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Effect of Polypropylene Fiber in Concrete

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ABSTRACT:

A new type of concrete, known as polypropylene fiber reinforced concrete (PFRC), has been developed to address the two main drawbacks of conventional concrete: low tensile strength and brittle failure. The aim of a research program is to evaluate the performance of PFRC by increasing its ductility and energy absorption. In this study, an experimental investigation was conducted to explore the properties of PFRC compressive strength The fiber volume fraction (v) was 1%.. The results showed a significant improvement in compressive strength compared to plain concrete.

Keywords: Conventional Concrete, Low tensile strength, Brittle failure, Polypropylene Fiber Reinforced Concrete (PFRC), Ductility, Energy Absorption, Compressive Strength, Flexural Strength , Shear Strength, Fiber Volume Fraction.

Introduction:

Concrete is a fundamental building material used in various civil engineering works. Despite its extensive use, the material has limitations in terms of quality, strength, and durability. Research efforts have been dedicated to improving these aspects while simultaneously finding cost-effective ways to use concrete in construction. While concrete is strong in compression, its tensile strength is limited, and it lacks ductility and resistance to cracking. The presence of internal micro-cracks weakens the material, causing it to eventually fracture. For instance, rigid pavements may develop cracks due to temperature variation, shrinkage, or heavy loads. Traditionally, reinforced steel bars and restraining techniques have been used to enhance the tensile strength of concrete members, but these methods do not increase the tensile strength of concrete itself. Micro-cracks can develop in plain concrete even before loading, which propagate and open up during loading. Researchers have found that adding small, closely spaced, and uniformly dispersed fibers to concrete improves its crack resistance and static and dynamic properties. This type of concrete is known as fiber reinforced concrete (FRC). This dissertation aims to compare the behavior of polymer fiber reinforced concrete mixed with fiber to plain concrete.

Polypropylene Fiber

Polypropylene stands out among synthetic fibers due to its exceptional physical, mechanical, thermal, and electrical properties, making it a cost-effective material. The current market offers two main types of polypropylene fibers, namely fibrillated and monofilament, each with their unique characteristics.

Specification of Polypropylene Fiber

- Diameter: 33-35 micron
- Cut length: 6mm, 12mm, 24mm
- Tensile Strength: 6000kg/cm2
- Melting Point: >250C
- Elongation: 45-55%
- Moisture: <1%

Physical Properties of Polypropylene Fiber

Strength: Polypropylene fiber is a strong fiber that has good resistance to abrasion and tearing.

Elasticity: Polypropylene fiber is a highly elastic fiber that can stretch up to 30% of its original length without breaking.

Water resistance: Polypropylene fiber is a hydrophobic fiber that is highly resistant to water, which makes it suitable for use in products that are exposed to moisture.

Chemical resistance: Polypropylene fiber is highly resistant to chemicals, including acids, alkalis, and organic solvents.

Heat resistance: Polypropylene fiber has a high melting point of around 165°C, which makes it suitable for use in products that are exposed to high temperatures.

Lightweight: Polypropylene fiber is a lightweight fiber that has a low density, which makes it suitable for use in products that require a lightweight material.

Low thermal conductivity: Polypropylene fiber has a low thermal conductivity, which means that it is a good insulator and can help to reduce heat loss in products.

UV resistance: Polypropylene fiber is highly resistant to ultraviolet (UV) radiation, which makes it suitable for use in outdoor products that are exposed to sunlight

Advantages of Polypropylene Fiber

a) The tensile strength is enhanced.

b) The fiber-reinforced concrete exhibits greater impact resistance.

c) The permeability is decreased.

d) Drying shrinkage is prevented.

e) It is effortless to mix and use.

f) It regulates cracking.

g) Rebound loss is reduced, which results in direct savings and gains.

h) It improves flexibility and abrasion resistance.

i) It is a chemically inert and highly integrated product.

j) It reduces the need for steel reinforcement in industrial floors.

k) It can be compacted with all types of fibers.

l) It is a material that is resistant to rust and alkaline substances.

m) It is suitable for use in pumped concrete and shotcrete.

Disadvantages of Polypropylene Fiber

a) The fibres form very small lumps while mixing.

b) The fibres appearing on the surface of the concrete and are not recommended from the aesthetic views

Applications

a) Plain concrete and wall plastering.

b) Used in footings, foundations and tanks.

c) Pipes, burial vaults, pre-stressed beams etc.

d) Roads and pavements.

e) Bridges and dams.

