strength and strain capacity. The process of reinforcing the concrete using fibers increases its strength. So, fiber reinforced concrete is a composite material made up off portland cement, aggregate and incorporating discrete discontinuous fibers (Johnston, 2010).

There are many fibers like steel, glass, natural organic, mineral, polypropylene and synthetic fibers are used in partial replacement of cement in reinforced concrete (Rajaraman, 2018). Synthetic polymer fibers are made from polymer based materials such as polypropylene, nylon or polyethylene. These synthetic fibers are used in concrete reinforcement for the following benefits of it.

- Reduced plastic settlement and shrinkage cracks
- Increased toughness and impact resistance
- Provides energy absorption

According to Rajaraman (2018) borosilicate fiber is used in concrete reinforcement and its compressive and flexural strength performance have been analysed. The test has been conducted for various percentages of borosilicate fiber reinforced concrete and they concluded that at some level the borosilicate fiber reinforced concrete gives good compressive strength.

According to Rajaraman (2017) the structural behaviour of aluminium fiber reinforced concrete has been analysed. The test has been conducted for various percentages of aluminium fiber reinforced concrete and the researcher concluded that at some level the borosilicate fiber reinforced concrete gives good compressive strength (Nathan, 2018). Discusses about the optimum performance of steel fiber reinforced concrete by measuring compressive and flexural performances for various percentages of steel fiber replacement. The glass fiber reinforced concrete is been proposed and analyzed by Nathan (2017). The result shows that glass fiber reinforced concrete produces good compressive and flexural strength.

Fig. 1: Synthetic polymer fibre

In all the previous cases, different fibers are used in the process of reinforcement of concrete and their compressive and flexural strength performances were analyzed. This study deals about the use of synthetic polymer fiber as shown in Fig. 1-3 in concrete reinforcement. The physical properties of polyester fiber are listed in Table 1.

Table 1: Physical properties of synthetic polymer fibre

Properties	Units	Polyester
Cut length	Mm	12
Effective diameter	μ(micron)	20-40
Specific gravity	-	1.34-1.39
Melting point	°C	250-265
Elongation	%	20-60
Youngs modulus	MPa	>5000
Alkaline stability	-	Very good
U.V. Stability	-	Very good
Youngs modulus	MPa	17.5×10^3 MPa
Ult. elongation	-	50-70 (%)
Aspect ratio	-	340

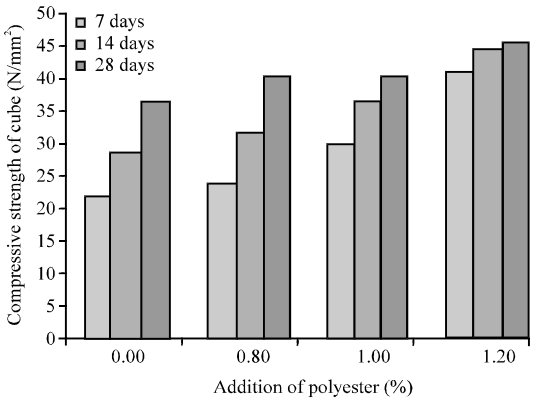

Fig. 2: Comparison of compressive strength of cubes

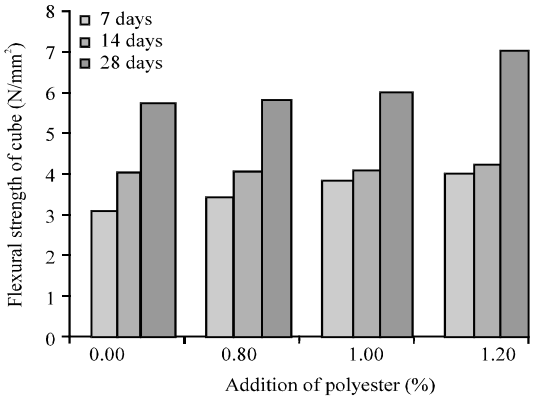

Fig. 3: Comparison of flexural strength of beams

MATERIALS AND METHODS

M. grade concrete were prepared in different shapes such as cubes and beams by using different percentages of aluminium fiber, locally available OPC 53 grade cement and river sand. The properties of synthetic polymer fiber are listed in Table 1. In order to test the synthetic fiber reinforced concrete (ASTM C1018-89, 1991; Anonymos, 1983) 3 cubes and three beams were prepared for each set of concrete and first set of cubes and beams are included for compressive and flexural strength test after 7th day. Similarly, the second set of cubes and beams are tested after 14th day and third set of cubes and beams are tested after 28th day. The results are observed and tabulated.

The specimens are prepared with the three different percentages of addition synthetic polymer fibre such as 0.8, 1.0 and 1.2%. The compressive, split and flexural strength of the specimens were tested and listed in Table 2 and Table 3.

Table 2: Test results for compressive strength of cubes

	Average compressive strength in N/mm²			
	Polyester fibre concrete			
Curing days	Control concrete	0.8(%)	1.0 (%)	1.2(%)
7	22.44	23.72	29.64	30.86
14	28.77	31.64	36.40	40.88
28	36.61	40.67	44.47	45.59

Table 3: Test results for flexural strength of beams

	Average flexural strength in N/mm²			
	Polyester fibre concrete			
Curing days	Control concrete	0.8(%)	1.0(%)	1.2(%)
7	3.46	3.43	3.74	3.95
14	4.28	4.32	4.21	4.15
28	5.86	5.88	6.23	7.18

RESULTS AND DISCUSSION

Table 2 and 3 shows the test results conducted on different samples of cubes and beams. Table 2 shows the compressive strength of cubes and Table 3 shows the flexural strength of beams otained from the tests. The test results showing that at 1.2 % addition of synthetic fibers, the reinforced concrete is getting good compressive and flexural strength.

CONCLUSION

The mix design was prepared for the M. grade concrete with addition of synthetic polymer fibre with various percentages in concrete. The specimens were casted tested. Compressive strength of 1.2% synthetic polymer fiber reinforced concrete has found to be 15% increase in strength, when compared to that of conventional concrete. Split tensile strength of 1.2% synthetic polymer fiber reinforced concrete has found to be 15% increase in strength, when compared to that of conventional concrete. Flexural strength of 1.2% synthetic polymer fiber reinforced concrete has found to be 20% increase in strength, when compared to that of conventional concrete. So, 1.2% concentration of synthetic polymer fiber is found to be the optimum percentage.

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