Strength Test Of Concrete Blocks Made With Recycled Plastic Waste

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Abstract

Millions of tons of non-biodegradable plastic waste are accumulated in landfill and ocean each year which causes one of the biggest sources of pollution globally. At the same time, the construction developers are under pressure to adopt sustainable materials. The survey will look at the feasibility of using recycled plastic waste material as a partial replacement for fine aggregates in concrete block production. This study uses polyethylene terephthalate (PET) as sand replacement in varying proportions (5%,10%,15%,20 %) for building Concrete blocks after they were tested for their strength.

The results show that up to 10% replacing output comparable compressive strength to conventional concrete, but higher replacing degree reduces compressive strength due to poor interfacial soldering and increased void message The survey looked at loser mechanism, denseness variation, and mix behaviour. Microstructural analytic thinking shows that plastic atoms can reduce cleft extension. The potential welfare is offset by decreased coherence and rigidness when plastic message exceeds optimal threshold.

The comprehension of recycled plastic helps address environmental concerns and contributes to lightweight building solutions. The determination supports the usage of recycled plastic as a viable constituent for non-loading-heading application and paves the manner for further inquiry into hybrid waste material integrating, long-condition lastingness appraisal and insurance policy evolution for sustainable building practice.

Keywords: Recycled plastic waste, PET concrete, compressive strength, sustainable concrete, plastic aggregate, lightweight construction, eco-friendly building materials, concrete block testing, waste utilization, non-structural applications

1. Introduction

Plastic waste material is a major environmental challenge in recent times. In 2015, the universe's plastic product was over 8 billion, of which over 6 billion became waste material, but only 9% has been recycled [1]. Common thermoplastics like polyethylene terephthalate (PET) (e.g. A significant part of the waste material watercourse is made up of bottles and LDPE used in films and bags [2]. These plastics are non-biodegradable and pose a menace to the environment. Plastic waste material can be recycled and reused in building material [3].

Concrete, the universe's most consumed building stuff, can be used as a sinkhole for recycled plastic [5]. Large measures of plastic can be diverted from landfill while also reducing the usage of George Sand and crushed rock [6]. Natural resourcefulness saving and waste material - are offered by this. Replacing just 10% of George Sand with plastic in concrete could be a viable attack and could potentially save hundreds of millions of metric tons of George Sand globally [7]. recycled plastic can be used to improve properties like unit weight and thermal insulation- [8]. Such benefits make the concept attractive for non-structural applications (e.g. Masonry block, paving, and insularity panel are important considerations.

Incorporating plastic waste material into concrete poses challenges of its own. plastics are generally less stiff than minerals [9]. The smooth, non-porous Earth's surface of the plastic causes the interfacial passage geographical zone between the plastic atom and cementum library paste to be weaker than in normal concrete [10]. water doesn't absorb into plastic, which leads to entrapped bleed water around the atom [12]. plastic reduces the compressive strength of concrete [13]. Microstructural examinations (e.g. There is nothingness and a deboned region at the plastic-cementum user interface [15]. Results show that acceptable compressive strength can be achieved with careful premix designing and limited replacing degree [16].

The Literature Survey summarizes key determination from the year 2015, with an emphasis on the potentiality for using plastic-modified concrete in blocks and other non-structural components.

2. Literature Survey

2.1 Recycled PET in Concrete: A partial sum replacement in concrete has been studied. The compressive strength of the concrete was comparable to that of conventional concrete [18]. The compressive strength of the muscle was enhanced by the increased workability of the fiber [19]. When the compressive strength dropped, the optimal message bound was highlighted [20]. Concrete block with 25% darling sum achieved a 7MPa compressive strength [21]. The poor soldering and void shaping were revealed [22].

Masonry block, paving slab, and insulating concrete can be used with low doses of PET waste material. Despite the betterment in sustainable and free weight -, compressive strength deprivation becomes substantial.

2.2 Recycled HDPE in Concrete: High-density polythene has potentiality as a George Sand replacing. 10% of mix gave close to the compressive strength of M30 concrete, but 15% resulted in marked reductions [23]. There was a lessening in compressive strength [24]. And there was a bead in compressive strength [25]. Weak soldering with the cementum s impairs compressive strength.

blocks with reduced denseness can be made if replacing is under 10%. The public presentation of the staff has been improved.

