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# ECO-FRIENDLY BRICKS FROM PLASTIC WASTE: A SUSTAINABLE SOLUTION FOR CONSTRUCTION AND WASTE MANAGEMENT

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**Abstract**
The continuous accumulation of plastic waste requires performance-based eco-friendly recycling solutions to manage environmental challenges. The research investigates the practicality of creating environmentally friendly bricks through substituting various plastic waste kinds which include Polyethylene Terephthalate (PET) and High-Density Polyethylene (HDPE) and Polyvinyl Chloride (PVC) and Low-Density Polyethylene (LDPE) and Polypropylene (PP) at substitute proportions (5–20%) with sand. Researchers assessed the plastic waste bricks for compressive strength measurements as well as water absorption rates and acid resistance and efflorescence phenomena and thermal characteristics and total costs. Bricks made with 5% plastic waste as a replacement produced optimal results that increased compressive strength by 7.8% (1,859.44 pounds per square inch at 28 days) while decreasing water absorption to 6.95% compared to regular bricks. The entire plastic brick sample group demonstrated no efflorescence as well as better thermal insulation qualities. The addition of excessive plastic content (≥10%) in the mixture caused the bricks to become weak with increased water uptake. The thermal stability diminished when the amount of plastic used in the mixture was raised according to thermogravimetric results. The increase in price of plastic bricks remains reasonable as they absorb no carbon from kiln-burning processes and thus offer a green solution. The research shows that plastic waste bricks with 5% plastic have potential as sustainable and workable building materials while more study is essential for cost reduction and wider implementation.

**Keywords:**
*Plastic waste management, Sustainable construction materials, Eco-friendly bricks, Thermogravimetric analysis (TGA), Circular economy.*

## 1. INTRODUCTION

Masonry engineers use bricks to build complete walls as well as floors and basic structural components. Modern construction relies heavily on brick products for building all structures. The production of traditional brick demands clay along with sand and water and a binding material. CO2 emissions occur while bricks require maintenance during a process that results in topsoil loss. The brick production process through kiln burning generates environmental destruction throughout the surrounding region. When making bricks through traditional methods both abundant power and vast amounts of carbon dioxide are consumed. Developing countries with uncontrolled brick industries depend on coal as their primary fuel source therefore creating increased atmospheric emissions. When ranked by the World Bank such industrial air pollution stands among the five largest pollutants. [1].

Public concern is rising globally about managing steadily accelerating production of plastic waste. The massive majority of plastic products end up in landfills and create detrimental ecological threats alongside human health risks. [2]. Scientists study sustainable solutions for reducing plastic waste through their development of eco-friendly waste plastic bricks. The combined efforts of materials scientists and civil engineers produced innovative building material solutions which answer the increasing demand for environmentally-friendly durable construction materials. Manufacturing of such eco-friendly bricks using recycled plastic represents a valuable response to managing waste while creating sustainable construction materials. [3]. Building materials produced from these bricks offer environmental benefits while demonstrating potential strength properties. Companies can measure the performance quality of these bricks by assessing their design strength combined with insulation abilities and economic affordability and environmentally sustainable production. Thorough analysis of these features creates a solid foundation for understanding the possible deployment of waste plastic bricks in construction while solving the urgent plastic waste management problem.

Making bricks with waste plastics presents various challenges because different types of plastic exist along with differing processing techniques and possible health risks and environmental impacts. It is essential to analyze the scientific along with technological economic and environmental aspects of waste plastic brick applications for building structures. [4].

