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# An Experimental Study: Effect of Polypropylene Fiber on Pavement Quality Concrete (PQC)

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## CHAPTER -1
## INTRODUCTION

### 1.1. Background Information

Today in construction industry has got top priority for sustainability. Concrete is man-made product which is the most commonly used in the construction industry in the world. To decrease/ control of cracking is especially more important normally first hours after pouring of concrete. polypropylene Fibers in concrete improving the mechanical properties. Fibers effectively restrict the propagation of contraction cracks through dispersing the internal stresses. more amount of fiber material used in the concrete to restrict the spreading of the cracks. The performance of the fiber-reinforced concrete depends on interaction between the cement matrix and the fibers, which depends on the adhesion and the friction forces. Due to their low surface energy and chemical structure, show extremely low wet ability and poor adhesion with the cementitious matrix. Looking for aggregates for concrete or any construction activity and to dispose of the waste from various industries is the present concern. In this study the recycled polypropylene fibers 12 mm were used in concrete mix for comparative study of compressive and flexural strength of the concrete and to reduces the shrinkage cracks on the surface of the pavement concrete. use of polypropylene fiber as a industrial waste in the construction industry and to maintain environmental balance.

The productive use of waste material represents a means of improving some of the problems of solid waste management. It helps to save and sustain natural resources that are not restocked. The use of polypropylene fiber in concrete is a relatively recent concept. One of the important reviews on the use of waste polypropylene fiber in concrete focused on the advantages and financial benefits of polypropylene fiber, besides their physical and mechanical properties.

### 1.2 Need and Importance of Polypropylene Fiber: -

Polymers have so many important properties, which may alone or together.

1. Durable
2. Corrosion resistant.
3. Good Insulation for sound, cold ,heat energy.
4. Economical.
5. Longer life.
6. Maintenance free
7. Hygienic.
8. Clean

9. Handling to Comfort.
10. Light in weight.
11. Good Insulation for sound, cold, heat energy.

**PROPERTIES OF POLYPROPYLENE FIBRE**

**A. Physical Properties:**

The physical properties are the mass properties, geometric properties, the thermal properties and the transport properties of the material.

**B. Mechanical properties:** These are the properties associated with the mechanical forces applied to the material. The mechanical properties are typically obtained from the mechanical tests, either on the constituents or on the composite itself. The properties depend upon type of fiber and matrix used.

**C. Other Properties:**

**a. High Strength and Stiffness Retention-**

Composites can be designed to provide a wide range of mechanical properties including tensile, flexural, impact and compressive strengths. And unlike traditional materials, composites can have their strengths oriented to meet specific design

**b. Light Weight-**

FRP composites have high strength to weight ratio. Therefore, for the same strength FRP composites are lighter.

**c. Creep-**

The addition of the reinforcement to the polymer matrix increases the creep resistance of the properly designed FRP part. Creep will not be a significant issue if the loads on the structure are kept below appropriate working stress level

**d. Resistance to Environmental Factors-**

**1. Freeze-thaw:**

FRP composites are not attacked by galvanic corrosion and have low water absorption, they resist the destructive expansion of freezing water.

**2. Weathering and Ultra-Violet Light:**

FRP composite structures designed for weather exposure are normally fabricated with a surface layer containing a pigmented gel coat or have an ultraviolet (UV) inhibitor included as an additive to the composite matrix. Both methods provide protection to the underlying material by screening out UV rays and minimizing water absorption along the fiber/resin interface.

3. **Chemicals and Temperature:**

FRP Composites do not rust or corrode and can be formulated to provide long-term resistance to nearly every chemical and temperature environment. The composites successfully withstand the normally destructive effects of de- icing salts and/or saltwater spray of the sea.

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## 1.3 AIM: -

To study the strength and flexural behavior of polypropylene fiber used in Pavement Quality Concrete (PQC)

## 1.4 OBJECTIVES

1. To Analysis the performance of polypropylene fiber in Concrete.
2. To evaluate the effect of polypropylene fiber concrete on cracking.
3. To determine the optimum proportion of the polypropylene fiber to enhance the maximum strength.