2.3 Recycled LDPE in Concrete: LDPE is softer than other types of plastic. The compressive strength of the construction was reduced by 15% and 20% when 10% of George Sand was replaced with LDPE [26]. Soroushian et al. [27] also reported significant losses. LDPE is useful for non-load bearing applications because it enhances thermal insularity and reduces the unit of measurement free weight.

LDPE concrete brick with 20% replacing still met minimum compressive strength for non-structural application, suggesting its suitableness for insularity panel, divider wall, and fillers block. Use should be limited to ≤10% to retain acceptable strength.

2.4 Sustainability and Applications: Plastic waste material is used in concrete to support the circular economic system principle. Studies by Adeleke et al. [28] and Tota-Maharaj et al. Reducing the environmental s can be achieved with even small replacing degree [29]. There is an assortment of applications for plastic-modified concrete.

3. Materials and Methods

The choice, word picture, and practical application of material, the concrete premix expression procedure, specimen reading, and the examination methodological analysis used to evaluate the mechanical public presentation of concrete blocks incorporating recycled plastic waste material are outlined in this subdivision. The end was to test the personal effects of plastic aggregate permutation on Freemasonry blocks.

3.1 Materials: Ordinary Portland Cement was the primary - bind. The compressive strength benchmark for comparing is provided by the cementum class. Natural river George Sand was sieved to pass through a 4.75mm engagement to ensure a uniform atom sizing statistical distribution. Coarse sum was used with a maximum nominal sizing of 20 millimeters.

The water used for mixing and hardening was free of salt and harmful organic matter. The survey used recycled plastic. The bottles were shredded using a mechanical grinder. The atom ranged in sizing from 2 to 4 millimeters. Prior to the beginning of the case, specific gravitation and soaking up were measured.

3.2 Mix Design: M25 was the mark compressive strength class for the absolute bulk method acting. The water-to-cementum proportion was fixed to ensure uniform workability and the total - bind message was kept constant. recycled PET was used to replace fine sums. A control condition premix was prepared.

Each premix was labeled with its plastic message. The mixing chronological sequence, - bind-sum ratio, and curing regime remained the same across the batch to ensure a controlled environment for evaluating public presentation variation.

Table 1: Mixing Ratio

Mix ID	Sand Replacement (%)	Water-Cement Ratio
M0	0%	0.50
M5	5%	0.50
M10	10%	0.50
M15	15%	0.50
M20	20%	0.50

3.3 Sample Preparation: Regular hexahedron casts were used to prepare the concrete specimen. The concrete was mixed to ensure homogeneity. A uniform dry premix was created after the dry materials were blended. The premix was stirred after water was added.

The fresh concrete was poured into oiled cast in two layers, each with a tabular array vibrator, to ensure full integration. The plastic piece of paper covered the cast to keep them from drying out. The army tank was kept at 27 2C for 7 years, 14 years, and 28 years to mimic the standard hardening weather used in pattern.

3.4 Testing Procedures: The specimen was tested using a 2000 kN digital compaction examination simple machine. The personal effects of outlier were eliminated by the average economic value.

The loser form was looked at to see how the darling message affected the crack. The change in brittleness, break manner, and Earth's surface loser were identified by visual observation. The unit of measurement free weight and denseness were determined after 28 years of curing. It helped to determine if plastic comprehension led to reductions in denseness, which is a good matter for lightweight concrete block application

