Research Paper

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Comparison of Synthetic Fiber Reinforced Concrete with Conventional Concrete in Construction of Concrete Pavements

Engineering

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ABSTRACT

If properly designed, constructed and maintained, reinforced structures are generally very durable. However, for structures in aggressive environment corrosion of steel can be significant problem. To overcome this problem, sometimes synthetic fibers are added to the concrete mix. Synthetic fibers are used in our study are polypropylene and polyester. In this study, the results of strength properties of synthetic fiber reinforced concrete are presented. Also conducted the conventional tests for concrete such as the compressive strength and flexural strength of concrete samples are made with different amounts.

Introduction

Concrete is most widely used material. Plain Portland concrete is a composite material and it exhibits brittle behavior. Once failure starts it totally lost its loading capacity. This problem can be overcome by adding synthetic fibers (song, 2004). Rigid pavements consist of a top concrete pavements resting on base course and sub-base course. The advantages of using rigid road pavements are most efficient and economical in highways and roadways when compared to flexible pavements (Hansen, 2001; Mohr, 2000).

Concrete pavements may undergo rapid deterioration, which causes the condition of vehicles will lost. FRC is composite material, consist of conventional concrete and dispersed structural fibers. According to the researchers FRC improves the durability, strength properties, and it prevents the micro and macro cracks (Hannant, 1983) and growth in cementitious composites, such as cement treated roads (Grilli, 2013).Under high temperature, polypropylene sublimate, and preventing cracks in outmost layer (Kalifa, 2000; Kalifa and Galle, 2001). According to several researches (Bentur, 2007; Banthia, 2006, Kumar, 2012; Balaguru and Shah,1992), using of synthetic fibers in concrete, improves the properties of concrete. Polypropylene fibers are widely in pavements (Zollo, 1984).

Fibers type, aspect ratios, lengths etc are affecting the properties of concrete. Polypropylene fibers are available in Monofilaments, multifilament and Fibrillated (Hannant, 1978). Fibers are finally cut into different desired lengths. At the time of concrete mixing, fibrillated fibers are expanded into a net due to friction with aggregates (Bayasi, 2002). Road pavements are generally two types they are asphalt concrete pavements and cement concrete pavements. The repair of asphalt pavements is easier than the cement concrete pavements in case of large amount of damage works (Yong, 2000). The supplementary cementations materials are well accepted in concrete mixes because of overall economy (Sree Rama Kumar, 2000).

In commercial, hydraulic and residential structures theFRC are widely used. Thedifferent artificial materials like polypropylene, steel. Glass, asbestos, polyester, nylon, carbon and natural materials like coconut and horse hair are used in concrete to prepare fiber reinforced concrete. Among this steel, glass, polypropylene, nylon and carbon fibers are most popular in the preparation of fiber reinforced concrete (Banthia, 2012; Stevens, 1995). By 1970's glass, steel and synthetic fibers are populated for concrete (Sridhara, 1971).By adding fibers in concrete mix we improve the strength properties and brittleness (Vikrant, 2012).

Polypropylene has a low density and modulus of elasticity. The melting point of polypropylene is lower than the steel fibers. Polypropylene fibers are widely used because of good cracking control. The density and elastic modulus of glass is low compared to steel fibers (Ramakrishnan, 1987). The selection of type of fiber is guided by fiber properties and cement matrix properties (Ramakrishnan and Hosalli, 1989).

The fiber reinforced concrete is used in structural applications like beams, columns, pre-stressed concrete and plate structures. Some of new approachesbeing investigated we alter the construct and design concrete structures (Patton, 1983; Rossi and Acker, 1987). Increase the flexural strength by fibrillated fiber at 0.1 percentages by volume, but he observed at 0.2 to 0.3 percentages of fiber content the flexural strength is slightly decrease (Ramakrishnan, 1999)

In this work, the effect of addition of different amount polypropylene and polyester fibers content on compressive strength and flexural strength of paving grade concrete mix with conventional concrete mix has been evaluated and discussed.

Experimental investigations

Materials

Cement: Ordinary Portland cement (OPC 53 Grade) conforming to IS-12269:1989 having physical properties as specific gravity, initial setting time and final setting time are 3.15, 120 min, and 340 min respectively.

Aggregates: Good quality of river sand was usedas the fine aggregate conformed to sand of Zone: II, having a specific gravity of 2.65. Locally available crushed angular material maximum size of coarse aggregate 20mm and it passing through 22.5mm and retained on 20mm sieve. The coarse aggregate having specific Gravityas 2.82**,** Fineness modulus as 7.68and water adsorption as 3.65.

