Discrete Fiber used in Road Pavement

Nilesh Shewale[1] , Vinay Bagul[2], Saurabh Bhadke[3], Kaveri Pawar[4] ,Sudarshani Beldar [5]

[1]Assistant professor at Civil Department of Sanghavi College Of Engineering, Nashik, Maharashtra, India
[2345]Student Of B.E. Civil at Sanghavi College Of Engineering, Nashik, Maharashtra, India

Abstract *: Concrete roads are very conventional roads and can provide a safe and smooth flow of traffic. Due to the use of concrete in roads it has become quite an advantage for a greater life span and low maintenance. But concrete roads may undergo cracking, spalling and concrete is weak in tension and also little ductility. So as to mitigate these problems Inclusion of fiber can provide a great benefit to concrete pavement. This Research "The Use of Discrete Fiber in Road Pavements" is done so as to improve the quality of concrete pavement. In this research the fiber used is polypropylene fiber and polyester fiber. The concrete mix used is M35. This Research "The Use of Discrete Fiber in Road Pavements" is done so as to improve the quality of concrete pavement. In this research the fiber used is polypropylene fiber and polyester fiber. The concrete mix used is M35. In one specimen only plain, concrete mi is tested for compressive strength, flexural strength and split tensile strength. In second specimen of polypropylene fiber is added with the concrete mix and again tested for the same three tests*.

IndexTerms - : Roads , Fiber , Pavements , Polypropylene , Polyester

---

INTRODUCTION

Roads are cheap means of transportation. It is used for the safe movement of vehicles. It is important to maintain for its long service. For the safe movement of traffic, the road pavement should be durable enough. The most important purpose of a pavement is to transferloads to the sub-base. The benefit of using rigid pavement is its sturdiness and capability to tolerate hard environmental conditions. A rigid pavement is created from cement concrete or reinforcement concrete slab. A rigid road pavement provides an efficient, comfortable, and cost-effective design for the roadways and highways. Due to its high flexural stiffness and mechanical resistance, a rigid pavement allows to homogeneously transfer the vehicular loads to the underlying layers, preventing load and stress concentrations in the subgrade. But concrete pavements may suffer quick weakening, in the form cracks, fissures and failures, which can cause loss of serviceability and unsafe driving situation. This occurrence is chiefly due to the stiff behavior of cement concrete together with its little resistance to fatigue phenomena and its small resilience. Shrinkage cracking of concrete is a major problem in basic cement concrete pavements.

Pavement

Pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic such as road or walkway.
In India two types of road pavements is commonly use likely Rigid Pavement and Flexible Pavement

Rigid Pavement

Rigid pavement is the technical term for any road surface made ofconcrete. Concrete roads are called rigid while asphalt-covered roads are flexible. In Rigid pavements those which are surfaced with Portland cement concrete (PCC).

Rigid Pavement

Flexible Pavement

Flexible pavements are constructed using bituminous materials. These can be either in the form of surface treatments such as bituminous surface treatments generally found on low volume roads or, asphalt concrete surface courses generally used on high volume roads such as national highways. Flexible pavements those which are surfaced with bituminous (or asphalt) materials

Flexible Pavement

Discrete Fibers

It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers

Discrete Fibers

Fiber reinforced concrete

Fiber reinforced concrete (FRC) is defined as a composite material consisting of concrete reinforced with discrete randomly but uniformly dispersed short length fibers.

Fiber reinforced concrete

Historical Background

The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mudbricks. In the 1900s, asbestos fibers were used in concrete. In the 1950s, the concept of composite materials came into being and fiber-reinforced concrete was one of the topics of interest. Once the health risks associated with asbestos were discovered, there was a need to find a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC), and synthetic (such as polypropylene) fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion, and shatter resistance in concrete. Larger steel or synthetic fibers can replace rebar or steel completely in certain situations. Fiber reinforced concrete has all but completely replaced bar in underground construction industry such as tunnel segments where almost all tunnel linings are fiber reinforced in lieu ofusing rebar. Indeed, some fibers actually reduce the compressive strength of concrete.

Types of fiber reinforced concrete

- **Steel fiber concrete: -**

  Aspect ratio of steel fibers is 30 to 250. It has high structural strength. The diameter of steel fibres varies from 0.25mm to 0.75mm. Steel fibers control the crack width tightly and hence improves the durability of the concrete.

  It's used in airport and highway pavement, structural and precast applications, bridge decks, industrial flooring, etc.

