

Synthetic Fibers Used for the Construction of Concrete Pavements

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Abstract: A Cement concrete pavement gives good durable service life and excellent applicability in heavy traffic. In plain cement concrete pavements corrosion and shrinkage cracks are the major problems. Addition of synthetic fiber to concrete mix, overcome the shrinkage and corrosion problems. In this study, discuss the effect of addition of multifilament and fibrillated polypropylene fibers on paving grade concrete mix. The concrete properties such as slump, compressive strength and flexural strength are evaluated and also compare the multifilament and fibrillated polypropylene fiber reinforced concrete mixes. The results show that the polypropylene fibrillated fiber reinforced concrete is more effective in preventing shrinkage cracks and there is no adverse effect in multifilament and fibrillated on 28 days compressive strength of concrete.

Keywords: Pavement, durable, shrinkage, properties, polypropylene, fiber

1. Introduction

Concrete pavements are mainly two types they are cement concrete pavements and Asphalt concrete pavements. Cement concrete pavements are rigid pavements; asphalt concrete pavements are ductile pavements. Cement concrete asphalt gives good service life and it is applicable for heavy traffic loads. Repair of cement concrete pavements is difficult compared to asphalt concrete pavements (Yang 2000; Um 2000).

Fiber reinforced concrete is widely used in construction industry. FRC is also used in covering of concrete structure, tunnels, etc. polypropylene fibers are used as secondary reinforcement and it is used in slabs, floors, precast shells, canals, reservoirs and pavements (Zheng and Feldmam, 1995).

The recent trend of researches on FR focuses on strength properties of steel fiber reinforced concrete and plastic shrinkage cracking of FRC with hybrid type fibers (Kim 2005; Won 2004). The addition of synthetic fibers changes the properties of concrete mix. Polypropylene fiber reinforced concrete with a dose of 0.1% by volume of concrete is widely used in construction industry (Zollo, 1984).

Polypropylene fibers are in mainly three different forms, they are monofilament polypropylene fibers, Multifilament polypropylene fibers and Fibrillated polypropylene fibers (Hannant, 1978). Monofilament fibers having single strand and uniform cross sectional area. Multifilament fiber consists of number of continuous strands. Fibrillated fibers are manufactured fibers is in the form of tapes or films. Polypropylene fibrillated fibers are expanded into a net, during mixing due to friction in aggregates (Bayasi, 2002).

2. Experimental Details

2.1 Materials:

The materials used in this work, ordinary Portland cement, coarse aggregate of maximum size 20mm, quarried concrete sand as fine aggregate, tap water, high performance of water reducing agent Akarsh SP 123, polypropylene multifilament fiber (MF) and fibrillated fiber (FF) of average length 18mm.

2.2 Mix design:

The mix design proportions are given in table 1.

Table 1: Mix Design Proportions

Description	Mix proportions						
	-	MF	MF	MF	FF	FF	FF
Type of polypropylene Fiber	-	MF	MF	MF	FF	FF	FF
Dosage of fiber (% by volume)	0	0.5	0.1	0.15	0.5	0.1	0.15

The concrete mix proportion of control concrete is as follows:

C:F.A:C.A:W/C: 1:1.64:2.50: 0.4

With high performance agent (Akarsh SP123) = 0.34% by weight of cement.

1.3 Preparation of specimens

From each concrete mix, 150mmx150mmx150mm cube specimens are prepared for the testing of compressive strength, 500mmx100mmx100mm beam specimens are prepared for the testing of flexural strength were cast from concrete mixes containing with fibers and without fibers. These specimens are demoulded after 24 hours and marked for identification and kept specimens are cured in water at temperature $27^{\circ}\pm 2^{\circ}\text{C}$ till the age of testing.

3. Results and Discussion

3.1 Slump Test on Concrete Mix

In this experimental study to determine the properties of fresh concrete mix is workability. Shape and size of moulds, amount and condition of reinforcement, the properties of fresh concrete are impact factors.

The slump values of concrete mix are tabulated and it shown in table2. Result shows that addition of multifilament fibers and fibrillated fibers has detrimental effect on workability of concrete mix. From slump values, Increase the fiber dosage with increase in slump reduction.

Table 2: Slump Values of Concrete Mixes

Description	Mix proportions						
	-	MF	MF	MF	FF	FF	FF
Fiber type	-	MF	MF	MF	FF	FF	FF
Dosage of fiber (% by volume)	0	0.5	0.1	0.15	0.5	0.1	0.15
Slump, mm	76	32	19	17	55	42	30

3.2 Compressive Strength and Flexural Strength

Table 3 shows the compressive strength and flexural strength of concrete mixes at the curing period of 28 days. Addition of synthetic fibers to concrete mix not adversely affects the compressive strength compared to conventional concrete mix (Zollo,1984; Hasaba, 2006; Ramakrishnan,1987). From table 3, the compressive strength of multifilament fiber concrete mix is less compared to fibrillated fiber concrete mix and also observed that increase the fiber dosage, increases the compressive strength infibrillated concrete mixes.

The flexural strength of fiber reinforced concrete mix is slightly higher than the conventional concrete mix (Zollo, 1984; Hasaba, 2006; Banthia, 1999).Table 3 shows; the flexural strength of multifilament fiber concrete mix is slightly higher than the fibrillated fiber concrete mix.

So it may concluded that fibrillated fiber concrete mix performs similar to multifilament fiber concrete mix in development of compressive strength and flexural strength within the fiber dosage used in this work.

Table 3: Compressive Strength and Flexural Strength of Concrete Mixes (28 Days)

Description	Mix proportions						
	-	MF	MF	MF	FF	FF	FF
Fiber type	-	MF	MF	MF	FF	FF	FF
Dosage of fiber (% by volume)	0	0.5	0.1	0.15	0.5	0.1	0.15
Compressive strength (MPa)	48.3	48.7	50.2	48.1	50.7	46.7	50.8
Flexural strength (MPa)	5.3	5.2	6.1	6.3	5.6	5.8	6.0

4. Conclusion

The following conclusions are emerged from the present investigation,

1. At same fiber content Fibrillated fiber has lesser effect on workability reduction than multifilament fiber.
2. Addition of synthetic fibers to concrete mix not adversely affects the compressive strength compared to conventional concrete mix.
3. The flexural strength of multifilament fiber concrete mix is slightly higher than the fibrillated fiber concrete mix.
4. Polypropylene fibrillated fiber reinforced concrete may be used in the construction of concrete pavements.

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