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UTILIZATION OF RECYCLED POLYETHYLENE TEREPHTHALATE (RECYCLED PET) FIBERS FOR INNOVATIVE CONCRETE PROPERTY ENHANCEMENT

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Abstract — The construction industry's expansion, driven by larger and more intricate projects, has increased the demand for concrete across various sectors such as residential and infrastructure development, mirroring the ongoing trend of urbanization. To align with environmental concerns, the industry is now prioritizing eco-friendly construction methods. This study focuses on incorporating recycled Polyethylene Terephthalate (recycled PET) bottle fibers into conventional concrete. The goal is to vary the fiber percentage to achieve optimal compressive strength and desired workability, addressing the challenge of finding the right balance between these key factors. The PET fibers were irregularly cut and mixed with standard concrete materials, including cement, aggregates (fine and coarse), and water, with the addition of Plastocrete Plus as an admixture. The fiber size used was 25 mm long, with a width ranging between 1-2 mm, cut non-uniformly. The percentage of PET fibers was adjusted based on the weight of the cement to achieve enhanced strength and workability. The PET fibers at 0%, 2%, 4%, 6%, and 8% were tested for workability and compressive strength. Numerous specimens, including 15 cube specimens, were tested, and the optimal dosage of recycled PET fibers was determined. The results indicate that, after 21 days of curing, the 4% fiber content exhibited a significant increase in compressive strength, approximately 13.3%. The study validates the obtained optimum dosage by comparing it with relevant literature. Considering both the literature and the findings of this study, it is concluded that the practical application of PET bottle fibers in the construction industry is feasible.

***Keywords*: RPET fiber, compressive test, workability, concrete, eco-friendly construction**

1.0 INTRODUCTION

Over the past few decades, there has been a substantial rise in the construction industry's demand for concrete, primarily driven by factors such as rapid urbanization, infrastructure completion, natural disasters, and human activities [1]. With the global population growing, the need for residential buildings has intensified, leading countries to adopt industrial materials while minimizing the use of traditional options, which often lack sustainability [2, 3]. The escalating demand for construction materials has resulted in higher building costs, posing significant challenges in economically disadvantaged regions. While concrete is valued for its structural efficiency and cost-effectiveness, researchers have been exploring various materials that can be integrated into concrete to achieve desired engineering properties [4]. Alongside the surge in construction activities, there has been growing concern regarding environmental issues, particularly related to the improper disposal of non-biodegradable materials PET waste [5, 6]. Currently, the construction industry is increasingly recognizing the importance of adopting sustainable practices and eco-friendly materials, focusing on innovative solutions to improve concrete properties while addressing environmental impact [7, 8]. Moreover, researchers and engineers are actively working towards enhancing the performance and sustainability of concrete through the incorporation of alternative materials. PET bottles, being non-biodegradable, [9] pose risks when disposed of through conventional methods like burning, leading to the release of dangerous chemicals into the air. Nevertheless, concrete remains the primary choice for construction due to its advantageous properties, such as strength, durability, ease of fabrication, and non-combustibility [10, 11]. By incorporating plastic waste bottles in building units, this innovative method promotes environmental friendliness and energy efficiency, [12–14] as the resulting walls benefit from plastic's high tensile strength-to-weight ratio, ensuring strength, durability, and versatility.

In light of these challenges, the incorporation of recycled PET fibers in concrete not only addresses environmental concerns linked to plastic waste but also witnesses enhanced performance, and has garnered attention as a feasible and eco-friendly solution [15, 16]. These fibers act as crack arresters, modifying the cracking mechanism within the concrete, resulting in minimized crack widths, decreased permeability, and increased cracking strain. Furthermore, the integration of recycled PET fibers contributes to a more sustainable concrete mixture, leading to cost reductions in production and a reduced environmental footprint [17, 18]. PET has been extensively utilized in various types of concrete to enhance their properties and promote sustainability. Adding PET fibers in concrete mixture [19], exhibits improved crack resistance, reduced permeability, and increased tensile strength, not only reduces manufacturing costs but also provides additional advantages, including decreased landfill expenses, energy conservation, and environmental preservation [20].

