J Bangladesh Agril Univ 24(2): 137–143, 2026 https://doi.org/10.3329/jbau.v24i2.91303

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

Research Article

Strength Properties of Concrete Incorporating Three Strand Twisted Nylon Fiber

Nabil Nowshad Tamim[1], Md. Bellal Hossain[2]✉ and Ashfaqul Islam Khan[1]

Department of Farm structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

ARTICLE INFO

Article history
Received: 28 January 2026
Accepted: 30 March 2026
Published: 30 June 2026

Keywords
Nylon Fiber,
Compressive Strength,
Tensile strength,
Fiber reinforced concrete

Correspondence
Md. Bellal Hossain
✉: bella@bau.edu.bd

OPEN ACCESS

ABSTRACT

This study investigates the effect of incorporating three strand twisted nylon rope fibers into concrete to improve its mechanical behavior, particularly compressive and splitting tensile strength. Concrete mixes were prepared with fiber dosages of 0, 2, 5, and 10 kg/m³ using a 1:2:4 mix proportion and tested at curing ages of 7, 14, and 28 days. Standard cylindrical specimens (100 × 200 mm) were cast, cured in water, and tested for compressive and tensile strengths. The diameter of nylon fiber is 1.95 mm and length are 25-50 mm. The results showed that moderate fiber inclusion improved tensile strength but excessive addition reduced both strength and workability. The fiber dosages investigated were 2, 5, and 10 kg/m³ (kg of fiber per cubic meter of concrete). Among these, 2 kg/m³ represents the low or optimal dosage, while 5 and 10 kg/m³ represent higher dosages. The optimum performance was observed at 2 kg/m³ which achieved approximately 30.66% higher tensile strength and 16.47% higher compressive strength at 7 days compared to the plain concrete. At 28 days, 2 kg/m³ maintained 9.27% higher tensile strength and 1.20% higher compressive strength, while higher fiber contents (5-10 kg/m³) led to significant reductions of up to 50% in both strengths. Excessive fiber content reduces workability and bonding efficiency, leading to strength loss. Therefore, a fiber dosage of around 2 kg/m³ is recommended for practical use in non-structural and medium-strength concrete applications such as pavement layers, floor slabs, sidewalks, precast panels and repair works, where improved crack control and toughness are desired.

Introduction

Concrete is the most widely used construction material in the world due to its high compressive strength, durability, and ease of production (Bentur and Mindess, 2007). However, its inherent brittleness and low tensile strength make it susceptible to cracking, shrinkage, and sudden failure under tensile stresses (ACI Committee 544, 1988). The inclusion of nylon fibers has been reported to enhance the mechanical properties and durability characteristics of concrete, particularly in systems with inherently lower strength, such as recycled aggregate concrete (Lee, 2019).

To overcome these shortcomings, researchers have investigated fiber reinforcement as an effective method of enhancing the tensile properties, crack resistance, and post-failure ductility of concrete (Banthia and Gupta, 2004). Fiber-reinforced concrete (FRC) involves the incorporation of discrete fibers within the matrix, which act as crack arresters and improve energy absorption capacity (Mindess et al., 2003).

Beyond nylon, a broad body of work has evaluated alternative fibers for concrete. Steel fibers consistently enhance post-cracking toughness, impact resistance, and flexural strength, with hybrid systems showing notable synergy (Banthia and Gupta, 2004). Polypropylene fibers are widely reported to control plastic-shrinkage cracking and mitigate explosive spalling under fire, with limited effect on compressive strength at low dosages (ACI Committee 544, 1988). Glass especially alkali-resistant (AR) glass and basalt fibers improve tensile and flexural response but require attention to alkali durability and fiber matrix bond (Bentur and Mindess, 2007). Carbon fibers offer very high stiffness and crack-bridging efficiency, yet their cost and dispersion challenges have constrained mainstream use (Mindess et al., 2003). Natural fibers (e.g., jute, sisal, coir) provide a low-cost, lower-density alternative with promising toughness gains, though variability and durability remain concerns (Bentur and Mindess, 2007). Within this landscape, nylon fibers are often highlighted for balancing ductility and crack control with good chemical resistance, making them a

Cite This Article
Tamim, N.N., Hossain, M.B., and Khan, A.I. 2026. Strength Properties of Concrete Incorporating Three Strand Twisted Nylon Fiber. *Journal of Bangladesh Agricultural University,* 24(2): 137-143. https://doi.org/10.3329/jbau.v24i2.91303

practical option where workability can be maintained (Qureshi et al., 2023).

