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Use of Discrete Fiber in Rigid Road Pavement

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ABSTRACT- Concrete roads are very common and can provide safe and smooth traffic. Thanks to the use of concrete on the roads it has become a very good quality of life and low maintenance. However, concrete roads may be cracked, cracked, and the concrete weakened and malfunctioned. To alleviate these problems Fiberglass installation can provide significant concrete advantages. The study "Use of Separated Ropes in Solid Roadways" was conducted to improve the quality of concrete roads. In this study the fiber used was polypropylene fiber and polyester fiber. The concrete mix used is M25. In just one example, concrete mixes were tested for compressive strength, flexural strength and strength split strength. In the second specimen 1.6% polypropylene fiber was added to the concrete mixture and tested in three similar tests. In the third sample 0.4% of polyester fiber is applied to the concrete mix and tested for compressive strength, flexural strength and tensile strength is divided. In the fourth specimen both 1.6% polypropylene fiber and 0.4% polyester fiber were mixed with concrete mix and three tests were tested.

Road transport is undoubtedly the nation's way of life and its development is of paramount importance. Small traditional paraffin and its maintenance requirements and rehabilitation performance indicate the size of the concrete concrete areas. There are several advantages of cement concrete for small stone concrete. This paper focuses on the POLYMER FIBER REINFORED CONCRETE PAVEMENTS, a recent development in the field of reinforced concrete design. Comparative studies of these conventional concrete routes were performed using Polypropylene fiber waste as fiber reinforcement

KEYWORDS- Concrete pavement, polypropylene fiber, polyester fiber, Ccompressive strength, Flexural strength, split tensile strength.

I. INTRODUCTION

The use of discrete fiber in roadways was carried out to improve the quality of concrete paved stones. Roads are used for safe driving. It is important to take care of its lengthy tenure. The pavement needs to be sturdy enough for automobiles to drive through it safely. The primary objective of the paved method is to transfer the load to the base below.[3] The advantage of using strong concrete is its strength and its ability to withstand harsh environmental conditions. The solid pavement is made of cement concrete or concrete foundation. The sturdy paved area provides an efficient, comfortable, and inexpensive design of roads and highways. Due to its flexible durability and mechanical resistance, the paved system allows for even distribution of vehicle loads in the lower parts, preventing the concentration of load on the lower part.[2] But pointed concrete lines can quickly fade, in the form of cracks, cracks and failures, which can lead to loss of utility and hazardous driving conditions This is mostly caused by cement concrete's robust nature and its low resistance to conditions of fatigue and its low durability.[5] Reduced concrete cracking is a major problem in the basic methods of cement concrete. However, the usage of cables can minimise these effects. Concrete that has fibres added to it to strengthen structural integrity is called fiber-reinforced concrete (FRC).[7] To fix concrete constructions, many types of fibres can be included into the concrete. A high grade concrete may be produced more efficiently with each strip. When mixing concrete mixes, fibre is added. A percentage of the entire volume will be shown as the value that has to be added. Steel, polypropylene fibre, and synthetic fibre are the types of fibres that may be added to concrete roadways to increase their strength. Different characteristics of each fibre can raise the calibre of concrete.A solid paved area consists of a high concrete slope resting on the lower courses, usually a basic course and a lower floor option.[8] A few important advantages are linked to the adoption of rigid roads that are different from conventional flexible corridors. In particular, solid road pavement offers good, comfortable, high-performance and cost-effective options when working on heavily loaded roads and highways. Indeed, because of its flexible rigidity and mechanical rigidity, the paved system allows for evenly distributed vechicular loads in the lower layers.[12]

On the other hand, concrete paints may quickly collapse, in the form of small and large cracks, fractures and failures, which can result inloss of utility and hazardous driving situations This is mostly caused by cement's poor behaviour and limited resilience to fatigue conditions and its low hardness. However, these harmful features can be reduced by the reception of the fibers. Indeed, they were scattered structural fibers can be added to the fiber reinforced (FRC) concrete mixing phase.[9] Many studies have been conducted over the past decades regarding the operation of

the FRC. It seems that fibers can significantly improve the durability, strength and stiffness of a cement matrix.

II. MATERIAL USED

A. Aggregates

Aggregates are one of the most important concrete components that give the body concrete and reduce shrinkage.[11] Clean, sturdy, and long-lasting aggregate is required for a successful concrete mix. Typically, fine aggregate and coarse aggregate collections are used.