Researchers explored concrete performance with PET bottles as fibers and silica fume as a cement replacement. Revathi et al. [21, 22] investigated the optimal mixing of silica fume to improve mechanical and durability properties and found that concrete containing recycled PET bottle fibers exhibited enhanced hardened characteristics. Similarly, Thomas and Moosvi [23] demonstrated that incorporating recycled PET bottle fibers significantly increased the tensile, elastic, and flexural strength of the concrete samples. Hasan-Ghasemi and Nematzadeh [24] investigated the effects of using PET as a fine aggregate substitute in self-compacting concrete (SCC) after exposure to thermal conditions. It was found that higher temperatures and greater PET substitution levels led to substantial decreases in mechanical properties. Specifically, the compressive strength, tensile strength, and elastic modulus reduced by approximately 60% in the SCC specimen with 15% PET substitution after exposure to 600°C compared to the SCC without PET and thermal exposure [24, 25]. Nevertheless, Asdollah-Tabar et al. [26, 27] found that incorporating coarse PET filler can enhance fracture toughness and fracture energy in polymer concrete when compared to polymer concrete containing fine PET filler. Research have also been conducted to investigate the impact of waste PET strips as reinforcement in concrete subjected to cyclic loading [28, 29]. PET concrete demonstrates increased load capacity, reduced variability, delayed damage propagation, and enhanced damage tolerance under cyclic loading. Kavinkumar et al. [30] further explored the use of plastic waste and PET bottles to create "plast-bricks." These bricks are lightweight, have smooth edges, and exhibit high compressive strength, making them a promising alternative in construction materials. Additionally, these bricks show minimal water absorption and are free from fractures or cracks. Mohammed [31], developed reliable equations to model the mechanical properties of concrete incorporating PET waste aggregate. These equations were deemed accurate and secure and can be extended to recycled concrete with various types of plastic waste apart from shredded PET waste [32].

Askar et al. [33] show that the addition of 0.2–0.4% PET to the concrete mixture results in an approximately 5% increase in compressive strength. When 0.2 to 0.3% PET polyester fiber is introduced, compressive strength see an enhancement of 10% to 20%. For achieving optimal concrete compressive strength, the recommended PET ratio as a natural aggregate replacement is 1%. The highest compressive strength for concrete reinforced with recycled PET is achieved at a volume fraction of 0.5%. Substituting 2, 4, and 6% of PET for fine aggregate shows an increase in concrete compressive strength, with the maximum improvement observed at a 2% replacement of PET. Utilizing plastic waste as a partial substitute for fine or coarse aggregate enhances the workability of the concrete mixture. The addition of 0.25% PET polyester can boost compressive strength by 10–20% and flexural strength by 5–15%, accompanied by a reduction in split tensile strength of approximately 15–30%. Conversely, several studies advocate for the use of 1% PET as an additive, potentially resulting in a 10% increase in concrete strength [34, 35]. However, the introduction of 15% PET may cause concrete segregation, likely due to a high water/cement ratio. Supporting this notion, Ismail and Al-Hashmi [36] conducted tests on samples with 10%, 15%, and 20% PET, observing a 5%, 7%, and 8.7% reduction in fresh density, respectively. Figueiredo et al. [40] incorporated PET as fine aggregates, leading to a roughly 14% decrease in compressive strength. In the experiments conducted by Vanitha et al. [37], concrete specimens were cast with PET aggregates substituting fine aggregates at levels of 2%, 4%, 6%, 8%, and 10%. Water hyacinth was also added at 10% and 20% by weight of water.

Past research has explored the impact of PET bottles, both in their entirety and as PET fibers, on concrete, whether in its normal state or when reinforced, in order to assess concrete properties. Previous investigations have focused on altering concrete properties by substituting fine aggregates with PET fibers, either entirely or partially. However, existing literature lacks information on the optimal dosage of irregularly shaped PET fibers in concrete. This study highlights the significant reduction in workability of PET concrete, a factor that subsequently influences concrete performance. Notably, prior works have not considered the crucial role of admixture interaction between fibers and concrete. Challenges persist in understanding the performance behavior of concrete when incorporating recycled PET bottles fibers. This study aimed to repurpose post-consumer PET bottles by converting them into small, irregular fibers and incorporating them into concrete to evaluate their influence on standard concrete properties. The key contribution of this study lies in identifying the optimal dosage (%) of PET bottles cut fibers that achieves both practical compressive strength and desirable workability. it suggests the 21 days of curing as an alternative option to attain compressive strength. Consequently, these fibers act as effective crack arresters, addressing concerns in plain concrete and enhancing the mechanical and durability aspects of the material. Beyond advancements in engineering materials, this research also makes a noteworthy contribution to environmental sustainability.