Steel Fiber Concrete

Glass fiber concrete: -

Glass fibers have a tensile strength of 1020 to 4090 N/mm2. The lengths of fibers that are used in this type of fibers are generally 25mm.

It has high flexural strength, ductility, and also resistance to thermal shock. Glass fibers have a variety of uses in swimming pools, swelling lining, formwork, ducts, and roofs etc.

Glass fiber concrete

- **Synthetic fibers :-**

Synthetic fibers are manmade fibers from textile and petrochemical industries. It has high chemical resistance the melting point of synthetic fibers is high and the modulus of elasticity is low.

There are different types of synthetic fibers like carbon, nylon, and polyester, polypropylene etc. Synthetic fibers are used in shotcrete, road construction and cladding panels

Synthetic fibers

Polypropylene Fiber

The Polypropylene fiber, correspondingly known as polypropylene or PP, is a synthetic fiber, altered from 85% propylene, and is used in a variety of uses. As we know concrete provides a strong road pavement but it may undergo plastic and shrinkage cracking. So, to mitigate these problems polypropylene Fiber reinforced concrete (PFRC) has provided for improving these deficiencies. The accumulation of fibers in concrete increases the stiffness, flexural strength, tensile strength and bearing strength. The polypropylene fiber also reducesthe steel reinforcement requirement and also improves the ductility.

Polypropylene Fiber

Polyester Fiber

Polyester fiber is an artificial fiber which can be used in the pavement construction to avert micro cracking and also helps to increase flexural strength, compressive Strength of pavement. These fibers also reduce drying Shrinkage as well. The use of polymeric fiber has been increased nowadays because there is no menace of decay and is very cost effective. There is no risk of corrosion because polyester fiber is alkali resistant. Generally Polyester fibers can be used in industrial and warehouse Floor, pavements and even in overlays and precast Products. Polyester macro-fibers can be used as a true Substitute to welded wire fabric, steel fibers and Conventional light gauge steel reinforcing for precast Slabs on grad and applications. The Properties of polyester fiber-reinforced concrete.

Polyester Fiber

Material

- Cement
- Aggregates
- Fine aggregates
- Coarse aggregates

- Polypropylene fiber
- Polyester fiber
- Water

Cement

In this test Khyber cement Grade M53 OPC is used. When water is added to it paste is formed which Hardens with time.

Aggregate

Aggregates are one of the vital constituents of the concrete which gives body to the concrete and also reduce shrinkage.

Fine Aggregate

These are typically sand or crumpled Stone that are less than 9.55mm in diameter. Sand was used as a fine aggregate

Coarse Aggregate

These are particulates that are Greater than 9.55mm. Coarse aggregate used for this Research is 20mm.

Fiber

The fiber used for the test is Polyester and Polypropylene. These fibers have hydrophobic surface. Usage of these fibers as reinforcement diminishes Permeability, shrinkage resistance, mends both Compressional and tensile strength of concrete. The fiber used for this test were Polypropylene and Polyester fiber

Water

The water used should be free from Impurities so as it does not affect the mix. If the water contains extensive amounts of chlorides may bring about Efflorescence and dampness