The incorporation of twisted nylon fibers into the concrete matrix improves post-cracking performance by bridging cracks, delaying crack propagation, and enhancing the energy absorption capacity of the composite under loading. Among various fiber types, nylon fiber has attracted attention due to its ability to improve tensile performance and crack control in cementitious composites, making it relevant to the present study. Twisted Nylon Fiber particularly offers advantages such as high tensile strength and low brittleness in concrete. Twisted nylon strands can bridge micro-cracks, restrain crack propagation, and provide enhanced ductility compared to conventional concrete.

Nylon fiber in particular offer several advantages such as high tensile strength, alkali resistance, low density, and flexibility (Qureshi et al., 2023). They are effective in bridging microcracks, restraining crack propagation, and improving toughness (Khan et al., 2023). However, several studies have also reported that while nylon fibers enhance splitting tensile strength, they may reduce workability and slightly decrease compressive strength at higher dosages (Ahmad et al., 2021; Qureshi et al., 2023). Previous studies have demonstrated that the incorporation of nylon fibers, either alone or in combination with natural fibers such as jute, can significantly improve the mechanical properties of concrete, including compressive, tensile, and flexural strength (Bheel et al., 2021).

Despite these advances, the optimal dosage and form of nylon fibers, especially twisted nylon strands, remains understudied. Most research emphasizes polypropylene or steel fibers, leaving a gap in systematic evaluation of nylon fibers in conventional mixes (Bentur and Mindess, 2007; Qureshi et al., 2023). This study therefore aims to fill that gap by investigating the incorporation of twisted nylon fibers and evaluating their effect on compressive and splitting tensile strength at different curing ages.

This study specifically focuses on evaluating the performance of three-strand twisted nylon rope fibers as a low-cost reinforcement material derived from locally available resources, with emphasis on their practical application in conventional concrete mixes. Unlike most previous studies that investigate manufactured short fibers, this research considers rope-based twisted nylon fibers cut into discrete lengths, which may exhibit different dispersion behavior and crack-bridging efficiency within the cement matrix. The study aims to generate experimentally validated data on how such fiber geometry influences strength development across different curing ages, particularly under simple nominal mix conditions commonly used in developing regions. In addition, this work seeks to establish a practical dosage range that balances strength improvement with workability limitations, which is critical for field applications. The novelty of this research lies in the use of waste or low-cost rope-based nylon fiber in twisted form and its systematic evaluation in conventional concrete without admixtures or specialized mixing techniques. The expected outcome is to provide an application-oriented understanding that can support the use of locally sourced fiber reinforcement in non-specialized construction environments where cost efficiency and material availability are key constraints.

Methodology

Materials Used in the study

The reinforcing material used was a locally available 3-strand twisted nylon rope with an average diameter of 1.95 mm. The rope was manually cut into short fibers of 25-50 mm length. The nylon fibers (Figure 2) had good tensile strength, low density, and chemical resistance, making them suitable for concrete reinforcement. Fibers were added to the concrete mix in different proportions of 2, 5, and 10 kg/m^3 of concrete by volume batching.

Ordinary Portland Cement was used as the binding material. The cement was fresh, free from lumps, and stored in a dry environment to prevent moisture ingress.

Well-graded natural river sand was used as fine aggregate. The sand was clean and free from clay, silt, and organic impurities. As laboratory testing of physical properties was not conducted in this study, typical values reported in the literature were considered. The specific gravity of natural sand generally ranges from 2.55 to 2.65, with a fineness modulus between 2.3 and 3.1, indicating medium to coarse grading. The water absorption is typically around 1-2%. The sand is assumed to fall within Zone II grading according to standard specifications.

