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A PRELIMINARY STUDY ONPOLYPROPYLENE FIBRE REINFORCED CONCRETE

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Abstract— ***A number of new generation concrete are marking their way in the construction industry such as nano concrete , bacterial concrete and shotcrete. Polypropylene fibre reinforced concrete is just a new addition to this group. Apart from providing strtregth to concrete this type of concrete is cost reductive and requires less manpower. In the present research work an attempt has been made to produce polypropylene concrete using fibres.***

Keywords : Fibrereinforced concrete, polypropylene fibres, **Compression, Flexural Strength**

I.INTRODUCTION

Fiber has become an integral part of concrete Polypropylene application and so many types of materials have been tested such as steel, carbon, glass, plastic, polypropylene, nylon, and even natural materials such as cotton. 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 fibres has little effect. However, even small amounts of fiber addition leads to significant increases in the post-cracked toughness and ductility of concrete (Shah and Rangan, 1971). As well, significant improvements in crack control can be achieved, with a reduction in crack width and crack spacing in the concrete (Banthia et al., 1993; Banthia and Gupta, 2006). 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 (Johnston, 2001).

Polypropylene, 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. Polypropylenes 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 (Wang et al., 1987).

II. LITERATURE REVIEW

Kakooei et al. (2012) evaluated the effect of Polypropylene s on the properties of reinforced concrete structure. In their study the influence of different amount of Polypropylene content on concrete properties were investigated by measuring permeability, electrical resistivity and compressive strength. They found that concrete compressive strength increased proportionally with the increase in volume ratio of Polypropylene. They concluded that the presence of Polypropylene fibers had caused delay in the degradation process by reducing permeability, reducing the amount of shrinkage and expansion of concrete that can significantly affect the lifespan of the structure. They also concluded that electrical resistivity of concrete with fiber ratio of 1 and 1.5 kg m-3 had higher values in comparison with other samples.
Mechanical properties of Polypropylene fiber reinforced concrete and the effects of pozzolanic materials were investigated by Alhozainy et al. (1996). Collated fibrillated Polypropylene fiber at volume fraction ranging from 0.05 % to 0.3 % were added to the mixture containing different composition of cementitious binder including cement, fly ash, silica fume and slag. The authors summarized that Polypropylene had no statistically significant effect on the compressive strength and toughness of conventional concrete

Soroushian et al. (1995) evaluated plastic shrinkage cracking of Polypropylene reinforced concrete. They summarized that Polypropylene reduced the total plastic shrinkage crack area and maximum crack width at 0.1 percent fiber volume fraction. They also concluded that different Polypropylene volume fraction (0.05, 0.1, 0.2 percent) had statistically similar effects on the total plastic shrinkage crack area and the maximum crack width. Moreover, longer fibers produced less cracks at 0.1 and 0.2 percent fiber volume fractions and smaller maximum crack width at 0.05 percent fiber volume fractions, when compared with the shorter fibers.

III.EXPERIMENTAL PROGRAMME

3.1 Materials used

In this experimental study, cement, coarse and fine aggregates, water and polypropylene fibres are used.

Polypropylene fibres: In this project, raw Polypropylene materials were Polypropylene supplied by Reliance Industries Ltd. India. The commercial name of this material is Repol AS I 60N Homopolymer and has a round shaped white color chips with a maximum of 4 mm diameter size

Aggregates Fine aggregates of local natural river sand and gravel coarse aggregates with a maximum size of 19 mm were used
Water

Potable water free from impurities was used.

IV. EXPERIMENTAL METHODOLOGY

Two separate batches of concrete using the same mix design for each batch were prepared. The two types of extruded polypropylene fiber, at 1 % by volume of concrete, were added separately in each mix. For each of the two batches, five 100 mm x 100 mm x 350 mm beams for performing flexural tests were cast along with eight 100 mm x 200 mm cylinders for compressive strength determination according to ASTM C192.

A counter-current motion type pan mixer was used for mixing. Sand and coarse aggregates were added to the mixer and mixed suitably to provide a well-mixed mass. The Portland cement was then added to the batch and mixed for around three more minutes.

The required amount of polypropylene fiber was then added in the mixer and mixed for an additional two minutes.. In order to ensure that the fibers are well distributed in the mix, fibers were added gradually. Approximately two thirds of the water was added and mixed for two minutes to obtain an even distribution. The remaining water was then added to the batch and mixed for three minutes by the end of which the concrete was ready to pour.

