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A Review: Performance of Polypropylene Fiber Reinforced Concrete

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ABSTRACT

Plain concrete has low strain capacity due to which crack occur on the outer layer of the concrete structures. The fibers are incorporated in concrete to prevent the crack formation and enhance the tensile strength of the mix. Polypropylene fiber reinforced concrete (PPFRC) is a composite material that contains short discrete randomly distributed fibers. PP fibers in concrete shows promising results while enhancing the mechanical properties, stiffness and durability. This paper presents a review of properties of PPFRC based on various research works.

1. Introduction

The whole word is very well aware of the properties of concrete i.e., it is strong in compression as aggregates take the compressive load. Also, it is weak in tension and has a lower resistant to ductility and fracturing/cracking. Due to concrete's low tensile strain limit and low tensile strength, cracks occur on the surface of concrete. Therefore, various fibers are used in concrete to upgrade the pots crack characteristics of concrete and to increase its structural integrity.

Fibre reinforced concrete (FRC) is a composite material that contains uniform or erratically distributed short discrete fibres in cement matrix. The functioning of FRC hangs on the category of fiber, size, geometry, volume fractions, orientation of fibers and the manners in which these are mixed and distributed in concrete *(Vikrant S. Vairagade, et al 2012).*

Polypropylene Fibers:

Polypropylene fibres (PPF) are popular man- made synthetic fibres. Polypropylene fibers are manufactured from propylene gas and, this gas is produced from the petroleum by-products and cracking of feedstocks. These are also known as new generation chemical fibers.

Its major products are monofilaments, multifilament yarns, staple fibers, non-woven textiles, split filament, ropes, carpet backing etc. Its low specific gravity (0.9 gm/cc), better stiffness and excellent resistance against chemicals allow it to be used it as a constructional material and in many industrial applications *(K, Murahari et al, 2013, Tarteel Awad Hajali Ahmed, et al 2016)*

Fig:1Polypropylene Fiber *(Saurav Jyoti Parasor 2017)*

These fibers are of light weight and are easily handled which further helps to minimize the cost of polypropylene fiber reinforced concrete. Fibers are shown in fig:1 *(Saurav Jyoti Parasor 2017).* So, the main reason of using these fibers in concrete is to inhibit the formation of cracks and improve the mechanical characteristics of concrete mix. *(Vikrant S Vairagade et al, 2012, K Murahari et al, 2013)*

2. Literature Review

2.1 Effect of Polypropylene Fiber on Concrete

(a) Workability:

Slump tests were carried out in the fresh state of concrete to evaluate its consistency. Experiment results showed that addition of PP fibres in plain concrete reduces the slump values. *(Yew, M.K. et al 2015).* It was observed from experimental results that workability is decreased with higher value fraction of fibers. *(Kolli. Ramujee 2013, Saurav Jyoti Parasor 2017)*

With addition of PP fiber dose in concrete mix reduced the slump values corresponds to Samir Shihada (2011). It is credited to the adhesion and cohesiveness of the mix imparted by imparted by PP fibers. *(Samir Shihada, 2011)*

By adding PP fibers to concrete, entrapped air in the voids increases which reduces the workability, which results in creating difficulty in the compaction of concrete. These air voids contribute in reducing workability *(Divya S Dharan et al 2016).*

(b) Compressive Strength and Flexural Strength

To explore the effect of polypropylene fiber on compressive strength of fibre reinforced concrete, M20 concrete grade with PP fibers were used to cast the cubes and after 7 days and 28 days curing, tested to check compressive response. Polypropylene fibers of different lengths 15, 20 and 24 mm at 0.25% were adopted in this study. Increase in compressive was found with 24mm length of fibers at same dose i.e. 0.25% *(Vikrant S. Vairagade at al, 2012)*

Saurav Jyoti Parasor (2017) added polypropylene fibers of length 6 mm to concrete with various volume fractions as 0.1%, 0.2%, 0.5%, 1%, 1.25%, 1.5% and 2%. The range of

fiber volume fraction between 0.1% to 0.5% was obtained to achieve the maximum compressive strength. Fall in compressive response was noted when percentage fiber content increased more than 1%.