Objective of the studty :

Compare the compressive strength of plain cement concrete (M20) with polypropylene fibre reinforced concrete

Compressive Strength Test :

The following procedure is conducted for the compressive strength test:-

The dimensions of the specimen are cubes measuring 150x150x150mm, which are determined by taking an average of perpendicular dimensions at a minimum of two locations. The specimen is placed at the center of the compression testing machine and subjected to a continuously and uniformly applied load on the surface parallel to the direction of tamping. The load is incrementally increased until the specimen fails, and the maximum load carried by each specimen during the test is recorded, as illustrated in the figure. The compressive strength is calculated using the following formula:

Compressive strength = P/A x 1000

where P is the load measured in KN an

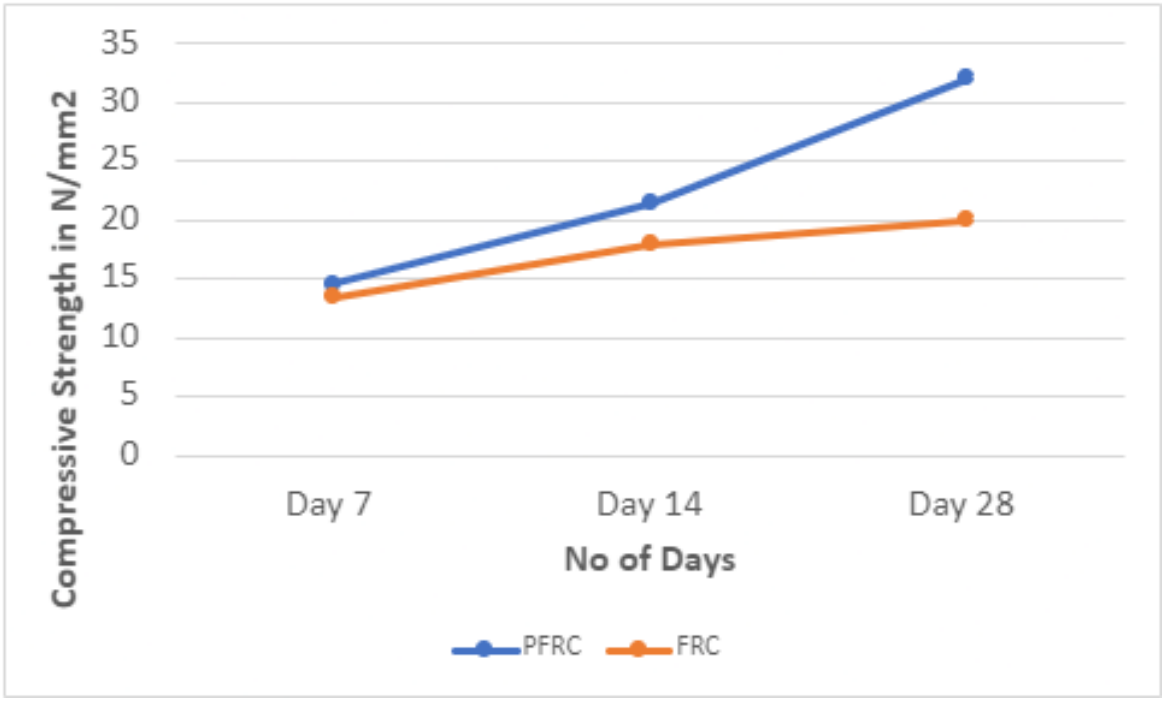
d A is the surface area of the cube, which is equal to 150x150mm.

Data of Polypropylene Fiber reinforced concrete with 1% of polypropylene fiber

Table 1 – Data of Polypropylene Fiber

No of Days	Loan Failure in 'KN'	Compressive Strength in N/mm2
7	330	14.6
14	482	21.4
28	720	32.1

From the above result the Compressive strength of PFRC is greater than the normal concrete (M20)



Graph 1 – Comparing the Compressive Strength of PFRC with FRC

Conclusion

The use of polypropylene fibers in concrete has several advantages over traditional normal concrete. Polypropylene fibers improve the compressive strength, durability, and impact resistance of concrete. They also enhance the flexural and tensile strength, reduce permeability, shrinkage, and cracking. Polypropylene fibers are lightweight, easy to mix and use, and chemically inert. Furthermore, they minimize the need for steel reinforcement, making

them a cost-effective and practical alternative. Overall, the use of polypropylene fibers in concrete is a viable option to improve the properties of concrete and enhance its performance in various applications.

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List all the material used from various sources for making this project proposal

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