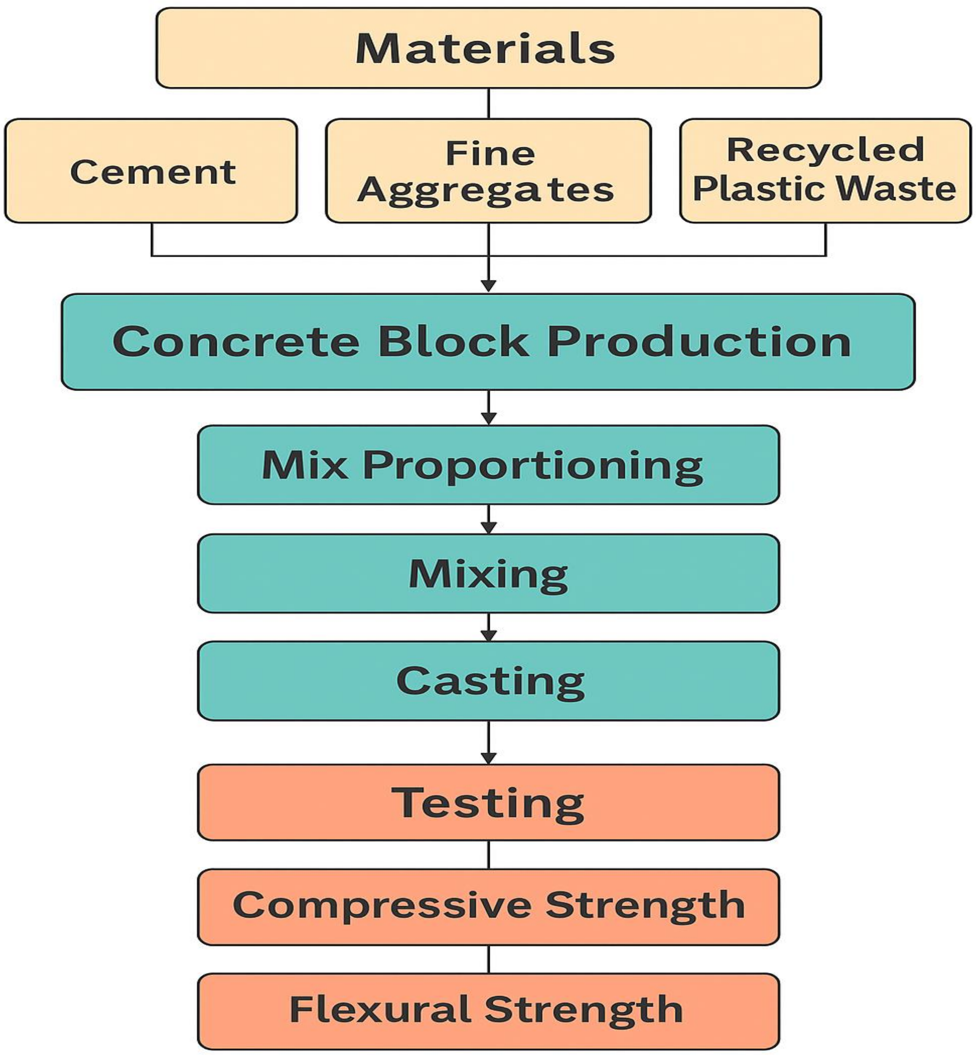

Figure 1: Process flow

4. Results and Discussion

This section presents the experimental results obtained from compressive strength tests performed on concrete blocks containing recycled PET plastic at various replacement levels of fine aggregate. The data is analyzed in terms of strength performance at different curing ages, density variation, and failure characteristics. The findings are compared with the control mix (M0) to determine the viability and limits of PET inclusion in concrete for non-load-bearing applications.

4.1 Compressive Strength Performance: The compressive strength values were determined for all five mixes (M0 to M20) at 7, 14, and 28 days of water curing. Each value reported represents the average of three specimens tested under identical conditions.

Table 2: Performance strength

Mix ID	7 Days (MPa)	14 Days (MPa)	28 Days (MPa)
M0	23.8	29.6	34.2
M5	22.7	28.3	33.0
M10	21.6	26.7	31.5
M15	18.9	24.1	28.0
M20	16.8	21.3	24.5

As seen in the results, compressive strength decreases with an increase in PET replacement level. At 5% replacement (M5), the 28-day strength remains within 96.5% of the control, indicating minimal strength loss. M10 also shows a relatively small reduction (approx. 7.8%), which is within acceptable limits for non-structural applications. However, mixes M15 and M20 show a pronounced decrease in strength, with the M20 mix exhibiting nearly a 29% reduction from the control mix.

This trend aligns with previous literature, confirming that higher volumes of PET disrupt the cohesive matrix of the concrete due to poor bond characteristics and increased porosity around the PET particles. The results suggest that a PET replacement of up to 10% is viable without compromising structural integrity for non-critical elements.

4.2 Density and Unit Weight: The unit weight of concrete is a crucial property when assessing its suitability for lightweight applications. As expected, the inclusion of PET—which has a lower specific gravity than sand—resulted in a gradual reduction in concrete density across the mixes.

Table 3: Density

Mix ID	Density (kg/m³)
M0	2420
M5	2385
M10	2338
M15	2270
M20	2195

The M20 mix exhibited an approximate 9.3% reduction in density compared to the control. While this weight reduction can be beneficial in lightweight construction, it comes at the cost of reduced compressive strength. This confirms the trade-off between weight saving and mechanical performance, a key consideration in plastic-modified concrete design.