Public concern continues to grow regarding plastic waste growth and disposal challenges across recent times. Since 2016 global plastic production has reached 320 million tons and continues to increase thus damaging the planet's ecosystems. [5]. Plastic recycling into bricks presents a modern solution for people dealing with the waste problem because it provides a dual benefit through sustainable construction. Research on building bricks with recycled materials experienced significant advancements over recent years. The research shows that plastic recycling both reduces environmental pollution while lowering construction material expenses so the building industry becomes greener. [6]. Laboratory testing indicates that plastic waste bricks match traditional bricks both mechanically and thermally so they represent an applicable solution for construction work. [7] [8]. Fast urban expansion together with waste output over recent years arises directly from worldwide population increases. Plastic waste has accumulated past its critical limits making it a prominent environmental concern according to research [9]. Multiple plastic waste items find their way into landfills or natural habitats and create detrimental environmental and health risks because of their non-reactive state. [10].

Bricks alongside other building materials heavily contribute to carbon emissions creating an industry-wide issue within construction. [11]. The building industry requires sustainable environmentally friendly building alternatives because it disturbs ecological systems while the world works toward climate change mitigation.

Recycling plastic for construction materials has stimulated significant interest among professionals. Strong and low-impact waste plastic bricks have drawn research focus along with their durable quality. [12]. Waste plastic reduction while maintaining mechanical features shows promise for brick-producing techniques such as extrusion and compression and injection moulding. [13]. This building material provides insulation benefits while offering flexibility in production formats and dimensions which need further examination.

Little research has been conducted understanding the effectiveness and durability of waste plastic bricks despite general availability of the materials. The main goal of this investigation focuses on evaluating waste plastic bricks from both an environmental standpoint using sustainable methods while analyzing their mechanical properties and energy usage alongside their life cycle assessments and ability to reduce plastic waste.

### 1.2. Different types of plastics

Solid waste management presents significant difficulties for Pakistan as one of many developing economies while plastic waste contributes substantially to these challenges.

The Pakistani waste management sector operates plastic trash recycling services and employs different recycling procedures. The production of environmentally sustainable bricks utilizes different kinds of discarded plastic materials. PET stands as one of the most recyclable plastic compounds because it exists in water bottles and food containers. The plastic materials used in hand soap packaging and plastic bags comprise HDPE making it suitable for reuse. Despite dangerous emissions that occur during heating processes Polyvinyl Chloride (PVC) materials are suitable for recycling in certain nations for manufacture of wires and pipes. The common plastic material LDPE powers the production of both supermarket bags and plastic wraps. The production of sustainable bricks benefits from Polypropylene (PP) which serves as an important source material due to its use in packaging yogurt and its role in bottle caps as well as straws.

## 2. Literature Review:

The military was plastic's only consumer when it was first used seventy years ago and since then it has become essential for modern life. New research indicates plastic waste will increase four times after 30 years. The scientific community has investigated all plastics back to their first mass production era in the 1950s. In 2015 humans produced 8.3 billion metric tons of plastic combined with 6.3 billion tons of plastic waste. Recovery systems in 2015 transformed only 9% of the total plastic waste into new products and generated 12% of its waste through incineration. Science Advances released findings showing that 79% of plastic waste gets refused while experts predict plastic production alone will amount to 26 billion tons by 2050. This outcome creates a long-term issue with plastic waste management until 2050 arrives. "Primary waste" refers to recycled plastic. [14].

Research by Kognole et al. (2019) demonstrated that plastic bricks produced better strength than standard bricks while exhibiting poor overall resistance. Through testing the authors determined that these bricks possessed flexural strength of 4.5 N/mm² as well as compressive strength of 13.5 N/mm². Plastic bricks demonstrated lower flexural strength although compressive strength held steady at similar levels to conventional bricks. Plastic bricks exhibited thermal conductivity at 0.18 W/mK that proved to be below conventional brick levels. Plastic bricks have shown the ability to substitute regular bricks but engineering tests reveal both enhanced fragility and limited success in various physical applications. [15].

According to Chauhan et al. (2019) the best achievement of compressive strength comes from using 1:2 plastic to sand proportions while each kilogram of sand needs two kilograms of plastic. Laboratory examinations of bricks made at a ratio of 1:2 led to compression results equivalent to normal bricks at 203.56 kg/cm². The bricks showed good water absorption percentage rates between 0.949 and 1.227%. The combination of sand and plastic material led to improved mechanical qualities as well as better thermal characteristics and acoustic benefits which resulted in sustainable brick substitutes. [16].