Synthetic fibers: Synthetic fibers namely Recron'3s fibers are Polypropylene and polyester fibers are used in this study. The suppliers of these fibers are Reliance industry by name RECRON'3s. These fibers are very commonly and abundantly available in India, and these are used to prepare the fiber reinforced concrete. Recron'3s fibers are manufactured in an ISO 9001:2000. Polypropylene and polyester fibers are used at a rate of dosage varying from 0.1% to 0.4% by volume.

Admixture: Akarsh SP 123 admixture has been used in this work. The specific gravity of this admixture as 1.10, and it acts as water reducing agent.

Water: Tap water has been used to mix the ingredients of concrete in this study.

Mix proportions: The M45 mix proportion of cement, fine aggregate and coarse aggregate as

1: 1.76: 2.85.

Table-1 shows the Mix proportion for M45 grade concrete
Table 1: concrete mix proportions

Material	Quantity	Proportion
Cement	410 kg/m^3	1
Fine aggregate	725 kg/m^3	1.76
Coarse aggregate	1170 kg/m^3	2.85
Water	160 kg/m^3	0.39
Fibers	0.1%-0.4% by volume	-
Admixture	0.5-0.8% of weight of cement	-
Slump	60-100 mm	-

2.2 Preparation and curing of test 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 $27^{0c\pm20c}$till the age of testing.

Experimental methodology
3.1Properties of Fresh 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.

3.2 Tests on hardened concrete
In this study to determine the mechanical properties of fiber reinforced and conventional concrete using non-metallic and metallic fibers under compression and flexural strength , for polypropylene and polyester fibers, 0.1 to 0.4% by volume. The tests for compressive strength on cubes were measured at 7, 14 and 28 days curing as pet IS: 516-2000, and test for flexural strength on beams were measured at 7, 14 and 28 days of curing as per IS:516-2000.

3.2.1 Compressive strength
The strength of concrete is usually determined by the crushing strength of 150mm cube specimens at a curing period of 7, 14 and 28 days. Steel mould of dimension 150mm x 150mm x 150mm used for casting of concrete cubes filled with polypropylene, 0.1 to 0.4% by volume of concrete and polyester, 0.1to 0.4% by volume of concrete.

3.2.2 Flexural strength
Steel mould of dimension 150mm x 100mm x 100mm used for casting of concrete beams filled with polypropylene, 0.1 to 0.4% by volume of concrete and polyester, 0.1to 0.4% by volume of concrete. The specimens were casted and tested to determine the average flexural strength at a curing period of 7, 14 and 28 days.

Results and Discussion
Figure 1 shows the variation of variation of compressive strength with age at 7, 14 and 28 days. It observed that from figure 1, the compressive strength of polypropylene fiber concrete mix is 60.50**;** compressive strength of polyester fiber reinforced concrete mix is57.03.

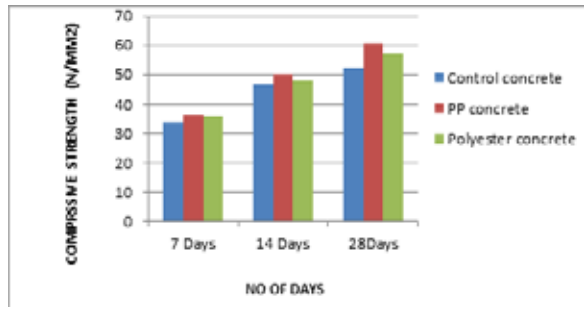


Fig 1: variation of compressive strength with age
Figure 2shows the variation of variation of flexural strength with age at 7, 14 and 28 days. It observed that from figure2, the flexural strength of polypropylene fiber concrete mix is 6.8;flexural strength of polyester fiber reinforced concrete mix is 6.5.

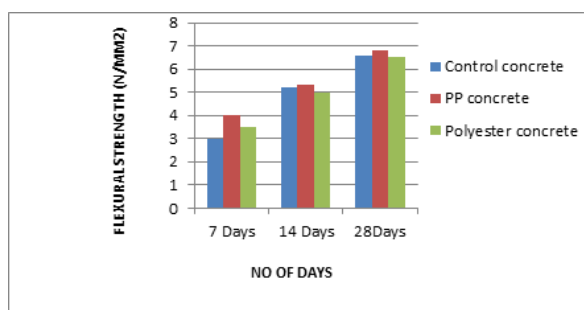


Fig2: variation of flexural strength with age

Conclusions
From the experimental work, the major conclusions are given below.

- The fiber reinforced concrete utilization in pavements reduces the maintenance cost.
- By inclusion of fibers is more advantage in case of pavements by reducing crack formation and also it gives early compressive strength.
- The concrete with polypropylene fiber is most efficient in inducing the additional strength to the concrete when compared to polyester fiber.
- The maximum compressive and flexural strengths are obtained with polypropylene fiber reinforced concrete.

So we conclude that the concrete with polypropylene fiber is the best fiber for pavement Quality concrete when compared to plain concrete and polyester fiber reinforced concrete.

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