1)Fine Aggregates

These are often small-diameter sand or broken stone. Sand served as an effective glue. To increase uniformity and workability, fine aggregate is employed. A parameter known as fineness modulus determines the sand's overall fineness. Sand has a fineness modulus range of 2.0 to 4.0.

2)Coarse Aggregate

Coarse aggregate shall consist of clean, hard, strong, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, angular pieces.[7] These particles measure more than 9.55 mm. The 20mm coarse aggregate utilised in this study.

Table 1:Results of various physical properties of aggregates

S No.	Property	Result	Specifications for BC	Test Method
1	Abrasion Value	23.35%	30%	IS 2386 Part 4
2	Impact Value	16.39%	24%	IS 2386 Part 4
3	Crushing Value	18.9%	30%	IS 2386 Part 4
4	Specific Gravity	2.68%	2.5-3%	IS 2386 Part 3

B. Fibers

Polyester and polypropylene are the types of fibre employed in the experiment. The surface of these fibres is hydrophobic. The use of these fibers as reinforcement reduces penetration, shrinkage resistance, increases the concrete's tensile and compression strength.

1)Polypropylene Fiber

Giulio Natta and German scientist Karl Rehn initially polished polypropylene as a crystalline isotactic polymer in March 1954. Since 1957, the Italian business Montecatini has produced a significant amount of isotactic polypropylene thanks to this groundbreaking discovery. The fiber length used in this research is 15mm.

2)Polyester Fiber

Polyester fiber is an artificial fiber that may be used in the building of pavement to prevent microcracking and also aids in increasing the compressive and flexural strength of the pavement. Additionally, these fibers lessen drying shrinkage. Because there is no decay threat and it is highly cost-effective, the usage of polymeric fiber has grown recently. The polyester fiber is brought online. Standard Grade A, size 125gm is used in this research.

Table 2: Physical properties of Fibers

S No.	Physical Properties	Results(7days) N/mm^2	Results (28days) N/mm^2
1	Compressive Strength Test	48.63	55.32
2	Flexural Strength Test	6.87	8.70
3	Split Tensile Test	4.84	5.87

III. METHODOLOGY

FRC can be mixed in a variety of ways. Most essential, the fibers should not split or be beat during mixing; instead, there should be an undesirable dispersion of the fibers. The majority of balling happens during the fiber process installation. Increased aspect ratio, fiber capacity percentage, and aggregate size and quantity will all increase balling affinities and decrease workability. The technique needed a minimum water content of 400 kg/m and a water ratio between 0.4 and 0.6 in order to adequately cover the adhesive's increased surface area.In comparison to regular concrete, ferro fibre concrete mixes frequently contain more cement, more fine aggregate, and coarse material of smaller size. When mixing fibres, a lot of vibration is frequently used. The greatest way to avoid fibre separation is external vibration. Surfaces are frequently thrown by rotating force, flow tubes, and metal trowels. The kind and concentration of fibers in concrete affect its mechanical properties, which strongly depend on them. It is possible to utilise the same tools and procedures as for regular concrete.Necessary tests Tests for flexural strength, pressure strength, and separation strength. For each combination, a set of 4 examples was used for all testing. Polyester and polypropylene will be the fibersutilised in the test. The concrete utilised is of grade M25. Standard concrete will be used for one template, 0.4% polyester will be used for another, 1.6% polypropylene will be used for another, and the final template will combine both fibers. These models are all contrasted with their synthetic counterparts.The ordinary portland cement issued in all mixtures.

IV. ANALYSIS OF RESULTS

Result of Polypropylene and Polyster Fibers with Concrete Mix

A. Compressive Strength Test

The cubes used in this test were cast, and their dimensions were 150 * 150 * 150 mm. First mould was constructed with a normal concrete mix using the M25 mix design. A second identical-sized cube was made with 1.6% polypropylene fiber. With the same mix proportion, the third cube included 0.4% polyester fiber. While the final cube was made using a mix design with the equal amounts of polypropylene and polyester fiber (1.6% and 0.4%, respectively). As shown in table no. 3 and figure no. 1 and 2.