2.0 MATERIALS AND METHODS

2.1. Materials

In this study, the materials employed for casting the examined specimens encompassed fundamental components commonly present in concrete—namely, ordinary Portland cement, fine and coarse aggregates procured from the construction site, and the optimal quantity of water. Additionally, we integrated PET bottle fibers and a superplasticizer admixture (Plastocrete Plus). Ordinary Portland cement (OPC) with a locally available fineness of 2.63 was used in all concrete mixes. The fine aggregates comprised clean river sand with a silt content ranging between 0.06% and 0.002%, possessing a bulk density of 1743.52 kg/m3, and crushed gravel with a maximum size of 25 mm and a bulk density of 1568.2 kg/m3 for all mixes. The fine aggregate's fineness ranged between 2 and 3.5, while the coarse aggregate exhibited a fineness range of 5.5 to 8, targeting fineness moduli of 3.43 and 4.76, respectively. Recycled PET fibers, derived from PET bottles as depicted in figure (1), were introduced as an eco-friendly additive in concrete. These fibers played a pivotal role in enhancing crack resistance and reducing permeability, resulting in narrower cracks and increased concrete strength. This sustainable approach not only contributed to reducing waste and protecting the environment but also demonstrated the potential for cost savings and durability improvements. The concrete mix, which utilized OPC, played a role in influencing the mechanical performance of the concrete. Potable tap water was utilized for both mixing and curing, following quality guidelines to ensure the concrete's integrity and obtain reliable test results. The selection of aggregates, encompassing both fine and coarse materials such as sand and gravel, had a significant impact on workability and strength characteristics. To enhance workability and flow without increasing water content, the addition of the Plastocrete Plus admixture was employed, providing improved performance and durability. Various tools, including Vernier calipers, weight balances, concrete mixers, slump cones, curing cisterns, steel cube molds, sieves, and a mechanical sieve shaker, were used for the evaluation and testing of the concrete.

Figure 1 Recycled PET bottles after their single-use

2.2. Methods

2.2.1. Sieve analysis

The sieves employed in this investigation adhere to the specifications outlined in AASHTO M231, possessing ample capacity and an accuracy of 0.1 percent or a readability of 0.1 g for precise measurements. Mechanical sieve shakers were applied to agitate the sieves for approximately 10 minutes, ensuring thorough separation of the sample. The sieving duration for each shaker was regularly monitored, and adjustments were made as necessary. In the case of fine aggregates, the sieve sizes ranged from 4.75 to 0.075 mm, accompanied by a pan.

For coarse aggregates, the sieves spanned from 40 to 0.15 mm, and a single layer of particles was restricted on the sieve to maintain consistency during the sieving process. These meticulous procedures guaranteed a dependable particle size analysis of aggregates with recycled PET fibers, aligning with industry standards and quality control criteria. The Fineness modulus of fine aggregate fell within the range of 2-3.5, while the coarse aggregate varied from 5.5 to 8.0 (refer to Eq. 3). For all aggregates or combined aggregates, the fineness modulus ranged from 3.5 to 6.5 [38].

$$\text{Percentage retained on any sieve} = \frac{\text{Weight of soil retained}}{\text{Total soil weight}} x100 \quad (1)$$

$$\text{Cumulative percentage retained on any sieve} = \sum \text{Percentage Retained} \quad (2)$$

$$\text{Percentage finer than a sieve size} = 100\% - \sum \text{Percentage Retained} \quad (3)$$

$$\text{Coefficient of Uniformity:} \quad Cu = \frac{D60}{D10} \quad (4)$$

$$\text{Coefficient of Curvature:} \quad Cc = \frac{D^2 30}{D10 x D60} \quad (5)$$

Where Cu is the coefficient of uniformity, Cc is the coefficient of curvature, and D10, D30, and D60 are the particle sizes corresponding to 10%, 30%, and 60% finer materials on the cumulative particle size distribution curve as per Eq. (4) and (5), respectively.

