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# Comparative Analysis of Polypropylene Fiber for Rigid Airfield Pavement: Case study of Apron of Gautam Buddha International Airport

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**Abstract**

Airfield pavements come in three main types: rigid, flexible, and composite. Rigid pavements, made of Portland Cement Concrete (PCC) slabs on a prepared sub base or base, face challenges due to poor strength in tension and flexure. To address this, Polypropylene Fiber Reinforced Concrete (PFRC) has been introduced, enhancing toughness, flexural strength, tensile strength, and impact resistance. This study aims to compare rigid airfield pavement with PCC surface courses, with and without polypropylene fiber, focusing on strength parameters, thickness, and cost. The research asserts that PFRC serves as an effective modification technique for PCC, promoting effective rigid airfield pavement design. Strength parameters, including compressive strength, split tensile strength, and flexural strength, were assessed. Split tensile strength at 28 days increased by 18%, and flexural strength increased by 14.50%, demonstrating the positive impact of polypropylene fiber. In terms of pavement thickness, the PCC surface course of rigid airfield pavement with polypropylene fiber was 393 mm, while without it was 453 mm, showcasing potential thickness reduction. Total pavement thickness for design air traffic was 943 mm with polypropylene fiber and 1003 mm without. This reduction in thickness indicates a potential for material efficiency without compromising performance.

## 1. Introduction

Airport pavements are designed and constructed to provide adequate support for the loads imposed by aircraft and to produce a surface that is: firm, stable, smooth, skid resistant, year-round all-weather surface, free of debris or other particles that can be blown or picked up by propeller wash or jet blast (FAA AC 150/5320-6G, 2021). In recent years, there has been a notable demand for Portland cement concrete in the construction of airport runways, taxiways, and apron pavements. This is particularly driven by the need for commercial and military airports to upgrade their ground infrastructure in response to the growing volume of air traffic. Concrete, while widely used, faces a significant drawback due to its limited tensile strength. To address this issue in concrete pavements, a solution has been found by incorporating fibers of various materials, sizes, and shapes into the concrete mixture. This innovation has given rise to a novel composite material known as Fiber Reinforced Concrete (FRC). The inclusion of fibers enhances several key material properties of concrete, such as compressive and flexural toughness, fatigue resistance, and impact resistance (Ramakrishnan, et al., 1989); (Trottier & Mahoney, 2001); (Zollo & Hays, 1991). The inclusion of fibers enhances the properties of concrete by improving its capacity to impede the rapid and indefinite propagation of cracks, a phenomenon linked to catastrophic failure in regular concrete. These fibers create stress transfer bridges that span across cracks, effectively decelerating the advancement of larger cracks (Tammam & Feng, 2011). This allows the FRC to retain some post-crack strength, and to withstand much larger post-crack deformations than plain concrete. Various fiber types, including steel, synthetic, carbon, glass, and natural fibers, are employed in the construction industry. Synthetic fibers, exemplified by polypropylene fibers, possess distinctive attributes that render them highly suitable for concrete applications. Polypropylene fiber is chemically inert, non-corrosive, and lightweight. It exhibits high chemical resistance to mineral acids, bases, and inorganic salts (Tammam & Feng, 2011). Furthermore, polypropylene fiber boasts tensile strengths comparable to mild steel. In contrast to steel fibers, synthetic fibers like polypropylene do not alter the visual appearance of concrete, remain corrosion-free, and eliminate the risk of serving as potentially hazardous protrusions.

Airfield pavements are specifically engineered to cater to the unique requirements of aircraft and ensure their safe operation, differing in design from typical road pavements. Rigid airfield pavements, in particular, employ specific concrete mixtures and details. The aim is to provide adequate compressive and flexural strength to withstand the aircraft load on the apron during parking. In Nepal, rigid airfield pavements encounter common challenges, such as the development of cracks attributed to increased traffic loads, pavement aging, and an insufficiently structured maintenance plan. These issues have led to a decline in the apron's serviceability.

This study involved laboratory tests employing polypropylene fibers as modifiers for rigid airfield pavement. Experiments were conducted on standard-sized concrete cubes and cylinders, incorporating varying percentages of polypropylene fibers by weight of cement. The obtained results were then compared with those from normal cement concrete of M-45 Grade, a type commonly utilized in rigid airfield pavements at international airports in Nepal. The aim is to explore the potential use of polypropylene fiber-reinforced concrete in various sections of Nepalese international airport infrastructure, including aprons, runway ends, holding bays, and parking bays designed for Boeing B 777 – 300ER aircraft (with a gross weight of 777,000 lbs) (CAAN, 2011). The investigation focuses on evaluating compressive strength, flexural strength, and split tensile strength.

