Performance of Recycled Waste Polymer Fiber For High Strength

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Abstract- *The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Researchers all over the world are attempting to develop high performance concretes by using fibers and other admixtures in concrete up to certain proportions. Hence, in this paper was interested in finding out the optimum quantity of polypropylene fibers required to achieve the maximum compressive strength of concrete. The study looked at the how the use of additives affect several properties of the concrete. In this study a polypropylene (PP) fiber was mixed with concrete to study the mixture's dynamic response under impact load. References related to dynamic impact test for polypropylene fiber reinforced concrete (PPFRC) is very scarce and there is no specific research and information relating to this research.*

I. INTRODUCTION

In general, fiber has become an integral part of concrete application. Vast ranges of materials have been tested such as steel, carbon, glass, plastic, polypropylene, nylon, and even natural materials such as cotton. In general, the introduction of fibers into the concrete matrix was found to significantly alter the brittle tension response of the concrete material.

Before cracking the addition of fibers has little effect. However, even small amounts of fiber addition leads to significant increases in the post-cracked toughness and ductility of concrete. As well, significant improvements in crack control can be achieved, with a reduction in crack width and crack spacing in the concrete. The smaller crack widths and increased abrasion resistance promotes an improvement in the long-term serviceability of the structure by preventing the ingress of chemicals and water that can have deleterious effects.

Synthetic fiber, such as polypropylene fiber, is gaining popularity due to its low cost and non-corrosive nature. This type of fiber is of particular interest due to its corrosion resistance relative to steel, resistance to alkali attack, relatively low cost, and durability with a long service life. Polypropylene fibers can also be made into a variety of cross-sectional shapes and can be designed with different surface finishes, allowing for further improvement in bond properties. However, its hydrophobic nature is a major drawback and this still needs to be overcome. Polypropylene fibers are not expected to bond chemically in concrete matrix, but bonding has been shown to occur by mechanical interaction. The effort to explore and optimize its potential in both academic research and industrial development has been tremendously increased in the past decade.

Reinforcement Mechanisms in Fiber Reinforced (FRC): In the hardened state, when fibers are properly bonded, they interact with the matrix at the level of micro-cracks and effectively bridge these cracks thereby providing stress transfer media that delays their coalescence and unstable growth. If the fiber volume fraction is sufficiently high, this may result in an increase in the tensile strength of the matrix. Indeed, for some high volume fraction fiber composite, a notable increase in the tensile flexural strength over and above the plain matrix has been reported. Once the tensile capacity of the composite is reached, and coalescence and conversion of micro-cracks to macro-cracks has occurred, fibers, depending on their length and bonding characteristics continue to restrain crack opening and crack growth by effectively bridging across macro-cracks.

Effect on workability of Polypropylene fiber: Slump tests were carried out to determine the workability and consistency of fresh concrete. The efficiency of all fiber reinforcement is dependent upon achievement of a uniform distribution of the fibers in the concrete, their interaction with the cement matrix, and the ability of the concrete to be successfully cast or sprayed. Essentially, each individual fiber needs to be coated with cement paste to provide any benefit in the concrete. Regular users of fiber reinforcement concrete will fully appreciate that adding more fibers into the concrete, particularly of a very small diameter, results in a greater negative effect on workability and the necessity for mix design changes. The slump changed due to the different type of fiber content and form. The reason of lower slump is that adding Polypropylene fibers can form a network structure in concrete, which restrain mixture from segregation and flow. Due to the high content and large surface area of fibers, fibers are sure to absorb more cement paste to wrap around and the increase of the viscosity of mixture makes the slump loss.