TEST PROCEDURE

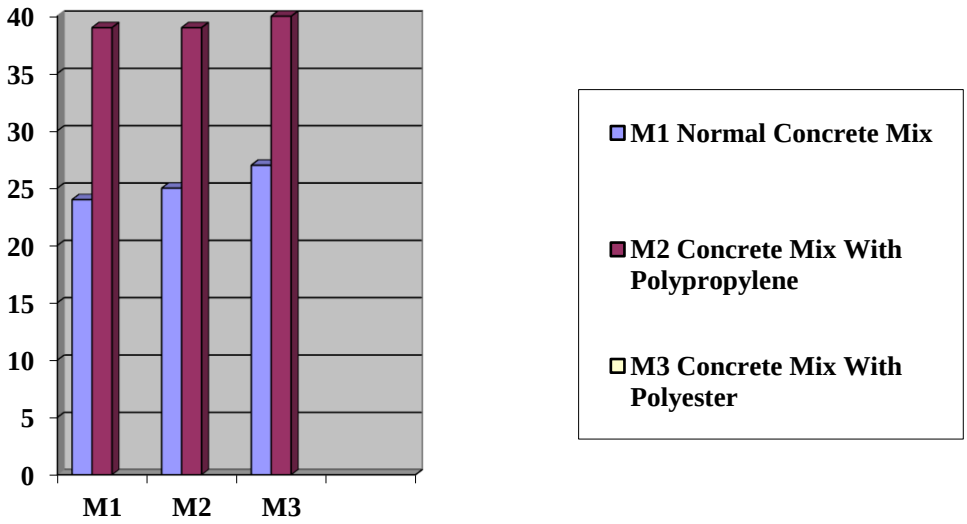
Compressive Strength Test –

In this test, cubes were casted and the dimension of these cubes was taken as 150×150×150 mm. In first cube only conventional concrete mix with M35 mix design was prepared. The second cube with same dimension was prepared with the incorporation of polypropylene fiber. The third cube with same mix proportion was made with the inclusion of polyester fiber and the last cube was prepared with the mix design with the addition of both polypropylene and polyester fiber with the same percentage. The casting molds are chosen to be made of cast iron and must be cleaned with oil on inner side for easy removal of cubes. The

specimen must be cast in 3 layers (5cm each) and appropriately compacted in order that honeycombing creation does not take place. The casted specimens are kept for 24 hours until it sets. After setting the specimens are detached from the mold and submerged underwater for stipulated time. The cube test for Compressive strength was done on 7 and 28 days respectively. Before placing on the UTM the specimen was completely dried. Then these testing specimens were placed in the space between bearing surfaces. The loading is applied axially on specimen without any shock and increased at the rate of 140kg/sq. cm/min. till the specimen downfall. Due to the constant application of load, the specimen starts cracking at a point & final failure of the specimen is noted.

Sr No.	Description	Compressive Strength Test	
		7 Days average strength N/mm2	28 Days average strength N/mm2
1	Normal concrete mix	24.20N/mm2	39.53 N/mm2
2	Concrete mix with 3% polypropylene fiber	25.65 N/mm2	39.92N/mm2
3	Concrete mix with 3% polyester fiber	27.41 N/mm2	40.34N/mm2

Table No 1. Result Compressive test



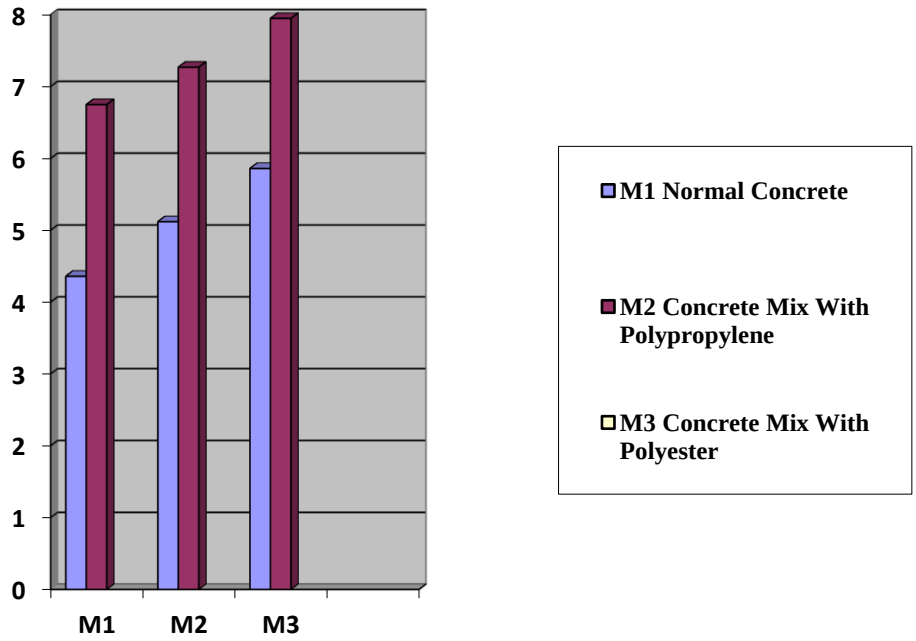
Graph No. 01 Flexural Strength Test

Flexural Strength Test: -

For flexural strength test beam samples of dimension 100x100x500 mm were casted. These flexural strength specimens were tested under four-point loading, using universal testing machine. In this test the required apparatus is mold in which specimen is casted, tampered rod for tamping purpose and flexural testing machine. The test specimen was prepared by filling the concrete into the mold in 3 layers of almost equivalent thickness. In first mold only conventional concrete mix with M35 mix design was prepared. The second cube with same dimension was prepared with the addition of polypropylene fiber. The third cube with same mix proportion was made with the addition of polyester fiber of and the last cube was prepared with the mix design with the addition of both polypropylene and polyester fiber withthe same percentage. Each layer was tampered 35 times using the tamping bar as specified above.