Locally available crushed brick chips (Figure 2) with a maximum nominal size of 20 mm were used as coarse aggregate. Due to the absence of detailed laboratory testing, standard values from previous studies were adopted. The specific gravity of brick aggregates typically ranges from 1.8 to 2.2, while water absorption is relatively high (approximately 8-15%) due to their porous nature. The bulk density generally varies between 1100 and 1400 kg/m^3. These properties are consistent with values reported in similar studies on brick aggregate concrete.

Potable tap water was used for mixing and curing of concrete. No laboratory testing of water quality parameters was conducted in this study. However, the water used was suitable for drinking purposes, and according to standard guidelines (e.g., ASTM C1602), potable water is generally considered acceptable for concrete production as it is free from harmful quantities of salts, organic matter, and other deleterious substances.

Mix Design

A nominal mix proportion of 1:2:4 for cement, sand, aggregate by weight was done with a constant water-cement mix. A control mix without fiber was also prepared for comparison. For ease of reference, the mixes are referred to as Type 1 (0 kg/m³), Type 2 (2 kg/m³), Type 3 (5 kg/m³), and Type 4 (10 kg/m³).

Mixing and preparation of specimens

Mixing of Ingredients: The dry materials (cement, sand, and coarse aggregate) were first mixed manually until a uniform color was achieved. The required dosage of nylon fiber (2, 5, or 10 kg/m³) was then added gradually and dispersed (Figure 2) thoroughly to avoid fiber clumping.

Casting of Mould

Cylindrical moulds of 100 mm diameter and 200 mm height (4 in × 8 in) were used for specimen preparation. A total of 84 specimens were cast for different mix types and curing ages. The concrete was placed in three equal layers, and each layer was compacted using a standard tamping rod to minimize air voids. After 24 hours, the specimens were demoulded and transferred to a water curing tank, where they were cured until the designated testing ages of 7, 14, and 28 days.

Testing Procedure

Density of Concrete: Density decreases (Figure 1) generally with the addition of nylon fibers.