## 2. Research Objectives

The primary aim of this investigation is to evaluate and contrast Polypropylene Fiber Reinforced Concrete (PFRC) with Portland Cement Concrete (PCC) pavement. The specific objectives of the study are as follows:

- To examine the impact of varying percentages of Polypropylene Fiber (PPF) on the strength of M-45 grade Portland Cement Concrete (PCC).
- To compare the pavement thickness when using PFRC versus PCC Surface Course.

## 3. Past Related Works

(Prasad, et al., 2013) conducted a comparative study on polypropylene fiber-reinforced silica fume concrete and plain cement concrete. The research focused on investigating workability and flexural strength. Results indicated that the addition of 0.4% volume fraction of polypropylene fibers significantly improved flexural strength by 4.95 MPa at 7 days and 7.32 MPa at 28 days. The concrete's performance under flexural loads consistently outperformed the reference mix. The study recommended a mixture with 10% silica fume and 0.40% fiber volume fraction as an optimal design in terms of both workability and flexural strength.

In (Lakshmi, et al., 2020) review of polypropylene fiber-reinforced concrete, the efficiency of such concrete was assessed based on workability, compressive strength, and crack formation. The study concluded that low elastic modulus fibers are ineffective in preventing crack formation under high stress. Additionally, an increase in fiber dosage negatively impacts concrete strength due to difficulties in achieving optimum packing conditions. The research also noted a significant loss in workability with higher fiber content.

(Gupt & Dulawat, 2020) studied polypropylene fiber's effect on cement concrete in rigid pavement. The main goal was to assess the feasibility of using polypropylene fibers as secondary reinforcement to modify plain concrete's brittle nature. (Nobili, et al., 2013) experimented with and monitored polypropylene-based fiber-reinforced concrete in road pavement, offering design guidelines. The study focused on a testing section within the 'Quadrilatero Marche-Umbria' road project tunnel in Italy. Results from a six-month monitoring of actual traffic loads were provided as feedback. The study demonstrated that fiber-reinforced concrete offers an efficient, safe, and cost-effective design solution for roadways, particularly within tunnels. (Mashrei, et al., 2018) examined polypropylene fibers' impact on concrete compressive and flexural strength, aiming to understand their influence on specific strength characteristics. The study focused on these strengths in concrete with polypropylene fiber (PF), analyzing variables like fiber percentage, concrete mix type, and the presence of steel reinforcement in a prism. The investigation explored how these factors affected concrete's compressive and flexural strength. (Dhilipkumar, et al., 2020) experimentally investigated steel and polypropylene fiber concrete, combining fibers for enhanced mechanical properties. The study tested different percentages of steel and polypropylene fibers and concluded that fiber addition improves concrete fracture properties. The researchers suggested comprehensive applications for hybrid fiber in various structures, including pavements, earthquake-resistant buildings, mine lining, and hydraulic structures.

(Zhang, et al., 2012); (Madhavi, et al., 2014); (Hamad, et al., 2019); (Sharma, et al., 2019); (Ede & Ige, 2014) and (Khan, et al., 2016) performed an assessment of Polypropylene Fiber Reinforced Concrete through both destructive and non-destructive tests for compressive strength, along with a flexural strength test. The findings determined the ideal proportion of polypropylene fiber that resulted in enhanced compressive and flexural strengths.

## 4. Experimental Programs

### 4.1. Materials

Specimen casting utilized raw materials such as cement, sand, aggregate, and polypropylene fiber. Local coarse and fine sand aggregates were sourced from the nearby Tinau River in Rupadehi for convenience. Arghakhanchi OPC 43 grade cement, certified by Nepal Standards, was obtained from Bhairahawa. Polypropylene fiber was sourced from H.R. Goel Group in Tripureshwor, Kathmandu.

#### 4.1.1. Coarse Aggregates

The coarse aggregate exhibited a well-graded characteristic suitable for application in a PCC surface course, ensuring a smooth and well-finished surface. Its grading adhered to the specifications outlined in FAA Advisory Circulars (FAA AC 150/5370-10H, 2018), meeting the prescribed physical requirements for coarse aggregate as shown in Table 1.