2.2.2. Mix design

The concrete mix design employed in this investigation aligned with the guidelines outlined by the American Association of State Highway and Transportation Officials (AASHTO), ensuring a well-balanced and efficient composition. The chosen mix design, denoted as 1:1:2 (M25), prescribed the proportions of concrete components—specifically, cement, fine aggregates, and coarse aggregates. Additionally, a plasticizer was introduced into the mix, incorporated at a dosage of 0.20% by weight of the cement content. Carefully set at 600 kg/m^3, the cement content aimed to achieve desired properties for normal concrete. This selected mix design considered critical factors influencing concrete performance with recycled PET fibers, ensuring an optimal level of workability, strength, and durability. Serving as a robust foundation, the concrete mix design facilitated the examination of recycled PET fiber impact on various concrete properties. Adhering to standards and utilizing appropriate materials, the study seek to evaluate the feasibility and advantages of incorporating recycled PET fibers for sustainable construction. PET fibers were introduced in varying percentages to the concrete mix, ranging from 0%, 2%, 4%, 6%, and 8% of the cement weight as depicted in Table 1. Cube specimens were meticulously cast following the code of practice and subjected to a controlled curing period of 21-28 days. Compressive strength and slump were identified, and the corresponding dosage of PET fibers was determined to achieve the desired properties. To attain the optimal strength and associated workability, samples underwent testing with varying quantities of PET fibers based on the weight of the OPC utilized. The mix design, exemplified by incorporating 2% PET fibers, necessitates 2.025 kg of cement, resulting in 40.5 g of PET fibers in the mix. Additionally, the relationship between the initial mix and subsequent mixes was established by employing approximately 1% of the cement weight. Simultaneously, the corresponding amount of Plastocrete Plus was added at 0.2% of the cement weight in each mix to regulate the workability of standard concrete, as outlined in the Table 1. Introducing PET fibers into normal concrete presented a notable challenge to the concrete's workability. In this research, a slump test was conducted to assess the quality and appropriateness of the incorporated PET content in a mix, ensuring the water-to-cement ratio is accurate. The test was executed on samples with PET content ranging from 0% to 8%, varying the admixture and water content.

Table 1 Recycled PET Fibers Dosage Per Concrete Mix Design

% of PET	Cement (Kg)	Fine aggregates (Kg)	Coarse aggregates (Kg)	Water (l)	PET (g)	Admixture (ml)
0	2.025	2.025	4.05	0.91125	0	4.05
2	2.015	2.015	4.03	0.90675	40.5	4.03
4	2.004	2.004	4.009	0.9018	81	4.008
6	1.994	1.994	3.989	0.8973	121.5	3.988
8	1.984	1.984	3.969	0.8928	162	3.968
3			Number of specimens per each % of PET			
Total	30.066	30.066	60.132	13.5297	1215	60.132

2.2.3. Slump test

The slump test entails placing the slump mold on a flat, non-absorbent surface. After thoroughly blending the dry concrete ingredients for uniform color, water was incorporated into the mix. The concrete was then layered in the mold, and each layer undergoes compaction 25 times using a tamping rod. The mold was filled to capacity, and excess concrete was removed. The mold was lifted swiftly and vertically, and, the subsidence or slump was measured in millimeters as the concrete settled, reflecting the workability of the mix [39]. The workability of the concrete mix was evaluated through the slump cone test. Initially, for ordinary concrete with the addition of Plastocrete®plus, the first trial was conducted with a water-cement ratio of 0.35. However, the obtained slump value did not meet the desired workability criteria. Consequently, the water-cement ratio was adjusted to 0.45, and 0.2% of Plastocrete®plus admixture was introduced to achieve a slump of 60mm, falling within the targeted range of 40-60mm.

2.2.4. Specimen preparation

In this experimental study, 15 concrete specimens with varying percentages of plastic fibers were meticulously prepared to ensure accurate and reliable results. PET fibers were gradually added to the concrete mix, ensuring uniform distribution. Cube specimens were carefully cast following the code of practice guidelines and compacted to eliminate voids. The specimens underwent a controlled curing period of 21-28 days with regulated temperature and moisture. To obtain statistically significant results, multiple cube specimens were prepared for each percentage of plastic fibers, ranging from 0% to 8%. This systematic approach allows comprehensive testing and analysis, providing insights into the optimal plastic fiber dosage for enhancing concrete performance and promoting sustainable construction practices.