### 1.5 Scope:

1) Waste polypropylene fiber directly disposed in environment is causes of land pollution. The addition of recycled polypropylene fiber to conventional concrete improves the compressive and flexural strength of the concrete. It also helps to reduce the environmental impact of waste polypropylene fiber.
2) This project was limited to determine the effect of fiber in terms of compressive strength, flexural strength and shrinkage cracks. Further study can be carried out to find the performance of fibers in concrete in terms of various sizes of polypropylene fiber in construction of pavement concrete.

CHAPTER 3
CASE STUDY

**3.1 GENERAL: -**

Fiber reinforced concrete has become the study of researchers to make its use more efficient in construction industry. From the study of literature, it is understood that the use of fibers in concrete is not sufficient to increase the strength and efficiency of concrete. The materials used in concrete needs to be tested to determine their properties. Using materials with good physical and mechanical properties together with addition of polypropylene fibers in concrete can enhance the performance of concrete as well as increases the compressive strength of concrete to much extent. In this project, the properties of aggregates like flakiness index, elongation index, specific gravity, water absorption, crushing value etc. determined the properties of aggregates. With proper mix design and proportioning, the concrete cube and beam were casted with 0, 0.700, 0.800, 0.900 and 1.000 Kg/Cum. of polypropylene fiber and cured for 7 day and 28 days. The concrete cube and beam with and without polypropylene fibers will require to be tested for compressive and flexural strength test. Based on the test results the conclusion will be drawn. The cost of using polypropylene fiber in Pavement Quality Concrete (PQC) can vary depending on various factors such as the type and quality of fiber used, project specifications, and market conditions. However, I can provide you with a general comparison between the cost and effects of using polypropylene fiber in PQC and conventional Pavement Quality Concrete.

**MATERIAL: -**

**A) Aggregates (Coarse and Fine Aggregates)**

Various properties of aggregates can affect the performance of concrete therefore, various considerations have to be kept in mind while selecting the material. Aggregates used in present study, were tested for their specific gravity and other properties and results have been tabulated.

**B) Cement**

Ordinary Portland cement 53 grade was used as it satisfied the requirements of IS: 11269:2003 with specific gravity of 3.15 is used throughout the study.

**C) Mixing and Curing Water**

Potable water used for mixing and curing of concrete.

**D) Fiber:** Having 12 mm fiber length fiber is used for the analysis of mix design review. Fiber manufactured by Kalyani Polymer Pvt. Ltd.

**(E) Admixture**:

Asian Paints (Maximoplast PC-200): It is a dark brown liquid based on a blend of specially selected organic polymers. Due to use of admixture concrete maintains the workability for longer periods even at high ambient temperatures.

## MIX – DESIGN

| | | |
|---|---|---|
| **A-1** | **Stipulations for Proportioning** | |
| a) | Grade of Concrete | **M-40 (PQC)** |
| b) | Type of Cement | OPC 53 Garde |
| c) | Maximum nominal Size of Aggregate (mm) | 28 |
| d) | Minimum Cement Content as per MoRTH 1700-2 (Kg/Cum) | 380 |
| e) | Maximum Water Cement Ratio as per MoRTH 1700-2 | 0.40 |
| f) | Exposure Condition | Normal |
| g) | Degree of Supervision | Good |
| h) | Type of Aggregate | Crushed |
| i) | Chemical Admixture type | Supreme |

| | | |
|---|---|---|
| **A 2** | **Test Data for Materials: -** | |
| a) | Cement | OPC 53 Garde |
| b) | Specific Gravity ofCement | 3.15 g/cc |
| c) | Chemical Admixture | Supreme |
| d) | Source of Coarse Aggregate | Ch 534+750 LHS Dahyane Query GHV Crusher |
| e) | Source of Fine Aggregate | Ch 534+750 LHS Dahyane Query GHV Crusher |
| f) | Source of Water | GHV Camp |
| g) | Source of Fly ash | Thermal Power Plant Bhusaval |
| h) | Specific Gravity at SSD Condition | |
| | 28 mm and down | 2.856 |
| | 10 mm | 2.843 |
| | Crush sand | 2.688 |
| | Fly | 2.300 |