Table 1: Physical Properties of Coarse Aggregates (FAA AC 150/5370-10H, 2018)

| Test | Method of Test | Specifications |
|---|---|---|
| Soundness Test | As per AASHTO T 104-99 | Not more than 5% |
| Abrasion Test | As per AASHTO T 96 | Not more than 30% |
| Lightweight pieces in aggregate | As per AASHTO T 113 | 0.5% max |
| Clay lumps and Friable particles | As per AASHTO T 112 | 1% max |

#### 4.1.2. Fine Aggregates

The fine aggregate primarily comprised natural siliceous sands characterized by hard, robust, and durable particles, aligning with the specifications outlined in FAA Advisory Circulars (FAA AC 150/5370-10H, 2018), meeting the prescribed physical requirements for fine aggregate as shown in Table 2.

Table 2: Physical Properties of Fine Aggregates (FAA AC 150/5370-10H, 2018)

| Test | Method of Test | Specifications |
|---|---|---|
| Soundness Test | As per AASHTO T 104 | Not more than 5% |
| Fineness modulus(Sieve analysis) Test | As per AASHTO T 37 | 2.3 to 3.1 |
| Lightweight pieces in aggregate | As per AASHTO T 113 | 0.5% max |
| Sand Equivalent Test | As per AASHTO T 176 | 45 min. |

#### 4.1.3. Cement Aggregates

The Portland cement used adhered to the specifications outlined in (ASTM C150, 2012). Specifically, Arghakhanchi OPC cement of 43 grade was employed in the preparation of the specimens.

#### 4.1.4. Polypropylene Fiber

Polypropylene fiber utilized in the specimen preparation adhered to the specifications of (ASTM C1116/C1116M, 2010), Type III as shown in Table 3.

Table 3: Properties of Polypropylene Fiber

| S. N. | Properties | Value |
|---|---|---|
| 1 | Length | 12mm |
| 2 | Specific Gravity | 0.91 |
| 3 | Diameter | 30-35 Micron |
| 4 | Melting Point | 165ºC |
| 5 | Compatibility with Cements | Excellent |

#### 4.1.5. Admixture

The water-reducing admixture employed, Conplast SP432BS, met the requirements specified in (ASTM C494, 2017), Type G, during the preparation of the specimens.

### 4.2. Methods

#### 4.2.1. Preparation of specimens

The mix proportions of the specimens for each individual test namely, compressive strength test (ASTM C39, 2021); flexural strength test (ASTM C78, 2021) and split tensile strength test (ASTM C496, 1996) are presented in Table 4. Six specimens were prepared for each polypropylene fiber content ratio, subjected to testing at both 7 and 28 days.

Table 4: The mix proportions of specimens for each test

| Test | Polypropylene fiber Content (%) | Days | Number of Sample | Number of Sample for Each Polypropylene fiber | Total Number of Sample |
|---|---|---|---|---|---|
| Split Tensile Strength Test | 0% | 7 | 3 | 6 | 30 |
| | | 28 | 3 | | |
| | 0.2% | 7 | 3 | 6 | |
| | | 28 | 3 | | |
| | 0.4% | 7 | 3 | 6 | |
| | | 28 | 3 | | |
| | 0.6% | 7 | 3 | 6 | |
| | | 28 | 3 | | |
| | 0.8% | 7 | 3 | 6 | |
| | | 28 | 3 | | |

For the initial preparation of laboratory samples, the concrete mixes were designed based on a trial mix design. Sample preparation and testing were conducted within a room temperature range of 33°C to 35°C.

#### 4.2.2. Compressive Strength Test

The reliable testing machine having sufficient capacity and capable of applying loads were used for compressive strength testing. To conduct the test, a calibrated compression testing machine was used. Prior to compression tests, compression testing machine (1800 KN capacity) was calibrated from Nepal Bureau of Standards and Metrology, Kathmandu. The compression strength test was performed in the laboratory. To perform the test, the prepared samples as confirmed to (ASTM C31, 2003) was used for testing. All ingredients were mixed for approximately 2-3 minutes, and the resulting concrete was poured onto a tray. A slump test was conducted to assess the workability of the fresh concrete. Following the slump test, the concrete was poured into cube molds measuring 150 x 150 x 150 mm for compression testing. These molds were then positioned on a vibrating machine for compaction. The formula used to determine compressive strength is shown in Eq. 1.