2.2.5. Compressive strength tests

The cube compression test was executed to evaluate the compressive strength of the concrete specimens, utilizing standard cubes sized at 150 x 150 x 150 mm. Compressive strength was assessed with a compression machine, with a minimum of three specimens tested at each age (21 and 28 days) to ensure statistical significance, as detailed in Table 2. Specimens displaying strength variations exceeding 15% were excluded for quality assurance. The average strength of the tested specimens was computed to represent the concrete's crushing strength. The study adhered to concrete strength requirements outlined in relevant standards and codes, confirming that the concrete containing PET fibers met the essential criteria for practical application, as illustrated in figure (3). The rigorous testing methodology aimed to obtain reliable and consistent results for subsequent analysis and evaluation. A formula was formulated: $F = P/A$ (Eq. (6)), where F represents the compressive strength (MPa), P denotes the gradual loading from the Universal Testing Machine (UTM), and A is the cross-sectional area of the material's resistance to load (mm^2).

Table 2 Compressive Strength Tested for 15 Specimens

No. of Specimen	% of RPET Fibers	C/S Area (mm²)	Days	Load (kN)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1				1105.5	49.13333	
2	0	22500	28	1044.9	46.44	48.14667
3				1099.5	48.86667	
4				708.4	31.48444	
5	2	22500	21	695.8	30.92444	31.71704
6				736.7	32.74222	
7				873.4	38.81778	
8	4	22500	21	868.3	38.59111	38.9363
9				886.5	39.4	
10				610.1	27.11556	
11	6	22500	21	674.2	29.96444	28.27852
12				624.5	27.75556	
13				765.6	34.02667	
14	8	22500	28	834	37.06667	35.44296
15				792.8	35.23556	

Figure (2) shows the number of specimens tested at different age, and how the cracks were arrested which indicates the optimum % dose of PET fibers required in this study.

Figure 2 Cube specimens for compressive testing under UTM

3.0 RESULTS AND DISCUSSION

3.1. Results

3.1.1. Recycled PET fibers

The recycled PET fibers utilized in this investigation were derived from diverse PET bottles through a manual preparation process, resulting in fibers exhibiting variable characteristics in terms of thickness, width, and length. This manual method introduced diversity into the concrete mix, potentially impacting its mechanical and structural properties. Following the removal of bottle necks and bottoms, the fibers were uniformly cut to a length of 25 mm. Notably, some fibers had a width of 1 mm, while others measured 2 mm, as illustrated in Figure (3). The fibers demonstrated a specific gravity of 1.34, signifying their relative density compared to water, and a water absorption rate of 0%, indicating their resistance to moisture. These specific dimensions and properties of the fibers were intentionally selected to assess their influence on the concrete's performance and to explore the feasibility and effectiveness of incorporating recycled PET fibers for enhancing concrete properties in an environmentally friendly manner.

Figure 3 Vernier caliper-PET fibers cut to approximately the same size

3.1.2. Particle size distribution analysis of fine and coarse aggregates

The sieve analysis aimed to evaluate the gradation of aggregate particles by size in the given sample. For fine aggregates, the results indicated a coefficient of uniformity (Cu) of 6.06243 and a coefficient of curvature (Cc) of 1.67416, meeting the criteria for well-graded sand. Similarly, coarse aggregates exhibited a coefficient of uniformity (Cu) of 4.3674 and a coefficient of curvature (Cc) of 2.273, indicating well-graded gravel. These outcomes affirm that both fine and coarse aggregates in the concrete mix with recycled PET fibers exhibit well-balanced particle size distributions, fulfilling design, production control requirements, and verification specifications. The well-graded characteristics of the aggregates contribute to improved workability, strength, and durability of the concrete, ensuring its suitability for various construction applications.