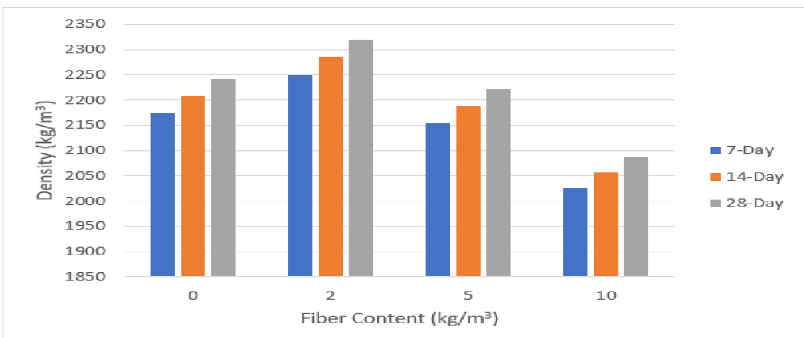

Figure 1: Variation of concrete density with fiber content

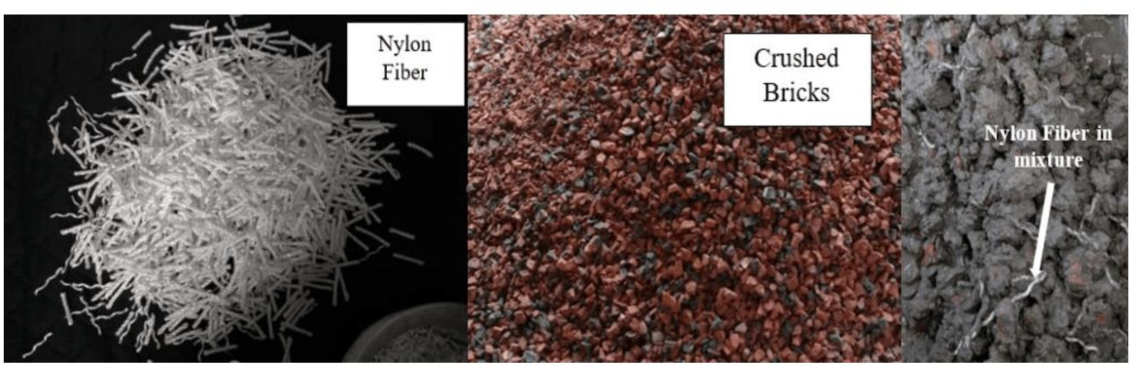

Figure 2: Fresh mixture of aggregates and nylon fiber

Strength Test

Compressive Strength Test: Cylinders were placed centrally in a compression testing machine, and load was applied continuously until failure. Compressive strength was calculated following ASTM C39.

Tensile Strength Test**:** Cylinders were loaded diametrically until splitting occurred. Splitting tensile strength was calculated following ASTM D638.

Testing Equipment

The compressive strength of the concrete specimens was determined using a standard compression testing machine, as illustrated in Figure 3. All specimens were tested under controlled loading conditions following the relevant standard procedures to ensure accuracy and consistency of results. The splitting tensile strength tests were performed using the same machine with a suitable loading arrangement.

Statistical Analysis

For each test condition, three specimens were tested, and the results are presented as mean ± standard deviation. Statistical analysis was performed to evaluate the variability of the experimental data. The observed variations among specimens were within acceptable limits, indicating good repeatability of the results. The inclusion of standard deviation provides a quantitative measure of data dispersion, ensuring reliability and consistency of the reported experimental findings.

Figure 3: Test setup for compressive strength

Results And Discussion

Behavior of Concrete with and without Fibers under Loading

The compressive strength of all concrete mixes increased with curing age. Among the mixes, Type 2 (2 kg/m³ fiber content) exhibited the highest compressive strength at all curing ages, while Type 4 (10 kg/m³) showed the lowest values. At 28 days, Type 2 demonstrated a slight improvement compared to the control mix, whereas higher fiber contents resulted in a reduction in strength.

The failure characteristics of the concrete specimens after compressive loading are presented in Figure 4. Figure 4(a) shows the external cracking pattern, while Figure 4(b) illustrates the internal structure of the fractured specimen. Fiber-reinforced concrete exhibited reduced crack propagation due to the crack-bridging action of nylon fibers.

This behavior can be attributed to effective stress distribution at lower fiber dosages, where fibers bridge microcracks and enhance the integrity of the concrete matrix. However, excessive fiber content reduces workability and leads to fiber agglomeration, resulting in weak bonding and increased voids. Similar findings have been reported by Qureshi et al., who observed improved performance at moderate fiber content and strength reduction at higher dosages.

The splitting tensile strength increased with the incorporation of nylon fibers at lower dosages. Type 2 (2 kg/m³) showed the highest tensile strength at all curing ages, particularly at 7 days. In contrast, higher fiber contents (5 and 10 kg/m³) resulted in reduced tensile strength compared to the control mix.