$$f_b = \frac{P}{l \ x \ b} \quad (1)$$

$f_b$ = Compressive strength expressed in N/mm$^2$

P = Maximum Load Applied in N

b = measured width in mm of the specimen,

l = measured length in mm of the specimen

### 4.2.3. Flexural Strength Test

A reliable testing machine with adequate capacity for applying loads was employed for flexural strength testing. The test utilized a previously calibrated hydraulic jack from a universal testing machine (UTM). Prior to flexural strength test, universal testing machine (800 KN capacity) was calibrated from Nepal Bureau of Standards and Metrology, Kathmandu. The flexural strength tests were conducted in a lab that had been calibrated beforehand. . After determining the mixing ratio from mix design, all the material (coarse aggregate, fine aggregate and cement) as per the mix design was weighed and was placed on the mixer. Water and admixture was added later on the mixer for Standard concrete and fiber was added in different percentage (0.2%, 0.4%, 0.6% and 0.8%) for fiber reinforced concrete. All the ingredient was mixed for about 2-3 minutes and then the concrete was poured on to the tray. Slump test was carried out to test the workability of fresh concrete. After the Slump test the concrete was poured on the beam mould of size 150 x 150 x 700 mm for flexural strength test. These molds was placed on the vibrator machine for compaction. The equation used to evaluate flexural strength is shown in Eq. 2 and Eq. 3.

$$f_b = \frac{P \ x \ L}{b \ x \ d^2} \text{ (when a > 20 cm) Or,} \quad (2)$$

$$f_b = \frac{3P \ x \ a}{b \ x \ d^2} \text{ (when a < 20 cm)} \quad (3)$$

$f_b$ = flexural strength expressed in terms of modulus of rupture, N/mm$^2$

a= the distance between the line of fracture and the nearest support, measured on the center line of the tensile side of the specimen (cm)

b = measured width in cm of the specimen,

d = measured depth in cm of specimen at the point of failure

L = length of the specimen in cm of the span on which specimen is supported

P = maximum load in kg applied to the specimen

### 4.2.4. Split Tensile Strength

The tensile strength of concrete was obtained indirectly by split tensile test, where the compressive line loads was applied along the opposite generators of a concrete cylinder placed with its horizontal axis between the platens of compressive testing machine. Prior to split tensile tests, compression testing machine (1800 KN capacity) was calibrated from Nepal Bureau of Standards and Metrology, Kathmandu. The cylinder was tested for their crushing strength at 7 days and 28 days. The load was applied through machine. The stress induced was split the cylinder vertically into two halves. After determining the mixing ratio from mix design, all the material (coarse aggregate, fine aggregate and cement) as per the mix design was weighed and was placed on the mixer. Water and admixture was added later on the mixer for Standard concrete and fiber was added in different percentage (0.2%, 0.4%, 0.6% and 0.8%) for fiber reinforced concrete. All the ingredient was mixed for about 2-3 minutes and then the concrete was poured on to the tray. Slump test was carried out to test the workability of fresh concrete. After the Slump test the concrete was poured on the cylinder mold of size 150 x 300 mm for split tensile strength test. These molds were placed on the vibrator machine for compaction. Six number of specimens was prepared for each proportion of polypropylene fiber content for 7 days and 28 days for testing. Split Tensile Strength of the specimen was calculated using Eq. 4.

$$f_{ct} = \frac{2P}{\pi\, x\, l\, x\, d} \qquad 4$$

$f_{ct}$ = Split tensile strength, N/mm$^2$

P = maximum load in Newton applied to the cylinder

l = length of the cylinder, mm

d = diameter of cylinder, mm

#### 4.2.5. Pavement Design

The FAARFIELD program was used for the design of the rigid airfield pavement. The air traffic mix data and underlying pavement layers design data below PCC surface was used from the apron design of Gautam Buddha International Airport as shown in Table 5 and Table 6. Modulus of Rupture (Flexural Strength) which was coming from the test result was used for the thickness design of PCC surface by using FAARFIELD program. The design life of pavement was to be 20 years.