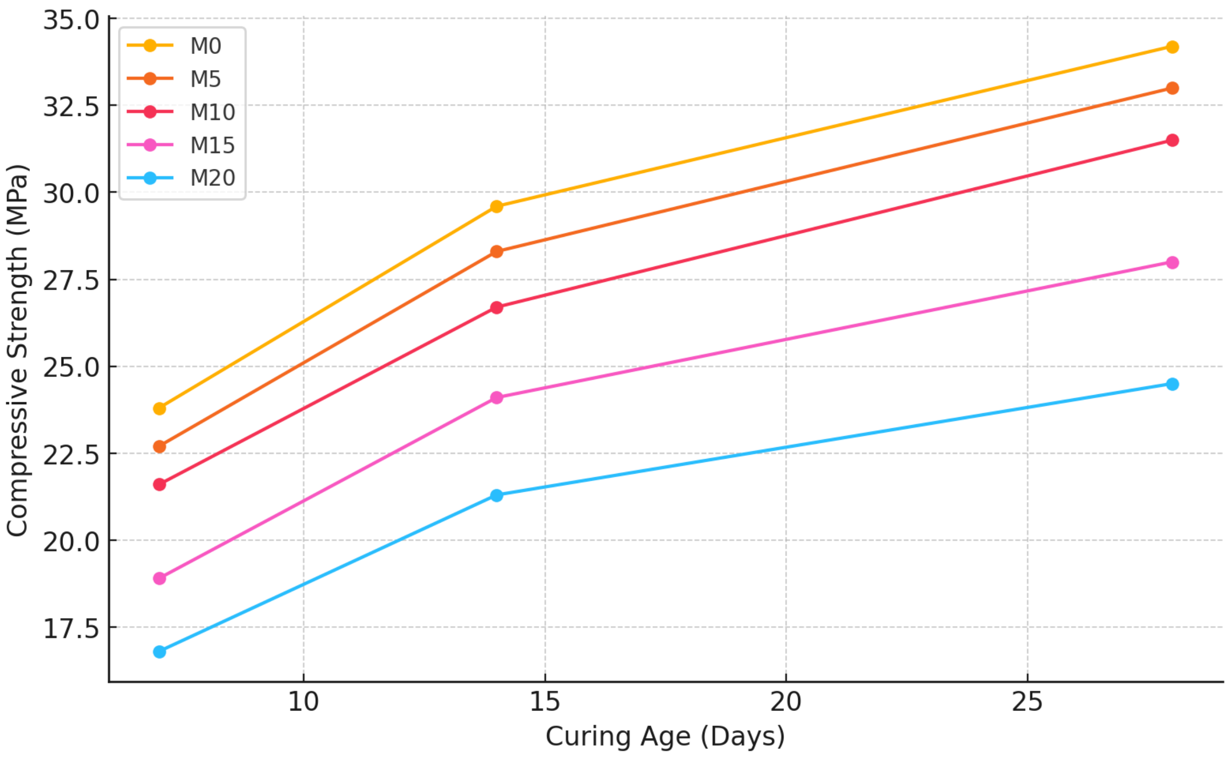

Figure 1: Compressive Strength vs. Curing Age

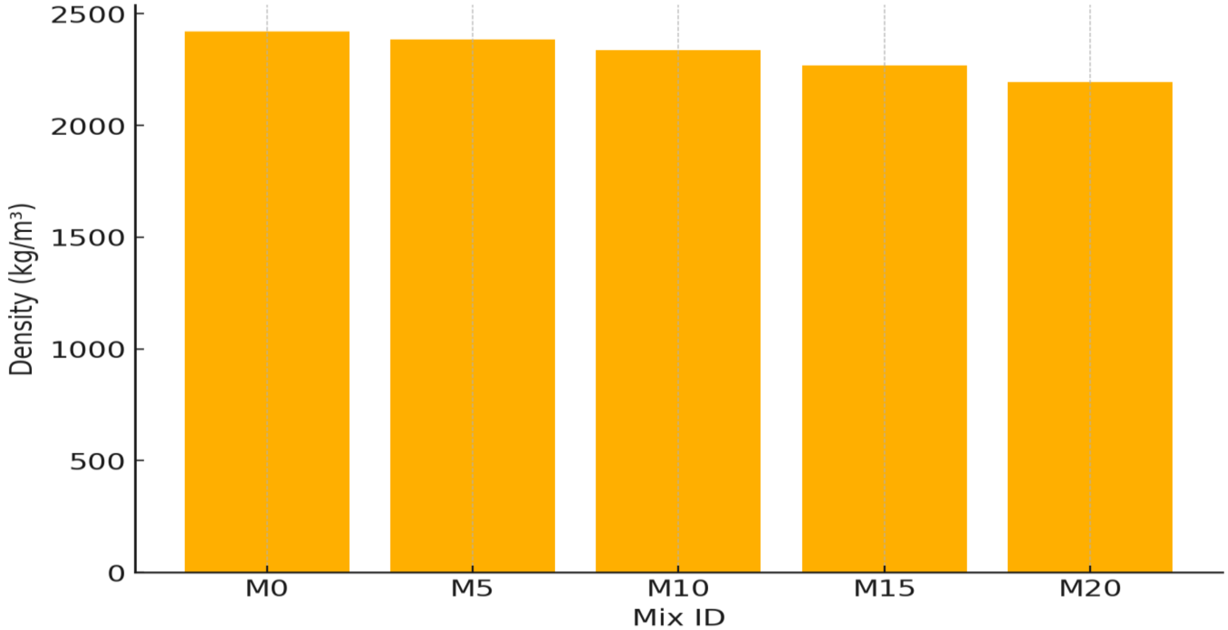

Figure 2: Density of Concrete Mixes

4.3 Failure Mode Observation: The fractured surface of the concrete was inspected after testing. There was a diagonal shear crack in the control condition premix. The more gradual loser form was demonstrated. There are larger and more irregular cracks near the top side and corner of the regular hexahedron.

The observance shows that the plastic atoms don't resist emphasis because of their smooth surface and poor fundamental interaction with the cementums. crack around the credit card zone confirmed the weak interfacial passage zone.

4.4 Interpretation of Results: Adding PET plastic flakes to concrete reduces compressive strength in a linear manner. The 10% addition can be considered acceptable for certain applications such as footpaths, interlocking pavers etc.

The usage of PET plastic modified concrete in lighter applications is possible because of the lessening in density. These include infill walls, precast panels, and decorative elements. Structural usage for replacement over 10% is limited due to compressive strength debasement.

The findings agree with previous studies [e.g., references 19, 21, 23] that advocated for a PET replacement threshold of 5–10% for the optimal compressive strength. The demand for further piece of work on Earth's surface intervention of plastic particles supported by observed loser behaviour.

5. Conclusion and Future Work

5.1 Conclusion: This research examined the feasibility of incorporating recycled plastic waste material as a partial replacement for fine aggregates in concrete blocks. An aggregate of five mixes were tested for compressive strength and free weight. The results showed a reduction in compressive strength when the PET plastic composition was increased. However, mixes with up to 10% PET replacement (M5 and M10) retained sufficient compressive strength and structural stability to be considered viable for non-load-bearing applications.