V. EXPERIMENTAL RESULTS AND DISCUSSIONS

5.1 Compressive strength: Table 5.1 presents the compressive strength of each mix at 7 and 28 days of testing. As expected, compressive strength of the mix at 28-day was approximately 42 MPa. The standard deviations were 0.65 MPa and 0.41 MPa for 7-day and 28-day test, respectively. It can be seen that the addition of fibers into concrete mixtures has no significant effect on the compressive strength

Mix	Compressive strength (MPa)	
	7-day	28-day
Regular PP fiber	31.42	42.16
SF co-extruded PP fiber	30.13	41.35
SD	0.65	0.41

Table 5.1: Compressive strength data

5.2 Flexural Testing
5.2.1 Fracture mode
In general, the location of the fracture in all tested specimens occurred within the middle third of the span of the beam as shown in Figure 5.2.1.

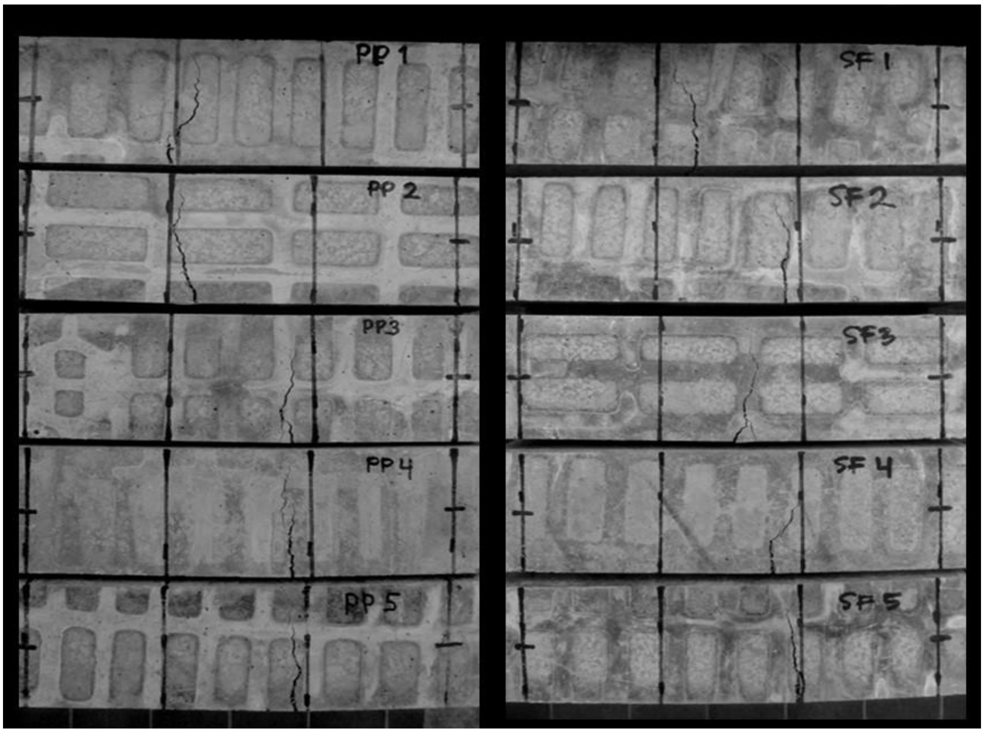

Figure 5.2.1: Images of specimens of each mix after testing. RPP (left) and SFPP (right)

5.2.2 Flexural response

Figure 5.2.2.1 and 5.2.2.2 show the flexural response of both mixes contains RPP and SFPP fibers, respectively. Typical flexural response of both FRC mixes clearly showed a two-peak response. The first peak indicated the flexural strength of concrete, while the second peak showed the ability of the fiber additive to sustain increases in load once the first cracks occurred.