Table 5: Pavement Layer Structure below PCC Surface (CAAN, 2011)

| No. | Type | Thickness (mm) | Modulus (MPa) | Poisson's (Ratio) |
|---|---|---|---|---|
| 1 | P-304 CTB | 250 | 3447 | 0.20 |
| 2 | P-154 UnCr Ag | 300 | 218 | 0.35 |
| 3 | Subgrade | | 161 | 0.40 |

Table 6: Air Traffic Information (CAAN, 2011)

| No. | Name | Gross Wt.(lbs) | Annual Departures |
|---|---|---|---|
| 1 | B777-300 ER | 352441 | 1,000 |
| 2 | B757-200 | 116119 | 1,600 |
| 3 | B737-800 | 79243 | 7,400 |

## 5. Results and Discussion

### 5.1. Compressive Strength

The Compressive test was carried out on compression testing machine after curing with water for 7 days and 28 days. Table 7 and Fig. 1 shows average Compressive Strength (CS) test results for the 7 days and 28 days. Figure 1 depicts fiber content versus CS. The compressive strength value increases with the increment of fiber content and it reaches to a maximum value of 52.96 MPa at fiber content 0.40%, which is about 15% increase with respect of compression strength of the no-fiber mix (control mix). When the fiber content is increased further, the strength begins to decline.

Table 7: CS values for different Fiber Content for 7 days and 28 days

| Fiber content | Compressive strength (MPa) | |
|---|---|---|
| | 7 Days | 28 Days |
| 0.00% | 34.760 | 46.160 |
| 0.20% | 37.926 | 50.190 |
| 0.40% | 39.410 | 52.960 |
| 0.60% | 38.150 | 50.770 |
| 0.80% | 36.990 | 48.670 |

The variation of CS value against various percentages of fiber of 7 days and 28 days is shown in Figure. It demonstrates a reciprocal relationship in which increasing the cement content improves the strength of the 7-day and 28-day mixtures.

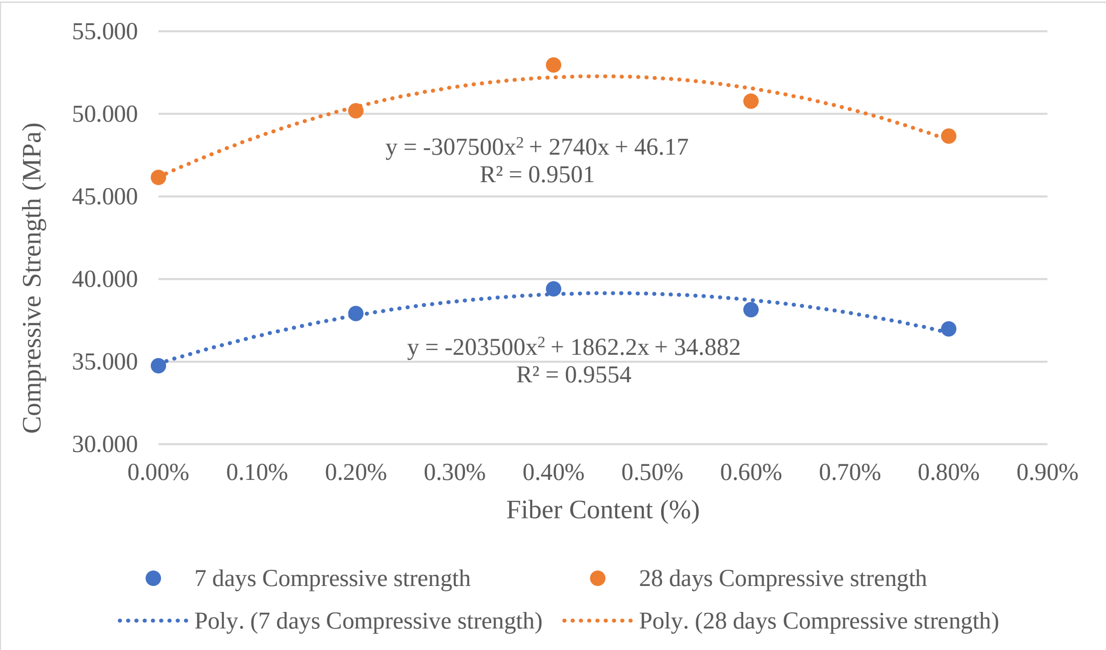


Figure 1: Variation of CS with different % of fiber content of 7 days and 28 days

The higher value of compressive strength achieved at fiber content of about 0.40% and started to decrese when the fiber content increased beyond the 0.40%. It is may be due to high volume fiber interface with the cohesiveness of the concrete matrix causing difficulty in concrete compaction with lowering its workability.