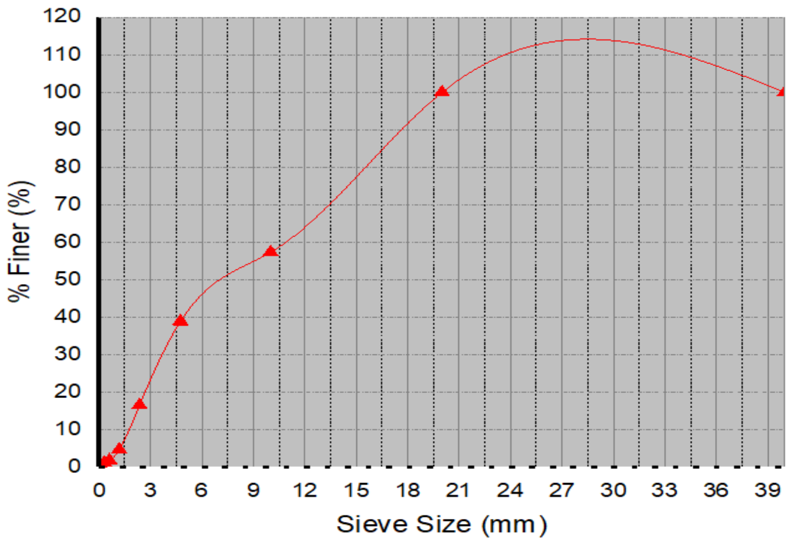

Figure 4 Particle size distribution of aggregates

3.1.3. Slump test

The slump value was used as an indicator of mix workability, aiming for a target range of 40 to 60mm in the concrete mixes (see Table7). The slump cone test was employed to evaluate workability, with the addition of Plastocrete®plus to enhance concrete workability. This ensured that the concrete could be easily placed and compacted during construction while maintaining the desired slump range. The research found that as the percentage of RPET fibers increased in the concrete, the workability decreased, as indicated by the slump value. The control concrete with 0% fibers had an initial slump of 60 mm, while 8% fiber content resulted in a slump of 40 mm. This reduction in workability but optimum is attributed to the presence of fibers impeding concrete particle movement, affecting ease of placement and compaction. These findings help optimize fiber content to balance workability and desired mechanical properties in the final concrete product.

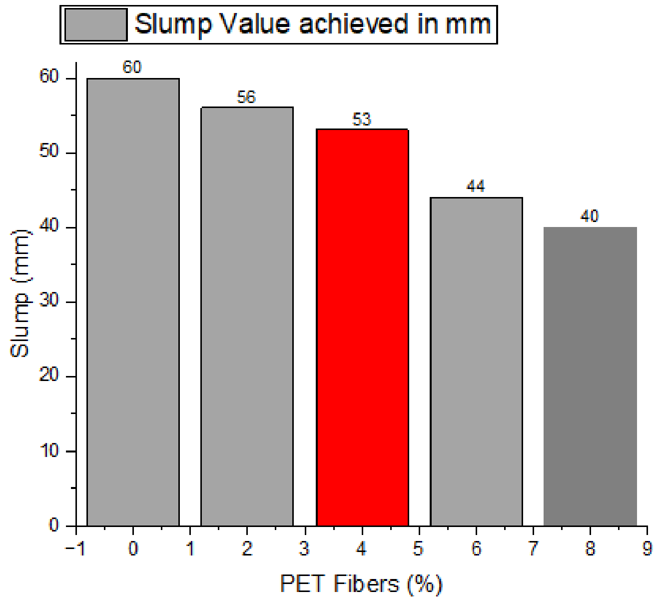

Figure 5 Effects of % PET bottle fibers on the workability of concrete

3.1.4. Compressive strength

Compressive strength is a crucial parameter reflecting the concrete's ability to withstand compressive forces and ensuring its overall structural performance and durability. Calculating the compressive strength using failure load and loaded area of cube specimens provides essential data for assessing the mechanical properties of the concrete with RPET fibers. The presence of PET fibers in the concrete was evident in crushed cube specimens, where minimal cracking and preserved cube shapes were observed compared to normal concrete. Figure 3 illustrates this, showing reduced cracking in cubes with PET fibers (2%, 4%, 6%, and 8%) compared to cubes without PET fibers (0% PET fibers). PET fibers act as crack arresters, modifying the cracking mechanism and reducing crack widths, enhancing the concrete's durability and load-bearing capacity. This visual evidence confirms the positive role of PET fibers in enhancing concrete performance and supports its potential as a resilient and sustainable construction material. Figure 6 indicates that concrete strength, influenced by curing duration and PET fiber percentage, peaked at 4% PET for 21-day curing, making it the optimal percentage for a balance of strength, crack resistance, and durability in eco-friendly construction.