Table 3: Compressive Strength Test of fiber concrete

S. No.	Description	7 days Avg. (N/mm2)	28 days Avg. (N/mm2)
1	Normal Concrete Mix	22.63	36.33
2	Concrete mix with 1.6% polypropylene fiber	23.70	38.07
3	Concrete mix with 0.4% polyester fiber	47.35	50.53
4	Concrete mix with both 1.6% and 0.4% of polypropylene and polyester fiber	48.63	52.32

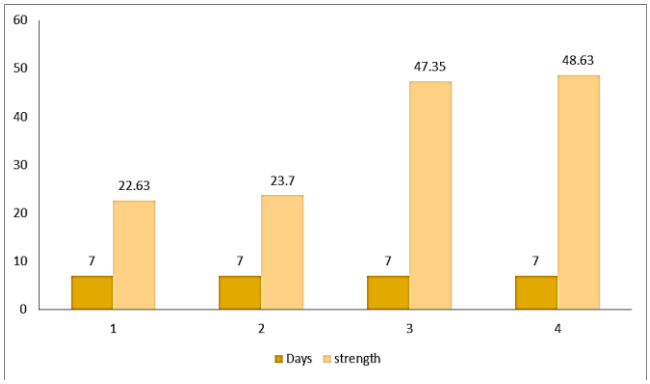

Figure 1: Compressive strength in 7 days

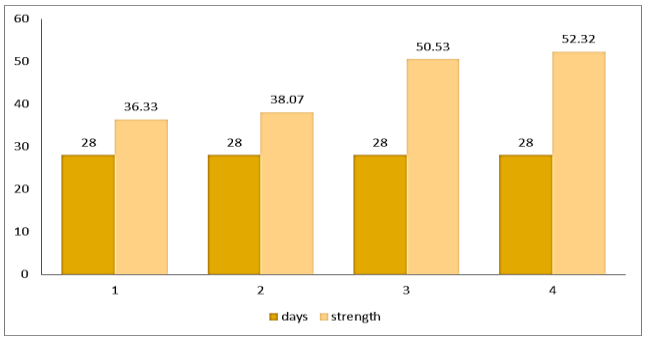

Figure 2: Compressive strength in 28 days

B. Flexural Strength Test

Beam samples with dimensions of 100x100x500 mm were cast for the flexural strength test. These types of dynamic forces were tested under loading of four points according to the I.S. 516-1959, using a universal test machine. The test sample was created by adding three layers of concrete to the mold that were almost the same size. First mold was constructed with a normal concrete mix using the M25 mix design. The same-sized second cube was made with 1.6% polypropylene fiber inserts. While the last cube was constructed with a composite design by combining polypropylene and polyester fiber with the same percentages 1.6% and 0.4%, the third cube with the same mix proportion was made with 0.4% polyester fiber inserts. As shown in table no. 4 and figure no. 3 and 4.

Table 4: Flexural strength test of fiber concrete

S. No.	Description	7 days Avg. (N/mm2)	28 days Avg. (N/mm2)
1	Normal Concrete Mix	4.53	5.87
2	Concrete mix with 1.6% polypropylene fiber	4.92	6.21
3	Concrete mix with 0.4% polyester fiber	6.4	7.7
4	Concrete mix with both 1.6% and 0.4% of polypropylene and polyester fiber	6.87	8.70