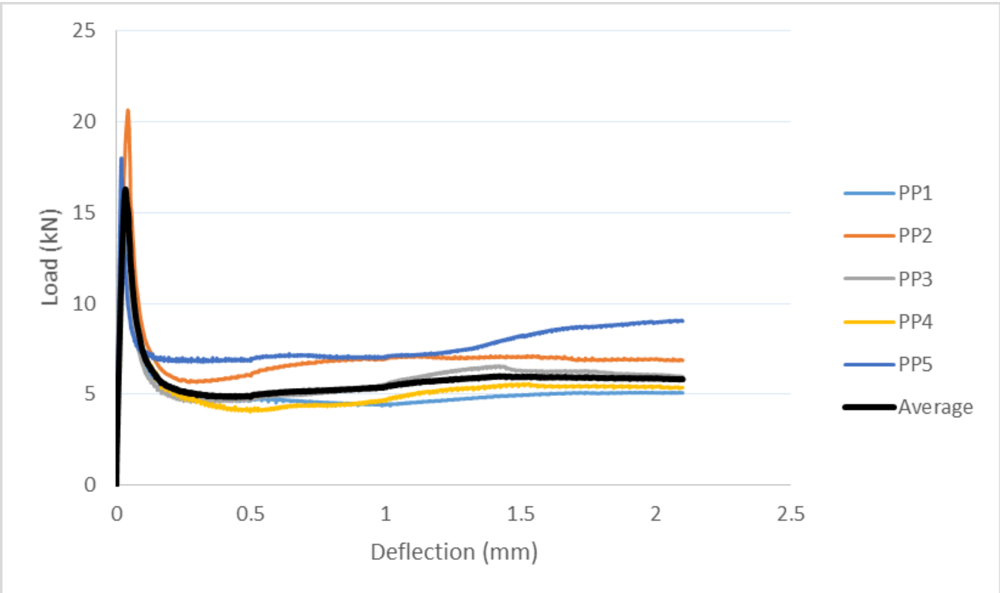

Figure 5.2.2.1: Load - Deflection curve Mix 1 with regular PP fiber

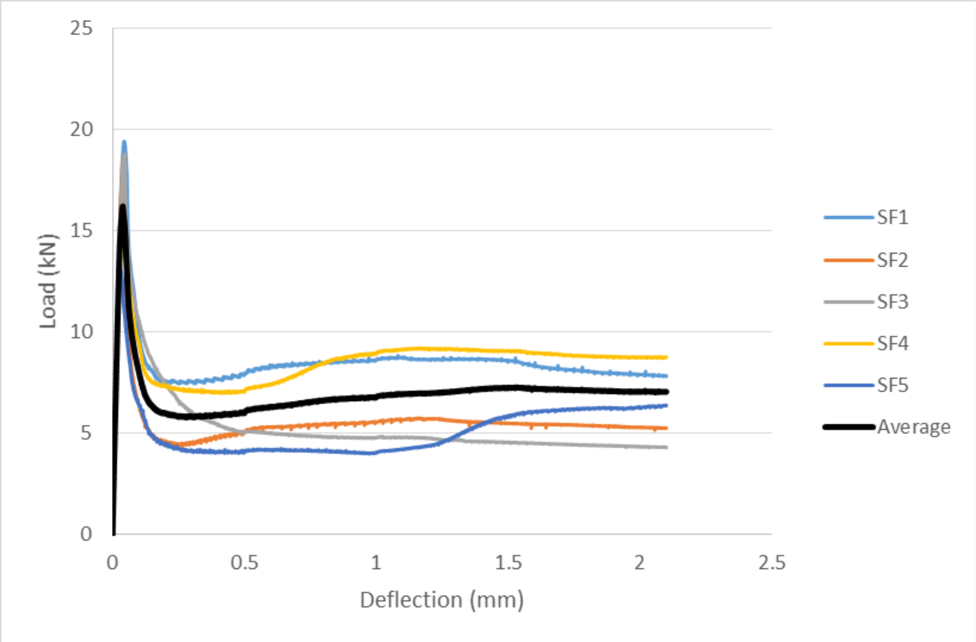

Figure 5.2.2.2: Load - Deflection curve Mix 2 with SF co-extruded PP fiber

5.2.3 Flexural toughness

Flexural toughness is defined as the post-crack energy absorption ability of fiber reinforced materials. It can be calculated using the area under the load-deflection curve up to the specified deflection. In general, FRC produced from concrete with similar strength will exhibit similar first crack toughness. This is because the first peak response depends entirely on the concrete strength.

The comparison of averaged flexural toughness of all mixes is given in Figure 5.2.3.1 The typical flexural response of plain concrete was also included. It can be seen that there are improvements in flexural toughness when the fiber was introduced to the concrete mixture. It also can be seen that the average flexural maximum load of the concrete in the three FRC mixes is similar at approximately 16 KN