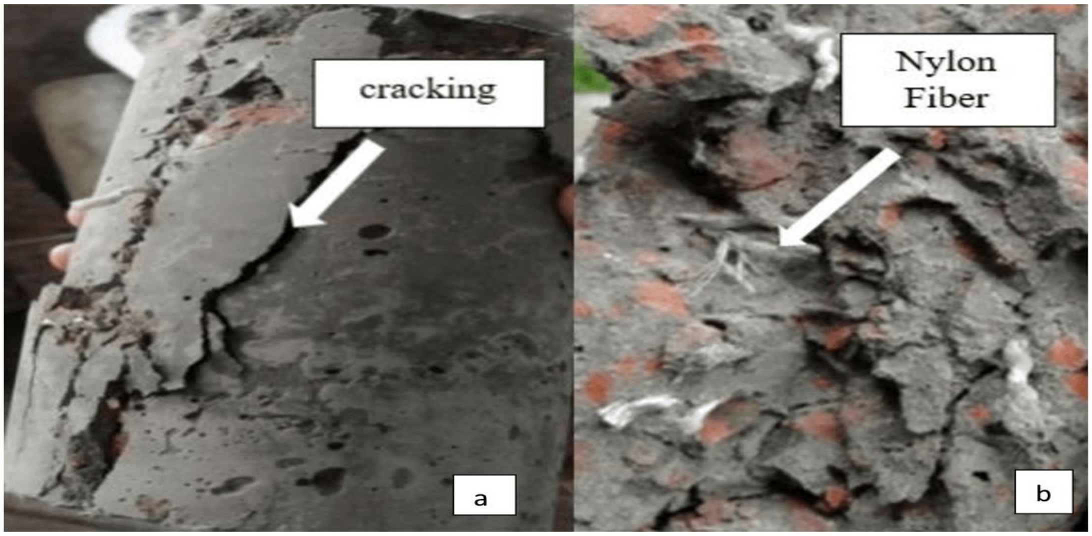

Figure 4: (a) Cracking due to Load (b) Internal structure

The failure behavior and test setup are shown in Figure 5. Figure 5(a) presents the splitting tensile strength test arrangement, while Figure 5(b) illustrates the resisting tensile crack with fiber. The presence of nylon fibers improved tensile resistance through crack-bridging mechanisms, resulting in more controlled crack development.

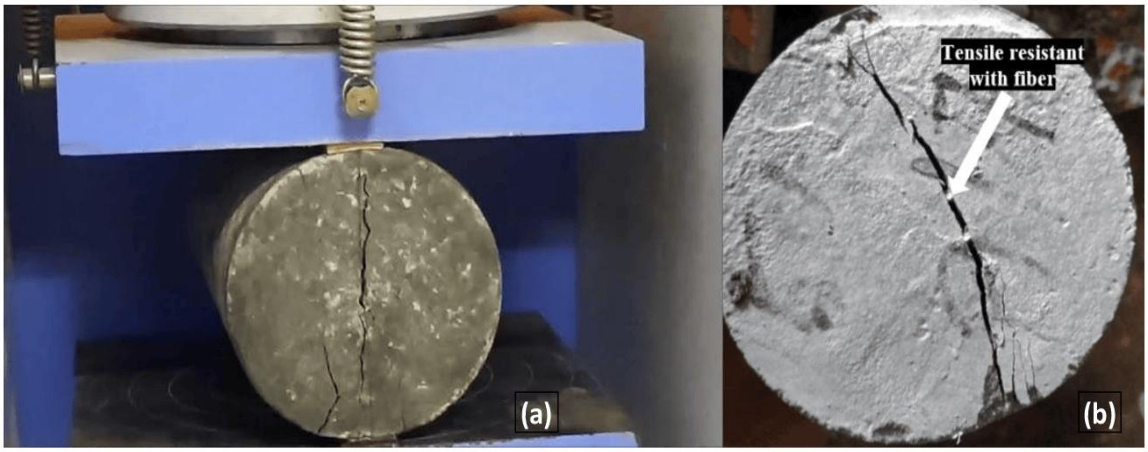

Figure 5: (a) Tensile strength test setup (b) Resisting tensile crack with fiber

The enhancement at lower fiber content is attributed to the ability of nylon fibers to delay crack initiation and propagation. At higher dosages, fiber clustering and reduced workability hinder proper stress transfer within the matrix. These findings are consistent with previous studies by Ahmad et al., which reported improved tensile performance at lower fiber contents and reduced effectiveness at higher dosages.

Compressive and Tensile Strength Development with Curing Age

The compressive strength of all mixes increased with curing age (Figure 6). Type 2 achieved the highest strength at all ages, indicating an optimum fiber content for improved compaction and crack resistance. Type 4 showed the lowest strength, likely due to poor workability and fiber clustering.

Tensile strength also improved with curing time (Figure 6). Type 2 consistently showed the best performance, reaching 3.14 MPa at 28 days. Higher fiber dosage (Type 4) reduced tensile strength, suggesting that excessive fiber addition negatively affects bonding and stress transfer.