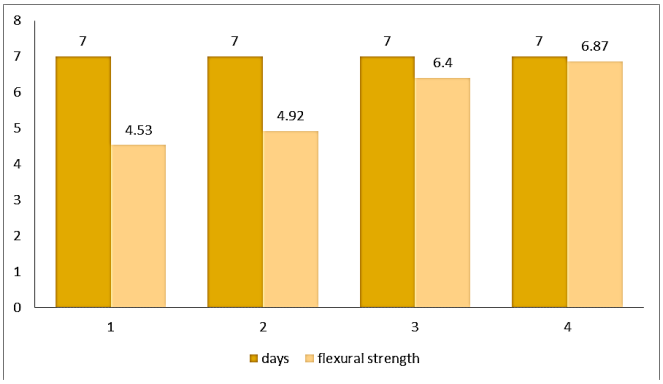

Figure 3: Flexural strength in 7 days

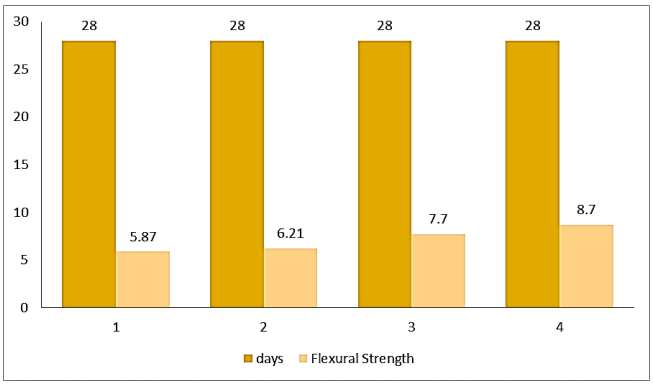

Figure 4: Flexural strength in 28 days

C. Split Tensile Strength

A cylinder that is 15 cm broad and 30 cm high will be used as the sample in this test. The employed metal mould has an inner diameter of 15 cm +/- 0.2 mm and a height of 30 cm +/- 0.1 cm. To stop the concrete from sticking to the moulds, a small layer of mould oil was applied before usage. The 4 different concrete mixtures were all moulded into 5 cm-thick layers. Each layer was manually put together. The outside concrete was levelled with the top of the mould using a trowel after packing the top layer, and it was then covered with aluminium foil to stop water leakage. Test samples were kept for 24 hours at a temperature of 27 ° +/- 2 ° C. Following this, the samples were removed from the mould and submerged for 28 days in pure, clean water. As shown in table no. 5 and figure no. 5 and 6.

Table 5: Split tensile strength of fiber concrete

S. No.	Description	7 days Avg. (N/mm2)	28 days Avg. (N/mm2)
1	Normal Concrete Mix	3.55	4.9
2	Concrete mix with 1.6% polypropylene fiber	3.75	5.56
3	Concrete mix with 0.4% polyester fiber	4.48	5.23
4	Concrete mix with both 1.6% and 0.4% of polypropylene and polyester fiber	4.84	5.87

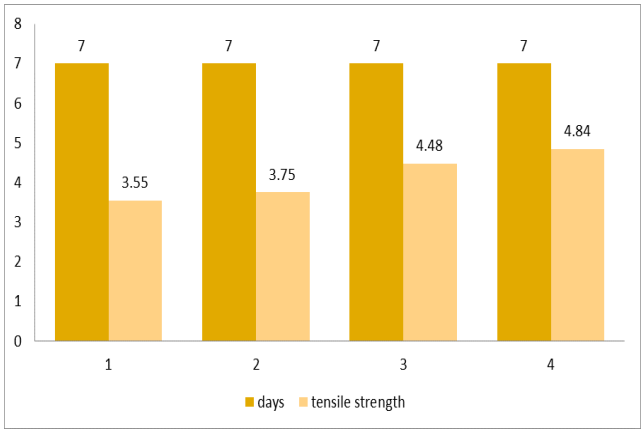

Figure 5: Split tensile strength in 7 days

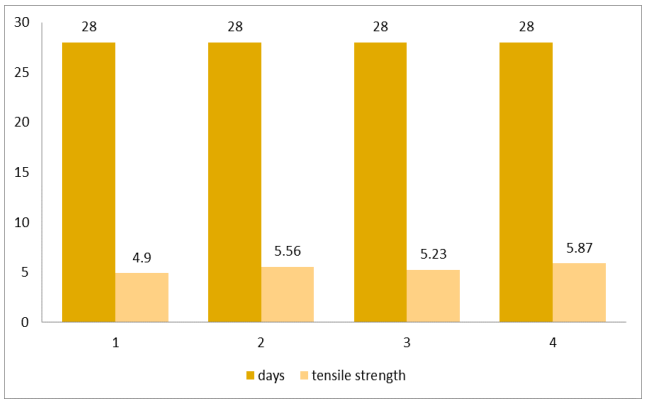

Figure 6: Split tensile strength in 28 day

V. CONCLUSION

- A standard concrete mix has a lower compressive strength than the other three compounds, however adding polyester and polypropylene to the concrete boosted its compressive strength.
- Standard concrete had a lower flexural strength than the other three combinations, but when polyester was added to the concrete at a rate of 0.4% and combined with polypropylene, the flexural strength of the mixture increased noticeably.
- Only concrete with 4% polyester fiber and the combination of both polypropylene and polyester boosts the strength above ordinary concrete mix, which has a lower separation strength than the other three.
- Concrete strengthened significantly more when polyester fiber was added than when polypropylene fiber was.
- The strength improvement achieved by combining polyester fiber with concrete is less significant than the increase achieved by combining polyester fibre with both polypropylene fiber and concrete.
- Over an open concrete road, the PFRC is more efficient. Because of their high cost and corrosion resistance, polymeric fibers like polyester or polypropylene are utilised. The PFRC requires special consideration of processes and construction processes to achieve optimal performance. The initial cost is 15-20% higher compared to the reduction in repair and rehabilitation activities, This reduces the cost of the PFRC by 30–35% compared to the readily paved method. Road networks facilitate resource mobility, communication, and contribute to growth and development in a big, quickly developing country like India.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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