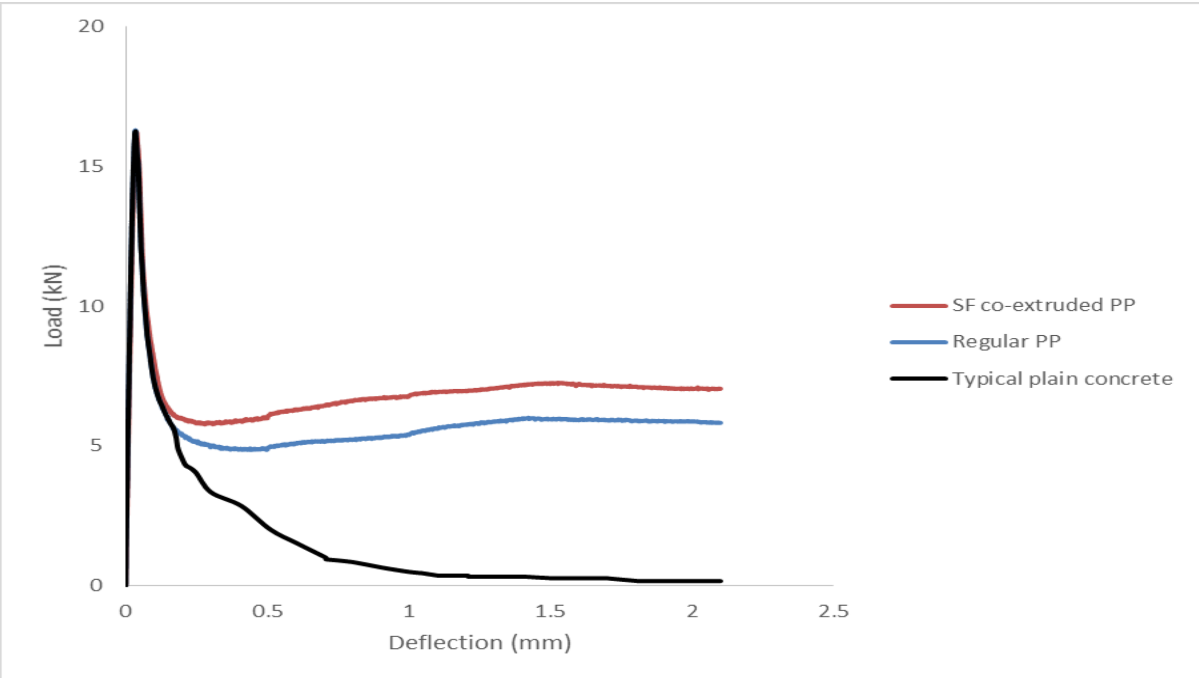

Figure 5.2.3.1: Averaged flexural response of FRC containing extruded fibers

A detailed performance presented in Table 5.3.3 as per ASTM C-1609. Although, the peak load (Pmax) of FRC containing RPP and SFPP were quite similar at 16.29 and 16.20 kN, respectively, and thereby reflected to the beams peak strength (fmax) at 4.89 and 4.86 MPa for RPP and SFPP, respectively. Nevertheless, it is revealed that FRC containing SFPP fibers performed better than FRC containing RPP.

The load values corresponding to ½ mm of net deflection at mid span (P600) were 4.88 and 6.02 kN for FRC containing RPP and SFPP, respectively. This numbers indicates the residual strength of the specimens in their corresponding stress (f600) of 1.47 and 1.81 MPa, respectively.
Moreover, the residual strength of FRC specimens containing SFPP fiber obtained at 2 mm of net deflection at mid-span (f150) was 2.11 MPa. This value is 19.89 % higher compared to that of FRC specimens containing RPP fiber (1.76 MPa). The corresponding value for toughness parameter revealed a similar trend. The T150 value of FRC specimens containing SFPP fiber was 13.7 Joules. This value is 18.1 % higher compared to that of FRC specimens containing RPP fiber (11.6 Joules). Therefore it can be concluded that concrete containing SFPP fiber performed better than that of concrete containing RPP fiber in flexural testing.

Parameter	Regular PP FRC	SF co-extruder PP FRC
P_{max} (kN)	16.29	16.20
f_{max} (MPa)	4.89	4.86
P_{600} (kN)	4.88	6.02
f_{600} (MPa)	1.47	1.81
P_{150} (kN)	5.88	7.04
f_{150} (MPa)	1.76	2.11
T_{150} (J)	11.6	13.7

Table 5.3.3: Average flexural toughness parameter according to ASTM C1609

CONCLUSIONS

The aim of the work presented in this thesis was to produce fiber materials that could be used as reinforcements in concrete applications.

1.Polypropylene (PP) chips material graded as fiber and staple application were used in this experiment.
2.Even though polypropylene fibers are among the most used fibers in concrete application, their performance has limitation in terms of interface bonding with concrete matrix. This research explores methods to address this limitation.
3.The techniques and methods used in this research were based on the understanding that improving the fiber performance should be attempted from the first step of production until the desired final product is obtained.
4.From the compressive strength test results it was evident that regular pp fibres gives maximum strength of around 42.16 Mpa
5. From the flexural response test, the first peak indicated the flexural strength of concrete, while the second peak showed the ability of the fiber additive to sustain increases in load once the first cracks occurred.
6.From the flexural toughness test it was evident that mix T150 with co extruder PP fiber gives maximum strength value of 13.7

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