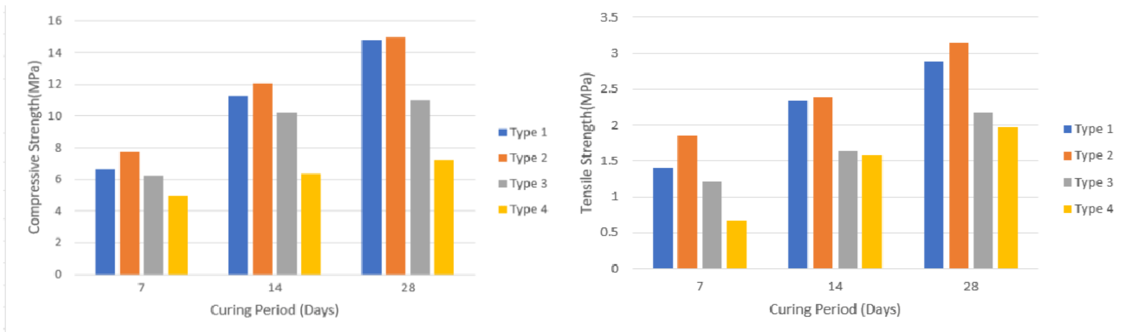

Figure 6: Strength Variation with Curing Period

Effect of Fiber Content on Strength Development

The results (Table 1) indicate that Type 2 produced a clear improvement in tensile strength, particularly at early curing ages, with an increase of up to 30.66% at 7 days compared to the control mix Type 1. The results of this study are in agreement with previous findings, where the incorporation of nylon fibers contributed to improved compressive strength at optimum levels, while improper proportioning could affect performance (Das & Mutsuddy, 2022).

Table 1: Percentage of strength gain (+)/loss (-) due to fiber content at different curing ages based on the strength values of zero fiber content specimens.

Nylon fiber content (kg/m³of concrete)	Compressive Strength			Tensile Strength		
	7 days	14 days	28 days	7 days	14 days	28 days
2	+16.47	+6.99	+1.20	+30.66	+2.35	+9.27
5	-6.29	-9.33	-25.75	-14.48	-30.01	-24.35
10	-25.64	-43.64	-51.21	-52.84	-32.85	-31.60

The variation of strength for different fiber-reinforced concrete mixes compared to the control mix (Type 1). It is evident that the inclusion of 2 kg/m³ fibers (Type 2) consistently improved both tensile and compressive strengths across all curing ages, showing the highest positive performance among the mixes.

At 7 days, Type 2 achieved a significant improvement in tensile strength of around 30% and a moderate increase in compressive strength of about 17% relative to the control, while Type 3 and Type 4 exhibited notable strength reductions. The results showed that the inclusion of 2 kg/m³ nylon fiber produced the highest overall performance among all mixes. At 7 days, the splitting tensile strength increased by approximately 30.66%, while compressive strength increased by about 16.47% compared to the control mix. At 28 days, the improvement was reduced but still noticeable, with tensile strength increasing by 9.27% and compressive strength by 1.20%.

In contrast, higher fiber dosages (5 and 10 kg/m³) resulted in significant reductions in both tensile and compressive strengths, in some cases exceeding 40–50%, indicating that excessive fiber content negatively affects mechanical performance.

This trend can be attributed to improved crack-bridging at lower fiber content, which enhances stress transfer across the matrix. However, at higher dosages, fiber clustering, reduced workability, and poor dispersion lead to weak bonding and increased voids.

Table 2: Compressive and splitting tensile strength of concrete at different curing ages (mean ± standard deviation, n = 3)

Fiber Content (kg/m³)	Compressive Strength (MPa)			Splitting Tensile Strength (MPa)		
	7 days	14 days	28 days	7 days	14 days	28 days
0	6.67 ± 0.86	11.27 ± 1.59	14.80 ± 2.52	1.41 ± 0.06	2.34 ± 0.15	2.88 ± 0.04
2	7.76 ± 2.97	12.06 ± 1.78	14.98 ± 2.23	1.84 ± 0.15	2.40 ± 0.01	3.14 ± 0.23
5	6.25 ± 0.56	10.22 ± 1.39	10.99 ± 2.56	1.21 ± 0.07	1.64 ± 0.19	2.18 ± 0.08
10	4.96 ± 0.93	6.35 ± 0.15	7.23 ± 2.05	0.66 ± 0.04	1.57 ± 0.04	1.97 ± 0.07

Similar observations have been reported by Qureshi et al. and Ahmad et al., who found that moderate fiber addition improves tensile performance, while excessive fiber content reduces overall strength.