| | 31 mm (%) | 10 mm (%) | C.Sand (%) | Total | | |
|---|---|---|---|---|---|---|
| % | 41 | 21 | 38 | 100 | | |
| IS Sieves (mm) | Avg. Percentage of Passing (28 mm agg.) | Avg. Percentage of Passing (10 mm agg.) | Avg. Percentage of Passing (Fine agg.) | Combined Percentage of Passing | Specification Limit | |
| | | | | | Lower | Upper |
| 31.5 | 100.00 | 100.00 | 100.00 | 100.00 | 100 | 100 |
| 26.5 | 79.13 | 100.00 | 100.00 | 91.44 | 85 | 95 |
| 19 | 53.33 | 100.00 | 100.00 | 80.87 | 68 | 88 |
| 9.5 | 1.88 | 55.04 | 100.00 | 50.33 | 45 | 65 |
| 4.75 | 0.82 | 2.82 | 89.15 | 34.81 | 30 | 55 |
| 0.600 | 0.00 | 1.66 | 29.51 | 11.56 | 8 | 30 |
| 0.150 | 0.00 | 0.30 | 15.38 | 5.91 | 5 | 15 |
| 0.075 | 0.00 | 0.00 | 8.90 | 3.38 | 0 | 5 |
| **Pan** | | | | | | |

## 3.5 METHODOLOGY

Following sequence is going to be used to prepare test specimen: -

First collect the materials from source.

To determine the quality of material testing is to be done in laboratory.

M40 grade of concrete mix design will be used. Based on mix trial decide water cement ratio.

Cubes and Beams are casted by concrete mix for every ratio of adding fibers. The cube and beam specimen size are 150mm x 150mm x 150 mm and 750mm x 150mm x 150 mm respectively.

**Casting and Curing:**

Mostly M40 concrete is used for various construction works, but in this project M40 concrete is taken for analysis of pavement quality concrete by adding fibers such as 00,0.700,0.800,0.900 and 1.000 Kg/cum. Tests were conducted on coarse aggregates, fine aggregates and cement to determine their physical properties.

Concrete cube of 150mm x 150mm x 150 mm and the beam of 750mm x 150mm x 150 mm were casted and tested for 7- and 28-days strength.

## RESULTS AND DISCUSSIONS

Based on the trials conducted for M40 grade. The Compressive and flexural test conducted on concrete cube and beam. comparatively checked the result of conventional concrete and polypropylene fiber mixed concrete. The ratio of polypropylene fiber in concrete and Maximum Compressive and flexural strength results at 28 days considered for optimum utilization ratio of fiber

I) Results for M40 (PQC) Grade Concrete

**Table No. 12: 7 days Compressive strength by adding 0 Kg/Cum of fiber inconcrete mix**

| S.No | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Loa d (KN) | Comp. stren gth (N/m m2) | Avg. Comp. strengt h (N/mm 2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 8650 | 2.563 | 910 | 40.44 | 41.19 |
| 2 | 2 | 150 | 150 | 150 | 8600 | 2.548 | 940 | 41.78 | |
| 3 | 3 | 150 | 150 | 150 | 8590 | 2.545 | 930 | 41.33 | |

Table No. 13; 7 days Compressive strength by adding 0.700 Kg/Cum of fiber inconcrete mix

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. strength (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 9040 | 2.679 | 960 | 42.67 | 43.41 |
| 2 | 2 | 150 | 150 | 150 | 9030 | 2.676 | 990 | 44.00 | |
| 3 | 3 | 150 | 150 | 150 | 9050 | 2.681 | 980 | 43.56 | |