Similar study conducted by (Hasan, et al., 2019) have concluded that the strength increased and reached their maximum value at a fiber content of about 0.36% and started to decrease when the fiber content increased beyond the 0.36%. This is due to high volume fiber interface with the cohesiveness of the concrete matrix causing difficulty in concrete compaction with lowering its workability.

### 5.2. Flexural Strength (Modulus of Rupture)

Table 8 and Figure 2 show average Modulus of Rupture ($M_{RUP}$) test results for the 7 days and 28 days. Figure depicts fiber content versus $M_{RUP}$. The modulus of rupture value increases with the increment of fiber content and it reaches to a maximum value of 5.156 MPa at fiber content 0.40%, which is about 14.50% increase with respect of flexural strength of the no-fiber mix (control mix). When the fiber content is increased further, the strength begins to decline. The variation of $M_{RUP}$ values with fiber content in different percentage is presented in Table.

Table 8: $M_{RUP}$ for different fiber content %

| Fiber content | Flexural strength (MPa) | |
|---|---|---|
| | 7 Days | 28 Days |
| 0.00% | 3.733 | 4.504 |
| 0.20% | 4.148 | 5.096 |
| 0.40% | 4.267 | 5.156 |
| 0.60% | 4.148 | 4.919 |
| 0.80% | 3.437 | 4.681 |

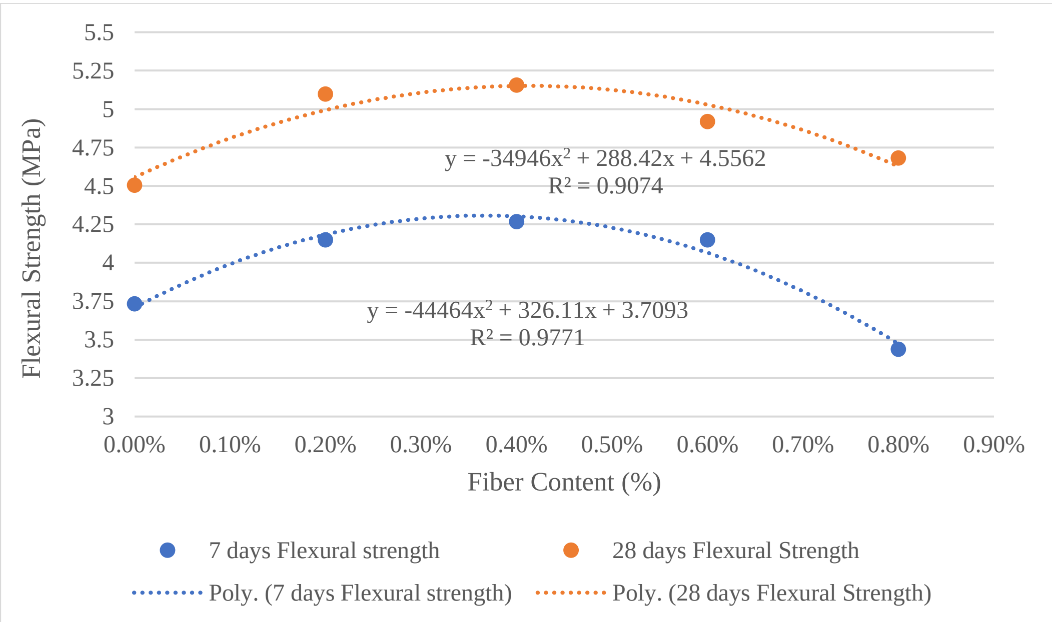


Figure 2: Variation of $M_{RUP}$ with different % fiber content of 7 days and 28 days

Figure shows the variation of Modulus of Rupture with different percentage of fiber content. The modulus of rupture value increases with the increment of fiber content and it reaches to a maximum and then it is decreased when the fiber content is further increase. FAA recommends that a design flexural strength is between 600 and 750 psi (4.14 to 5.17 MPa). The higher flexural strength with excessive cement contents or additives likely to negatively impact durability. Since the $M_{RUP}$ at 0.40% is 5.156 MPa and the maximum design value of Portland cement concrete (P-501) is 5.17 MPa. (FAA AC 150/5320-6G, 2021). Therefore, it is recommended that, 0.40% fiber content is suitable for the Portland cement concrete in terms of FS.