Sr No.	Description	Flexural Strength Test	
		7 Days average strength N/mm2	28 Days average strength N/mm2
1	Normal concrete mix	4.36 N/mm2	6.75 N/mm2
2	Concrete mix with 3% polypropylene fiber	5.12 N/mm2	7.27 N/mm2
3	Concrete mix with 3% polyester fiber	5.86 N/mm2	7.95 N/mm2

Table No 2. Result of Flexural test



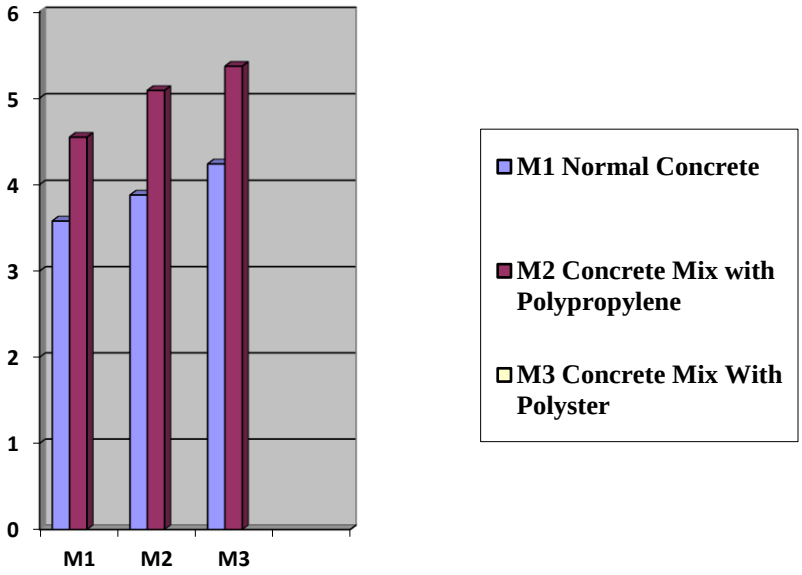
Graph No. 02 Flexural Strength Test

Split Tensile Strength Test: -

In this test the sample size is cylinder of diameter 15 cm and height of 30 cm. The Mold used is metal. The Molds were coated with a thin film of Mold oil before use to prevent adhesion of concrete. All the 4 concrete mixes were placed into the Molds in layers of almost 5 cm thickness. Each layer was compacted either by hand. The test specimens were kept in a place at a temperature of 27° +/- 2°C for 24 hrs. After this time, samples were detached from the Molds in unpolluted fresh water for 28 days. The water was changed every 7 days. After curing the water was wiped from the surface of specimen, then by using marker diametrical lines were drawn on the two ends of the specimen to verify that they are on the same axial place. Then dimensions of the specimen were measured.

Sr No.	Description	Split Tensile Strength Test	
		7 Days average strength N/mm2	28 Days average strength N/mm2
1	Normal concrete mix	3.58 N/mm2	4.55 N/mm2
2	Concrete mix with 3% polypropylene fiber	3.88 N/mm2	5.09 N/mm2
3	Concrete mix with 3% polyester fiber	4.24 N/mm2	5.37 N/mm2

Table No 3. Result of Split Tensile strength test



Graph No. 03 Split Tensile Strength

CONCLUSIONS

- Use of fibre in reinforced concrete improve the ductility of concrete and load carrying capacity
- Fibre rainfalls concrete are control cracking and deformation.
- Use of fibre in concrete produce more closely space crack and reduce width of crack.
- No workability problem was encountered for the use of polypropylene fibre and polyester fibre.
- The addition of polyester fibre in concrete shows a greater increment in strength than polypropylene fibre
- The compressive strength of the normal concrete mix is less than the other two mixes which are 3% of polypropylene and polyester. And same as another split tensile strength test and flexural strength test.
- It is less in cost and should be economical.

REFERENCES

[1] Cengiz, O.Turanli, L. (2004) "Durability of polypropylene fiber in Portland cement based composites" University of Surrey, Guildford. United Kingdom.M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Sounthararajaan V.M Dr., Anshul Jain , Abhishek Kumar Sing , S. Thrirumurugan , Shivakuar Anandan (2013) Evaluation of composite polypropylene fibre reinforced concrete .

[3] Chintan Patel, Kishan Patel, Prof. Manjurali, I. Balya , Prof. Vikrant A. Patel "Performance Evaluation of Polymer Fiber "RECRON-3S" in PavementQuality Concrete"