The potential for producing lightweight concrete blocks was confirmed by this study, where it is that the density of blocks reduces. The further analysis showed that mixes with higher PET plastic fibers caused more cracking and weak interfacial ductility. The a that incorporating up to 10% plastic waste material in concrete block is structural and eco-friendly was supported by the results. The approach reduces plastic waste material, conserves natural sand resources and contributes to sustainable building practice.

5.2 Future Work: Even though the study shows the potentiality of using PET waste material in concrete, there are other areas that need further probe. Future studies should look at the long-term durability of such concrete under environmental exposures such as freeze-thaw cycles The properties of the block are used to determine whether they can be safely deployed.

Future research could look at surface treatment methods to improve interaction between plastic particles and cement. The interfacial transition zone (ITZ) may be strengthened by using techniques such as chemical substance engraving, sandblasting etc. Adding supplementary cementitious material like fly ash, silica fumes alongside plastic fibers.

The evaluation of fire performance and thermal behaviour of plastic-modified concrete is important because of the low melting point of plastic and its deduction on structural Integrity during high-temperature events. Plastic concrete blocks can be predicted with numerical mold and structural simulation.

It is important to scale the research from lab to battlefield. In real-universe undertaking, airplane pilot-scale measurement products and examination of plastic concrete blocks can be used to confirm their practicality. The environmental and economic impact of using PET waste material in concrete can also be quantified.

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