**Table No. 14; 7 days Compressive strength by adding 0.800 Kg/Cum of fiber inconcrete mix**

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strength (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **1** | **150** | **150** | **150** | **9050** | **2.681** | **990** | **44.00** | **45.19** |
| **2** | **2** | **150** | **150** | **150** | **903** | **2.677** | **1010** | **44.89** | |
| **3** | **3** | **150** | **150** | **150** | **9040** | **2.679** | **1050** | **46.67** | |

Table No. 15 7 days Compressive strength by adding 0.900 Kg/Cum of fiber inconcrete mix

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strength (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 8700 | 2.578 | 1100 | 48.89 | |
| 2 | 2 | 150 | 150 | 150 | 8760 | 2.596 | 950 | 42.22 | |
| 3 | 3 | 150 | 150 | 150 | 8600 | 2.548 | 1050 | 46.67 | 45.93 |

**Table No. 16: 7 days Compressive strength by adding 1.000 Kg/Cum of fiber in concrete mix**

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strengh (N/mm2) | Avg. Comp. strength(N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 8870 | 2.628 | 1110 | 49.33 | 45.48 |
| 2 | 2 | 150 | 150 | 150 | 9040 | 2.679 | 960 | 42.67 | |
| 3 | 3 | 150 | 150 | 150 | 9045 | 2.680 | 1000 | 44.44 | |

**Table No. 17: 28 days Compressive strength by adding 0 Kg/Cum of fiber in concretemix**

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strength (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 8955 | 2.653 | 1190 | 52.89 | 53.48 |
| 2 | 2 | 150 | 150 | 150 | 9090 | 2.693 | 1200 | 53.33 | |
| 3 | 3 | 150 | 150 | 150 | 9065 | 2.686 | 1220 | 54.22 | |

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strengh (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 8650 | 2.563 | 1230 | 54.67 | 54.07 |
| 2 | 2 | 150 | 150 | 150 | 8600 | 2.548 | 122 | 54.22 | |
| 3 | 3 | 150 | 150 | 150 | 8590 | 2.545 | 1200 | 53.33 | |

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strengh (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 9160 | 2.714 | 1210 | 53.78 | 54.15 |
| 2 | 2 | 150 | 150 | 150 | 9075 | 2.689 | 1225 | 54.44 | |
| 3 | 3 | 150 | 150 | 150 | 9145 | 2.710 | 1220 | 54.22 | |

**Table No. 20; 28 days Compressive strength by adding 0.900 Kg/Cum of fiber in concrete mix**

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strength (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 9145 | 2.710 | 1200 | 53.33 | 54.39 |
| 2 | 2 | 150 | 150 | 150 | 9045 | 2.680 | 1215 | 54.00 | |
| 3 | 3 | 150 | 150 | 150 | 9020 | 2.673 | 1256 | 55.82 | |

**Table No. 21 days Compressive strength by adding 1.000 Kg/Cum of fiber in concrete mix**

| S.NO. | Lab ID | Length (mm) | Breadth (mm) | Height (mm) | Weight (kg) | Density (Kg/m3) | Load (KN) | Comp. Strengh (N/mm2) | Avg. Comp. strength (N/mm2) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 150 | 150 | 150 | 8800 | 2.607 | 1250 | 55.56 | 54.37 |
| 2 | 2 | 150 | 150 | 150 | 9095 | 2.695 | 1200 | 53.33 | |
| 3 | 3 | 150 | 150 | 150 | 9160 | 2.714 | 1220 | 54.22 | |

The compressive and flexural strength test conducted over Conventional concreteand polypropylene fiber reinforced concrete checked and results obtained. Adding of fibers in concrete 0, 0.700, 0.800, 0.900 and 1.000 Kg per Cum. of concrete. Compressive and flexural strength at 7 days, 28 days are determined.