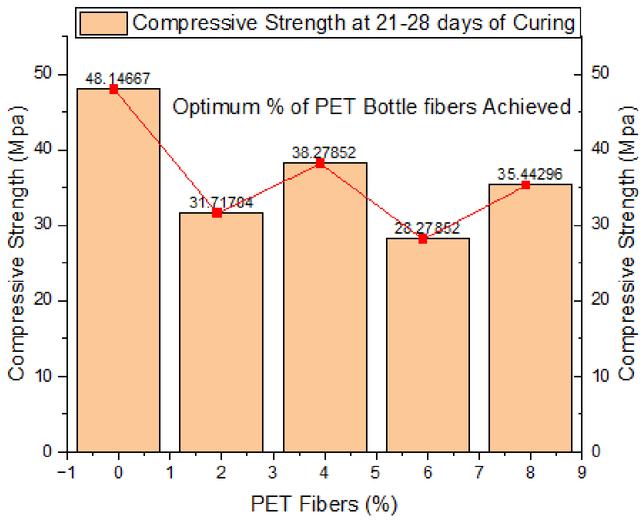

Figure 6 Strength of PET fiber concrete for 21&28 days of curing

3.2. Discussions and Comparison

The findings from this study reveal that an escalation in the percentage of PET fibers led to a reduction in the required amount of Plastocrete Plus and a decrease in the water-cement ratio by 2% and 0.45%, respectively. Notably, the tested normal concrete experienced a substantial increase in compressive strength but concurrently a decrease in workability, maintaining acceptability within the scope of this research. Among the battery of tests conducted and the 15 specimens presented, it is noteworthy that the compressive strength of concrete with 4% PET content after 21 days of curing slightly surpassesed that at 0% after 28 days of curing, as well as the strengths at 2% and 6% after 21 days, and 8% after 28 days of curing. The incremental methodology applied in this study resulted in a noteworthy 13.3% increase in compressive strength, aligning closely with the findings reported in literature. Upon inspection of various studies, divergent effects on compressive strength emerge. Figueiredo et al. [40] reported a 14% decrease in compressive strength when fine aggregates were replaced with PET. Conversely, Vanitha et al. [37] observed an increased compressive strength at 4% PET content but a substantial decrease beyond this threshold. Irwan et al. [41] found that as PET fibers increased from 0.5% to 1.5%, the compressive strength of normal concrete increased by 9.1%, but exhibited a decrease between 0.45% and 17.65%. Similarly, utilizing a PET volume fraction of 0.5% to 1.0% [42], noted a decrease in the compressive strength of PET fiber-reinforced concrete in the range of 1% to 10%. These comparative analyses signifies the complex and context-dependent nature of the influence of PET content on concrete compressive strength as depicted in Figure 7.