### 5.3. Split Tensile Strength

The tensile strength of concrete is only 10% of its compressive strength. It is clear that the addition of fibers to a concrete mixture is beneficial to the tensile properties of concrete. The fibers act as crack arresters in the concrete matrix prohibiting the propagation of cracks in the plastic and hardened states (Ahmed & Siddiqui, 2006).

Table 9 and Figure 3 show average Split tensile strength test results for the 7 days and 28 days. Figure 3 depicts fiber content versus Split tensile strength. The Split tensile strength value increases with the increment of fiber content and it reaches to a maximum value of 4.94 MPa at fiber content 0.40%, which is about 18% increase with respect of split tensile strength of the no-fiber mix (control mix). When the fiber content is increased further, the strength begins to decline. The variation of split tensile strength values with fiber content in different percentage is presented in Table.

Table 9: Split tensile strength values for different fiber content %

| Fiber content | Split tensile strength (MPa) | |
|---|---|---|
| | 7 Days | 28 Days |
| 0.00% | 3.171 | 4.18 |
| 0.20% | 3.458 | 4.6 |
| 0.40% | 3.614 | 4.94 |
| 0.60% | 3.463 | 4.728 |
| 0.80% | 3.326 | 4.482 |

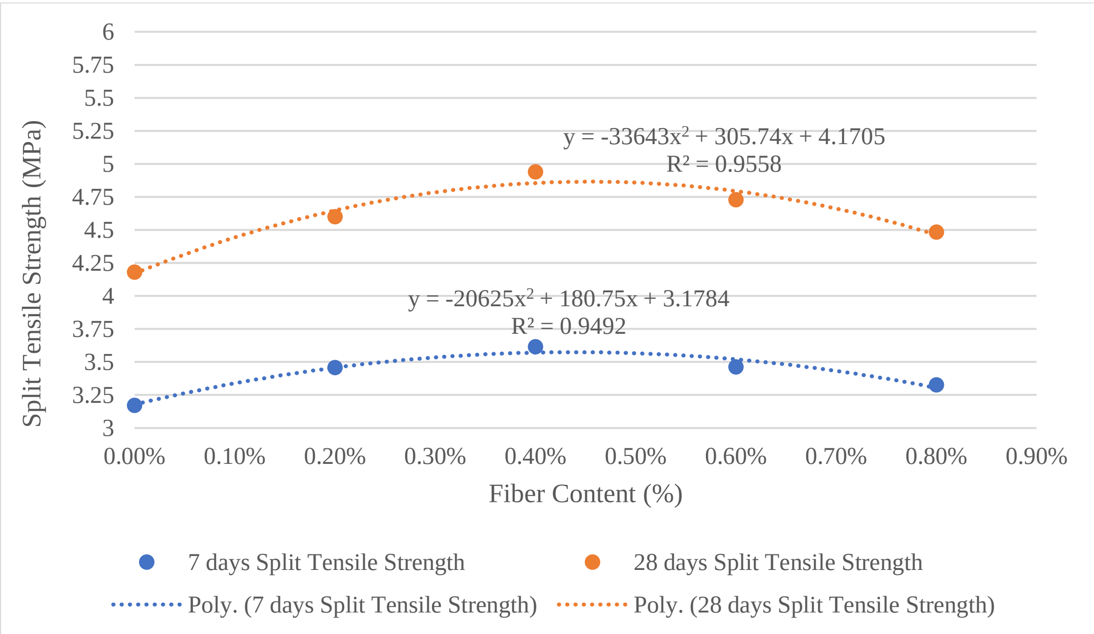


Figure 3: Variation of Split tensile strength of fiber content of 7 days and 28 days

The higher value of split tensile strength achieved at fiber content of about 0.40% and started to decrese when the fiber content increased beyond the 0.40%. Similar study conducted by (Hasan, et al., 2019) have concluded that the tensile strength starts to increase with the increasing of the volume fraction of fiber content thus reaches the maximum value of 4 MPa at fiber content about 0.36% which is about 16% with a comparison to the tensile strength of reference mix. The tensile strength is increased due to a bridging mechanism of polypropylene fibers, and after volume fraction 0.36% the extra fiber in the concrete causes a reduction in the bond strength between concrete ingredients so results in quick failure as compared to concrete with less volumes of fibers. Another study conducted by (Madhavi, et al., 2014) the split tensile strength increased with increasing fiber content. Fibers tend to bridge the micro cracks and hamper the propagation of cracks. When tensile stress is transferred to fibers, the micro cracks are arrested and thus improve the split tensile strength of concrete.