Polypropylene fibers are hydrophobic, that is they do not absorb water. Therefore, when placed in a concrete matrix they need only be mixed long enough to insure dispersion in the concrete mixture. The mixing time of fibrillated or tape fibers should be kept to a minimum to avoid possible shredding of the fibers .The type of polypropylene fiber recommended by manufacturers for paving applications is the collated fibrillated fiber. The length of fiber recommended is normally tied to the nominal maximum size of aggregate in the mixture. Manufacturers recommend that the length of the fiber be greater than twice the diameter of the aggregate. This would be consistent with past experiences with Polypropylene fibers and also with current theories on fiber dispersion and bonding". The manufacturers of fibrillated fibers recommend their products for the following purposes in paving: to reduce plastic shrinkage and permeability, to increase impact resistance, abrasion resistance, fatigue, and cohesiveness (for use in slip forming and on steep inclines), and to provide a cost effective replacement for welded wire fabric (WWF). However, they do not recommend specifying fibers for the control of cracking from external stresses, increased structural strength, slab thickness reduction, joint spacing reduction, or replacement of structural Polypropylene reinforcement. Monofilament fibers, according to fiber manufacturers, only provide control of cracking caused by shrinkage and thermal stresses occurring at early ages. These fibers provide no post-crack benefit and are used only for shrinkage cracking and not to provide improvements to other engineering properties.

Figure No.1 Polypropylene Fibers

II. FIBERS REINFORCED CONCRETE

The use of fibers to reinforce concrete materials is a well-known concept. It has been practiced since ancient times, with straw mixed into mud bricks and horsehair in mortars. Straw was used to reinforce sun-baked bricks and horsehair was used to reinforce masonry mortar and plaster. In modern times, the choice of fibers can vary from synthetic organic materials such as polypropylene or carbon, synthetic inorganic such as steel or glass, natural organic such as cellulose or sisal to natural inorganic asbestos.

Using fibers in concrete matrices addresses the issue of cracking in cement based materials. Concrete is considered to be a relatively brittle material with a low tensile strength compared to its compressive strength. When subjected to tensile stresses, unreinforced concrete will crack and fail. The use of fibers modifies properties of concrete both in plastic and hardened stages and results in a more durable concrete.

Fiber-reinforced concrete (FRC) has become an important material in the construction of buildings and other structures. Reinforcing fiber's ability to support load after cracking and to reduce the brittleness of concrete has positive effects on the structural performance of concrete.

This section describes the general role of fibers in improving concrete performance and the involvement of polypropylene fibers, in particular. The properties of polypropylene material and the production process of the fiber are also presented. Finally, studies incorporating polypropylene fiber in concrete applications are reviewed

III. TYPES OF FIBER IN CONCRETE APPLICATION

1. Steel Fibers
2. Carbon Fibers
3. Glass Fibers
4. Synthetic Fibers
5. Natural Fiber

IV. METHODOLOGY

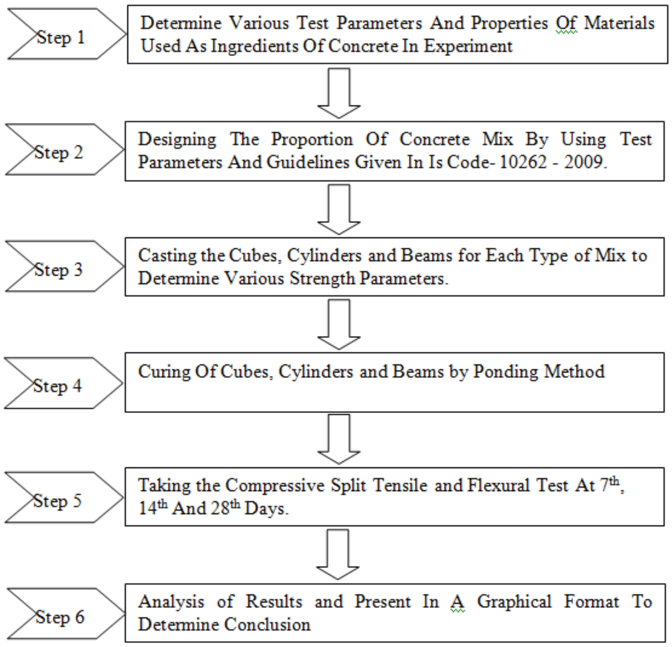

Figure No.2: Methodology for Completion of Dissertation

MIX DESIGN FORM40 CONCRETE

IS method of mix designed was used for mix design of M-40 grade of concrete. The quantities of ingredient materials and mix proportions as per design are as under.