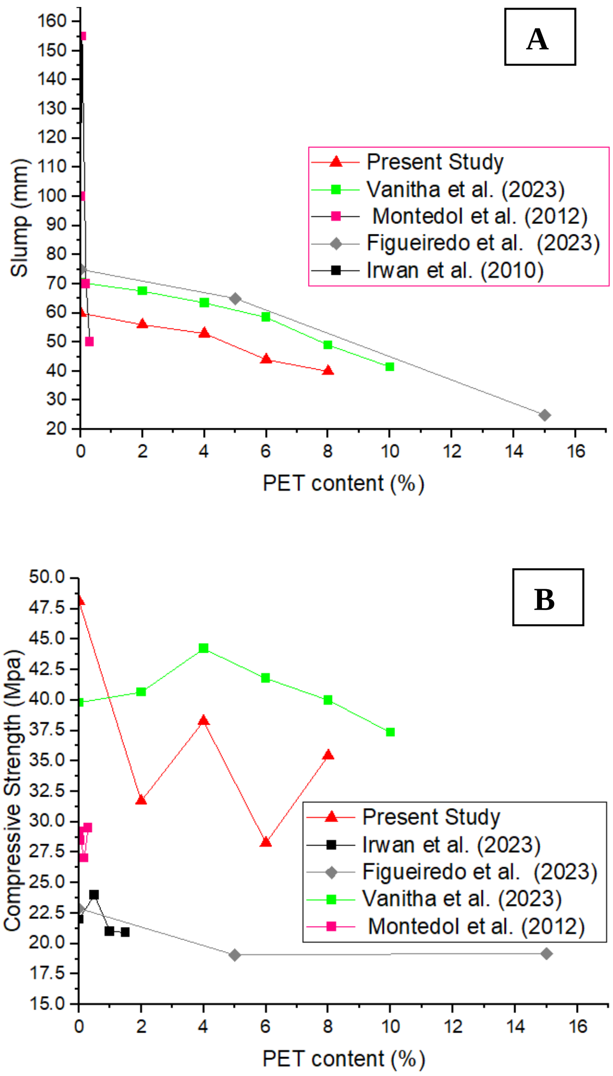

Figure 7 Workability (A) and strength (B) variation versus % of PET fibers incorporated

Table 3 Comparison of the Compressive Strength and Slump Between Present study and Literature

Author (s)	PET content (%)	Optimum Dosage (%)	Curing (days)	Compressive Strength (Mpa)	Slump (mm)	Specimen (Size)	Addition / Replacement
Present Study	0 2 4 6 8	4% of PET fibers with 14% increse in Strength	28 21 21 21 28	48.15 31.72 38.28 28.28 35.44	60 56 53 44 40	Cube (150 mm x 150 mm 3x150 mm)	Addition
Irwan et al. (2010)	0 0.5 1 1.5	0.5% of PET fibers increase to 9.1% of Strength	28	22.00 24.00 21.00 20.93	High % of Slump lead to readuced workability		Addition
Figueiredo et al. (2023)	0 5 15	Results remain unchanged at 14 days compared to Literature, while at 28 days decreased to approximately 14%	14&28	22.9 19.08 19.21	75 65 25		Replacement of aggregates
Vanitha et al. (2023)	0 2 4 6 8 10	4% of PET fibers with 5% increse in Strength	28	39.8 40.65 44.22 41.78 40 37.34	70.5 67.5 63.5 58.5 49 41.5	IS 516-1959. 150 mm x 150 mm x 150 mm	Replacement of aggregates
MontedoI et al. (2012)	0 0.05 0.18 0.3	Slight increase	28	29.23±1.4 28.5±0.5 27.04±1.1 29.52±0.6	100 155 70 50	Cube (150 mm x 150 mm 3x150 mm)	Addition

4.0 CONCLUSION

This study demonstrates that incorporating recycled PET bottle fibers significantly influences the mechanical properties of concrete, offering a promising and eco-friendly solution for the construction industry. Key findings pinpoint 4% of PET fibers as the optimal dosage for balancing the improved strength and workability. Visual evidence from crushed cube specimens highlights the positive impact of PET fibers on crack resistance. The key findings are summarized as follows.

1. Integrating a specific number of PET bottles, cut into irregular shapes, into the concrete mix has been shown to enhance the compressive strength of concrete. This innovative approach offers a sustainable and effective method for improving concrete performance by repurposing recycled PET bottles.

2. Incorporation of Plastocrete Plus or an equivalent dosage of admixture influenced the workability of the PET concrete. This additive enhances the plasticity, cohesiveness, and ease of placement, ensuring a well-balanced combination of workability and structural integrity in PET concrete formulations.

3. The optimal compressive strength and slump performance of the tested concrete were achieved after a 21-day curing period, surpassing the results obtained after the conventional 28-day curing duration.

4. The optimal dosage of PET fibers was found to be 4%, indicating that neither too low nor too high a quantity is necessary to achieve optimal results.

5. The achieved increase in strength of approximately 13.3% using the methods described in this study may be increased or decreased, but it is not expected to increase further.

6. These findings align with those of previous studies, supporting the consensus on strength improvement and the added value of enhanced workability. This reinforces the robustness and consistency of the observed effects, contributing to the collective understanding of PET fiber concrete.

To broaden the applicability, future research should be conducted to assess the tensile, flexural, creep and crack resistance strength. This research advocates the adoption of recycled PET fibers in construction, promoting sustainable practices, and minimizing plastic waste, highlighting their role in innovative and eco-friendly construction materials.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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