The experimental study over conventional concrete and fiber reinforced concrete shows that the compressive strength of concrete after addition of polypropylene fiber increases slightly. The compressive strength at 7 and 28 days of 0.900 Kg/Cum. of polypropylene fiber mix concrete has increased by 10.41% and 1.70% respectively. But further addition of polypropylene fiber in concrete, compressive strength very slight difference observed that means when using of high dosages of polypropylene fiber the effect goes on decreases. Further flexural strength of concrete is increase by

2.56 % for 7 days and 7.54 % of 28 days respectively.

# Chapter 5

# CONCLUSION

As per obtained results concludes that addition use of fiber in concrete increasesslight compressive strength of concrete up to limit.

It has been observed that in M40 (PQC) grade of concrete :-

- Addition of fiber up to 0.900 Kg/cum of concrete increases the compressive strength by 1.7 %, but flexural strength of concrete strength is increased by 7.54 %.

- Further flexural strength of concrete is increase by 2.56 % for 7 days and 7.54 % of 28 days respectively.

- In this case the % of 1.00 Kg/Cum. compressive strength is reduced by 3.67 % compared to 0.900 Kg/Cum. of fiber mix. Higher use of fiber in concrete affected performance of concrete and reduces the compressive strength.

- Hence it can be concluded that, Fiber is having good bonding with cement up to optimum Limit. with the optimum percentage of fiber is 0.900 Kg/Cum of concrete. It is also observed that fiber elements not affect the workability of concrete. Addition of fiber beyond 0.900 Kg/Cum reduces the compressive strength of concrete. Fiber is not harmful for utilization or handling. This reduces the polypropylene fiber waste in environment and helps to maintain the clean environment. Fiber maintained or tie the concrete life more than targeted/design in healthy therefore fiber is good innovation for construction industry.

# Chapter 6 FUTURE SCOPE

This project was limited to determine the effect of fiber in terms of compressive strength, flexural strength and shrinkage cracks. Further study can be carried out to find the performance of fibers in concrete in terms of various sizes of polypropylene fiber in construction of pavement concrete.

The future scope and effects of using polypropylene fiber in Pavement Quality Concrete (PQC) are promising and can have several potential benefits. Here are some of the future implications of using polypropylene fiber in PQC:

1. Enhanced Performance: Polypropylene fiber can contribute to improved performance characteristics of PQC. Ongoing research and development efforts are focused on optimizing fiber types, lengths, and dosages to achieve even better crack resistance, durability, and long-term performance. This can result in longer-lasting pavements that require less maintenance over time.
2. Sustainability: The use of polypropylene fiber in PQC aligns with sustainability goals. Fibers can help reduce the need for additional reinforcement, such as steel, thereby lowering the environmental impact associated with steel production and reducing the carbon footprint of the pavement construction process. Moreover, the potential for increased pavement longevity can contribute to the overall sustainability of transportation infrastructure.
3. Technological Advancements: Advances in fiber manufacturing and material science can lead to the development of innovative fibers with superior properties. Researchers are exploring different types of fibers, such as macro and micro synthetic fibers, hybrid fibers, and recycled fibers, to further enhance the performance of PQC. These advancements can bring about new possibilities for improving pavement quality, strength, and durability.
4. Improved Construction Practices: The use of polypropylene fiber in PQC may lead to advancements in construction practices. Contractors and engineers can refine their construction techniques to maximize the benefits of fiber-reinforced concrete. This can include optimizing fiber dispersion, mixture design, placement methods, and curing procedures to achieve consistent and reliable results.
5. Cost Optimization: As the demand for polypropylene fibers in the construction industry increases, economies of scale may lead to a reduction in the cost of fibers over time. Additionally, the potential for longer-lasting pavements and reduced maintenance requirements can result in cost savings in the long run.

It's important to note that the future scope and effects of polypropylene fiber in PQC will depend on continued research, technological advancements, and industry adoption. As new insights and innovations emerge, the use of fiber reinforcement in PQC is expected to evolve, offering even greater benefits in terms of performance, sustainability, and cost-effectiveness

# Chapter 7

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