Table No 1: Quantities of Material for M40

Sr. No	Material	0 % PP	0.5 % PP	1 % PP	1.5 % PP	2 % PP
1	Cement(kg/cum)	438	433.62	409.53	385.44	361.36
2	PP(kg/cum)	0	2.1681	4.0953	5.7816	7.2272
3	Water(litres)	197	197	197	197	197
4	Fine aggregate(kg /cum)	763.068	750.42	735.48	738.93	728.6
5	Coarseaggregate					
	10 mm Coarseaggregate(kg/cum)	400.15	393.52	385.81	387.49	382.25
	20 mm Coarseaggregate(kg/cum)	600.228	590.28	578.71	581.244	573.38
6	w/c ratio(ratio)	0.45	0.45	0.45	0.45	0.45
7	proportion	1:1.74:2.28	1:1.73:2.26	1:1.79:2.35	1:1.91:2.51	1:2.01:2.64

COMPRESSION TEST RESULTS

Table No 2: Average Compression Test Results

Sample	S1 (0 % SF)	S2 (0.5% SF)	S3 (1 % SF)	S4 (1.5% SF)	S5 (2% SF)
7 daysIn N/mm²	16.32	23.4	27.11	25.6	27.46
14 daysIn N/mm²	28.61	32.16	38.59	41.36	43.61
28 daysIn N/mm²	46.25	49.32	50.23	52.36	54.89

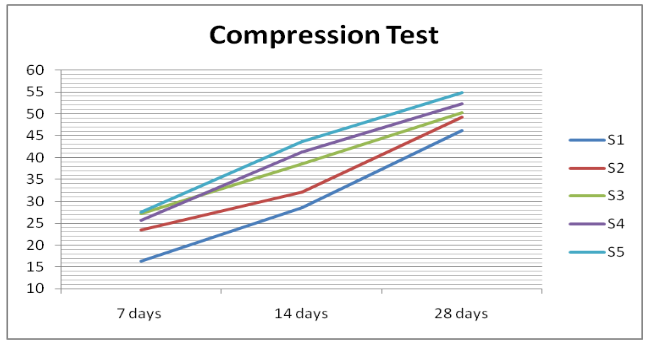

Figure No.3: Compression Test Results

Table No 3: Average Compression test Results Comparison with Concrete with Propylene

Sample	S1 (0 % SF)	S2 (0.5% SF)	S3 (1 % SF)	S4 (1.5% SF)	S5 (2% SF)
Polypropylene Reinforced Concrete in N/mm²	46.25	49.32	50.23	52.36	54.89
Conventional Concrete in N/mm²	46.25	46.25	46.25	46.25	46.25
Percentage Difference in N/mm²	0.00	6.22	7.92	11.67	15.74

SPLIT TENSILE TEST RESULTS

Table No 4: Average Split Tensile test Results

Sample	S1 (0 % SF)	S2 (0.5% SF)	S3 (1 % SF)	S4 (1.5% SF)	S5 (2% SF)
7 Days In N/mm²	1.91	2.62	2.72	2.86	**3.0**
28 Days In N/mm²	3.76	3.97	3.92	4.07	**4.42**