The compressive and splitting tensile strengths of concrete incorporating three-strand twisted nylon fibers were evaluated at 7, 14, and 28 days for fiber contents of 0-10 kg/m³, showing in Table 2 that strength generally increased with curing age and peaked at 2 kg/m³ (28-day compressive: 14.98 ± 2.23 MPa; tensile: 3.14 ± 0.23 MPa), while higher fiber dosages reduced strength due to decreased workability, indicating 2 kg/m³ as the optimum fiber content for improved performance.

Conclusion

This study evaluated the effect of incorporating three-strand twisted nylon fibers into concrete at different dosages. The results showed that fiber inclusion influenced both compressive and splitting tensile strength depending on the dosage level. The concrete reinforced with three-strand twisted nylon fibers exhibited improved crack resistance and higher splitting tensile strength compared to plain concrete. An optimum fiber dosage of 2 kg/m³ provided the best overall performance, with a significant increase in tensile strength and a slight improvement in compressive strength. However, higher fiber contents (5 and 10 kg/m³) reduced workability and led to significant decreases in strength due to poor fiber dispersion and increased void formation. Therefore, a low dosage of twisted nylon fibers is recommended for applications where improved crack control and tensile performance are required.

Author's Contribution

N.N.T: Design, formulation and supervision of experiment, writing of manuscript, Performing the field and lab experiments, collection and analysis of data.; **M.B.H**: Supervision of experiment and review of manuscript.; **A.I.K**: Performing the field and lab experiments, collection and analysis of data.

References

Lee, S. (2019). Effect of nylon fiber addition on the performance of recycled aggregate concrete. Applied Sciences, 9(4), 767.

ACI Committee 544 (1988). State-of-the-Art Report on Fiber Reinforced Concrete (ACI 544.4R-88). American Concrete Institute, Detroit, USA.

Ahmad, J., Zaid, O., Aslam, F., Martínez-García, R., Alharthi, Y. M., & Ouni, M. H. E. (2021). Mechanical properties and durability assessment of nylon fiber reinforced self-compacting concrete. Journal of Engineered Fibers and Fabrics, 16, 1-14.

Banthia, N., & Gupta, R. (2004). Hybrid fiber reinforced concrete (HyFRC): fiber synergy in high strength matrices. Materials and Structures, 37, 707-716.

Bentur, A., & Mindess, S. (2007). Fibre Reinforced Cementitious Composites (2nd ed.). Taylor & Francis, London.

Bheel, N., Tafsirojjaman, Y., Liu, Y., Awoyera, P. O., & Keerio, A. K. (2021). Experimental study on engineering properties of cement concrete reinforced with nylon and jute fibers. Buildings, 11(11), 505.

Das, S. S., & Mutsuddy, R. (2022). Investigation of the compressive strength of CFRP wrapped nylon fiber reinforced concrete cylinders. Journal of Engineering Science, 13(2), 85-92.

Khan, M. N., et al. (2023). Influence of nylon fibers on mechanical properties of concrete. Preprint, ResearchGate.

Mindess, S., Young, J. F., & Darwin, D. (2003). Concrete (2nd ed.). Pearson Education, Upper Saddle River, NJ.

Qureshi, H. J., Ahmad, J., Aljabr, A., & Garcia-Troncoso, N. (2023). Review on characteristics of concrete reinforced with nylon fiber. Journal of Engineered Fibers and Fabrics, 18, 1-17.

ASTM International. (2018). ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; West Conshohocken, PA, USA.

ASTM International. ASTM D638: Standard Test Method for Tensile properties of Reinforced Plastics. ASTM International.

ASTM International. ASTM C1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete. ASTM International.