Samir Shihada (2011) reported on the impact of PP fibers on compressive response of concrete. Using PP fibers of 15 mm length in M30 concrete, specimens of size 100 mm x 100 mm x 100 mm were casted. For two, four and six hours, specimens were heated to 200, 400 and 600^{o} C after 28 days of curing, and then tested for compressive strength. Various doses of PP fibres were considered: 0%, 0.5% and 1% by volume to check the influence of PP fibers on fire resistance of composite. The compressive strength of concrete was raised higher than the plain concrete with inclusion of fibers, and the optimum dose for enhancing concrete's fire resistance is 0.5 percent.

Another experimental study was carried out to inspect the mechanical properties of lightweight concrete comprising different combination of PP fibers such as 0.5,1, 1.5 and 2% and silica fume as 0 and 10 % at high temperature 400, 600 and 800 ^{o} C. It was concluded on S/N ratio that maximum compressive strength of concrete mix was noticed with 1% dose of PP fiber and 10% of silica fume at 20^{o} C. Also, the flexure strength of composite was maximum at 20^{o}C when 0.5% of PP fibers and 10% of silica fume were added *(Harun Tanyildizi, 2009).*

A.Mtasher Rana et al (2011) conducted experimental tests and stated that the inclusion of volume fraction of 0.4% and 1.5% increased the compressive strength up to 11 % and 56 %, and the same volume fractions developed the flexural strength up to 24.6% and 85%.

Priti A. Patel et al (2012) conducted a study to determine compressive strength, tensile strength and shear strength of concrete utilizing polypropylene fibers fractions of 0.5, 1, 1.5 and 2%. The addition of polypropylene fibers to concrete escalated the 28 days compressive strength of the nix with a dosage of 1.5 percent by 16% due to the confinement offered by fibbers, according to the study. Fiber doses from 0.5 to 2 % were also found to increase the flexural strength. Concrete with fiber content of 0.5% and 2% increased the shear strength by 23% and 47%, respectively.

Another study was carried out on high-strength oil palm shell lightweight concrete using PP fibers. This research also indicates that a low dose of fiber has a significant effect on flexural behavior of composite *(Ming Kun Yew. et, al, 2015).*

Divya S Dharan et. al (2016) carried out experimental investigations on M30 concrete reinforced with polypropylene fiber of blended types, and found that as fibers were added to the mix, the compressive strength of composite increased. This is due to the confinement that the fibers create.

(c)Split Tensile strength

Vikrant S. Vairagade, et al, (2012) planned an experimental program on M20 concrete using PP fibers of lengths 15, 20 and 24 mm. It is stated that there is notable rise in tensile strength with 24 mm fibres at 0.25% volume fraction.

Divya S Dharan et. al. (2016) also carried out tests to obtain the split tensile strength of polypropylene fiber reinforced concrete. Polypropylene fibers of blended type 24 mm, 40 mm and 55 mm) used with different doses: 0.5, 1, 1.5 and 2% in M30 grade of concrete. Cylinder were cast with and without polypropylene fibers and examined after 28 days of curing. It is reported that split tensile strength was increased about 22% as compared with conventional concrete.

Kolli.Ramujee (2013) also added PP fibers of 12 mm in range of 0.5, 1.0, 1.5 and 2.0% by volume in concrete. The split tensile strength was raised up to 1.5 % fiber content, then decreased at 2 % fiber fraction according to Author.

3. Conclusions

The following conclusions are drawn from the above-mentioned study on polypropylene fiber reinforced concrete:

- As the volume fractions of polypropylne fibres increase, workability declines.
- The low strain capacity of concrete rises with the addition of PP fibers to concrete.
- The addition of polypropylene fiber to concrete results in a noticeable increase in compressive strength.
- As compared to conventional concrete, PP fibers additions increased the flexural and split tensile strength.

Overall, the use of Polypropylene fibres as a crack bridging agent in concrete appears promising because it improves concrete characteristics and lowering the cost of FRC mix. So, it can be used to construct the roads, pavements, tanks, other structures etc.

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