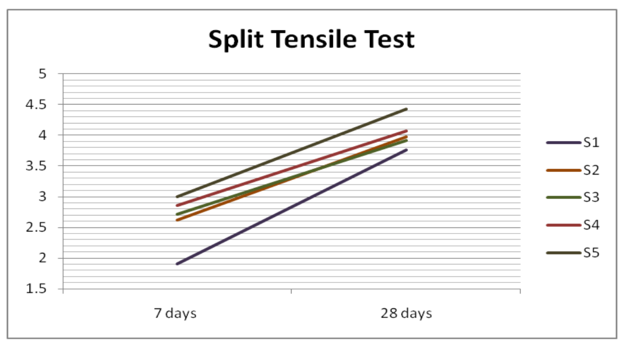

Figure No.4: Split Tensile Test Results

FLEXURE TEST RESULT FOR BEAM

Table No 5: Average Flexure Test Result for Beam

Sample	S1 (0 % SF)	S2 (0.5% SF)	S3 (1 % SF)	S4 (1.5% SF)	S5 (2% SF)
Flexure Capacity in KN	0.96	0.87	**0.98**	0.75	0.67

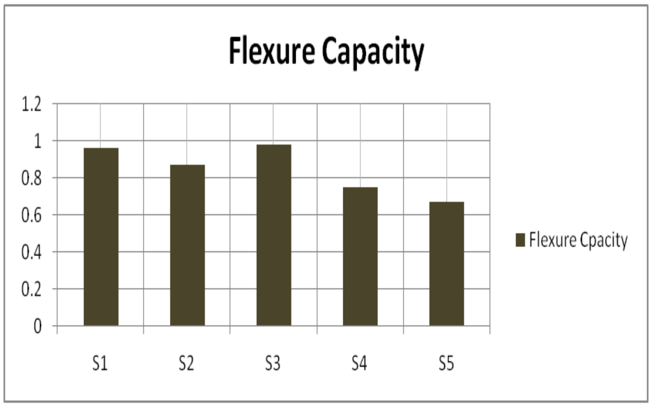

Figure No.5: Flexure Test Result for Beam

1. Cost Comparison

Table No 6: Cost comparison for 1 M3Quantity of Concrete with Polypropylene fiber

Sr. No	Material	Rate	Unit	S1 (0 % SF)		S2 (0.5% SF)		S3 (1 % SF)		S4 (1.5% SF)		S5 (2% SF)	
				Quantity in Kg	Amount	Quantity in Kg	Amount	Quantity in Kg	Amount	Quantity in Kg	Amount	Quantity in Kg	Amount
1	Cement	6.5	Kg	438	2847	433.62	2819	409.53	2662	385.44	2505.36	361.36	2348.84
2	Fine aggregate	4.4	Kg	763.068	3357.499	750.42	3302	735.48	3236	738.93	3251.292	728.6	3205.84
3	Course aggregate	5.2	Kg	1000.378	5201.966	976.09	5076	964.52	5016	968.73	5037.396	955.63	4969.276
4	Polypropylene Fiber	250	Kg	0	0	2.1681	542	4.095	1024	5.78	1445	7.227	1806.75
Total Cost				11406.4648		11738.071		11937.311		12239.048		12330.706	
Percentage Difference						**2.91**		**4.65**		**7.30**		**8.10**	

V. CONCLUSION

The experimental is carried out for five different combinations of samples and the Results and Discussions having following conclusions:

1. It is observed that compressive strength, split tensile strength and flexural strengths are on higher for 2% fiber as compared to 0%, 1%, and 1.5%fiber.
2. It is observed that compressive strength increases from 6.22% to 15.74% with addition of Polypropylene fiber.
3. It is observed that flexural strength increases from 17.55% with addition of Polypropylene fiber.
4. As the concentration of the Polypropylene fibers is increased the strength of the block is increased but in case of the behavior as the concentration of the Polypropylene fibers increase the failure up to a certain point is ductile failure and further it is observed to be brittle failure.
5. For the Door frame element flexure test is predominate and it was seen that S3 Performs well than other combinations.
6. The cost of Polypropylene fiber concrete defers by 2.91% to 8.10% than the conventional concrete but the increase in strength is more than 20% for all combinations.

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