### 5.4. Relationship between Variables

Trendline is a statistical approach for analysing the relationship between a group of dependent variables and an independent set of variables. In this study, based on experimental data, a polynomial second order model was developed to identify the influence of fiber content on the $M_{RUP}$. Table 10 shows the polynomial second order relationship of the variables using MS Excel software, which is a compressive system for analysing data.

Table 10: Summary of relationship between variables

| Relationship between | $R^2$ | Model |
|---|---|---|
| Fiber content (%) - $M_{RUP}$ of 28 days | 0.9074 | $Y_{(Predicted)} = -34946x^2 + 288.42x + 4.5562$ |

Where, Y = Modulus of rupture ($MRUP_{)}$

x = Fiber content (%)

From the above relation Optimum Fiber Content (OFC) and Modulus of rupture ($MRUP_{)}$ value at optimum fiber content was predicted which is presented in Appendix-C.

Optimum Fiber content (OFC) = 0.40%

$Y_{(Predicted)\ at\ OFC\ =}$ -34946*((0.40/100) *(0.40/100)) +288.42*(0.40/100) +4.5562

= 5.151MPa

Strength parameters of Portland cement concrete (PCC) surface course using optimum fiber content are presented in the Table 11.

Table 11: Strength parameters at optimum fiber content for PCC Surface Course

| Fiber Content | Strength Parameters (MPa) |
|---|---|
| | Modulus of Rupture |
| 0.40 % | 5.151 |

From the above table, it is seen that the optimum fiber content seems to satisfy the criteria of modulus of rupture provided in the Guidelines of (FAA AC 150/5320-6G, 2021).

### 5.5. Pavement Design

The FAARFIELD 2.0.18 program was used for the design of the rigid airfield pavement. The air traffic mix data and underlying pavement layers design data below PCC surface was used from the apron design report of Gautam Buddha International Airport shown in Table 5 and Table 6. Modulus of Rupture (Flexural Strength) which was coming from the test result was used for the thickness design of PCC surface by using FAARFIELD program. The design life of pavement was to be 20 years.

For above pavement layers structure below PCC surface, Air traffic information and Modulus of rupture values for 28 days with no fiber content i.e. 4.504 MPa and for optimum fiber content i.e. 5.151 MPa, Portland cement concrete surface course pavement thickness with and without using polypropylene fiber were calculated as 393 mm and 453 mm respectively using FAARFIELD 2.0.18 program. There was a reduction of pavement thickness by 60 mm when polypropylene fiber reinforced concrete (PFRC) was used.

### 5.6. Comparison of PCC and PRFC

Table 12 shows that the comparison of Portland cement concrete (PCC) surface course and Polypropylene fiber reinforced concrete (PFRC) surface course in terms of the parameters which was used for the study purpose.

Table 12: Summary of Comparison

| Parameter | | PFRC | PCC | Remarks |
|---|---|---|---|---|
| Strength | CS ($N/mm^2$) | 39.41/52.96 | 34.760/46.160 | 7/28 days for 0.40% PPF |
| | STS ($N/mm^2$) | 3.614/4.94 | 3.733/4.504 | 7/28 days for 0.40% PPF |
| | FS ($N/mm^2$) | 4.267/5.156 | 3.171/4.18 | 7/28 days for 0.40% PPF |
| Thickness | Up to Surface course (mm) | 393 | 453 | |

## 6. Conclusion

This study delved into the influence of polypropylene fiber content on the strength of the PCC surface course in rigid airfield pavement, employing compressive strength, split tensile strength, and flexural strength tests. The research demonstrated that an optimal polypropylene fiber content enhances the strength of the layer. However, exceeding this optimum content may compromise the bond strength between concrete ingredients, leading to a faster failure rate compared to concrete with lower fiber volumes. The experimental findings yielded significant conclusions: first, compressive, flexural, and split tensile strength exhibit an increase up to 0.40% polypropylene fiber content, followed by a decrease. Thus, the study recommends 0.40% polypropylene fiber as suitable for cementitious material. Second, the change in rigid airfield pavement thickness between Portland cement concrete (PCC) and polypropylene fiber-reinforced concrete (PFRC) was measured at 60mm, representing a 13.25% reduction compared to PCC pavement.

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