Akinyele, Igba and Adigun (2020) studied the structural properties of bricks made with waste PET in their research. The compressive strength measurements of 10.29 N/mm² from waste PET dough containing 5% of the material exceeded basic brick strength at 10.5 N/mm². Strength tests confirmed that waste PET bricks delivered superior results than normal brick structures with 8.53 N/mm² flexural strength. The higher capability of PET bricks to absorb water at 10.29% made them more sensitive to water-related damages compared to standard regular bricks with a water absorption rate of 6-7%. The research defines 5% waste PET as the best choice because it yields positive manufacturing outcomes along with low water absorption rates. [17].

The research of Prasath et al. (2021) resulted in the development of modified paver blocks which persisted as structurally sound as typical blocks based on laboratory data. The modified paver blocks achieved similar results to standard blocks regarding performance based on 10% water absorption and 4 MPa flexure strength and 25 MPa compressive strength. The modified blocks showed better insulation capabilities in addition to their potential role in sustainable construction materials. [18].

Ikechukwu and Shabangu (2021) showed that eco-friendly waste plastic bricks demonstrated equivalent strength properties and durability outcomes to conventional masonry bricks. Experiments combined smashed glass material at 30% with PET plastic resin at 30% and cement material at 40%. Laboratory outcomes indicated that the tested samples met transfer and compression strength requirements at 4 MPa and 33 MPa respectively and reached a maximum water absorption of 10%. The research showed that waste plastic bricks performed well for construction energy usage because they conducted heat less rapidly. [19].

Philip et al. (2021) researched how fly ash integrated with bentonite results in environmentally friendly construction bricks. Testing bricks that combined 50% fly ash with 30% bentonite and 20% water led to results showing compressive strength at 15 MPa together with 10% water absorption and a density measurement of 1.5 g/cm³. Experimental bricks employing both fly ash and bentonite showed better structural strength and longevity than typical construction bricks because they could function as sustainable construction materials. [20].

The lack of sustainable waste management solutions creates environmental problems according to Aneke and Shabangu (2021). The combination of foundry sand with scrap plastic waste revealed in their research that compressed bricks achieved strengths up to 85% beyond traditional clay bricks when using FS ratios from 20% to 40%. The optimal strength combination for waste material recycling in construction was based on a 70% FS to 30% SPW ratio which produced the strongest tensile and compressive strength results. [21].

Puri et al. (2022) made environmentally friendly bricks through a composition of 50% waste plastic alongside 25% stubble and 25% cement to show similar strength properties when compared to standard bricks. Tested building units had a water absorption level of 10% while reaching compressive strengths of 30 MPa and flexural strengths of 4 MPa and exhibited low thermal conductance. The research shows auxiliary plastic and stubble materials offer promising opportunities to develop sustainable construction solutions. [22].

Kulkarni et al. (2022) examined the influence of waste plastic on brick compressive strength and efflorescence levels together with moisture content evaluation. The use of plastic waste at a ratio of 25% resulted in strong bricks which had both enhanced compressive strength properties and below-average moisture levels alongside good performance results. The researchers identified bricks with 25% plastic waste as the best mix because they displayed optimal compression metrics together with minimal efflorescence rates and reduced water content [23].

Kulkarni et al. (2022) examined recycled HDPE and PP plastic waste for producing building blocks. This research confirmed the equivalent mechanical capacity of plastic bricks when compared to standard bricks through measurement of HDPE strength at 11.19 $N/mm^2$ and PP strength at 10.02 $N/mm^2$. The thermal properties of plastic bricks reached 0.13 W/mK while traditional bricks reached only 0.7 W/mK [23].

## 3. Materials and Methodology

### 3.1. Materials

A testing environment was developed to assess eco-friendly and sustainable waste plastic bricks through multiple material components. The research tested waste plastics as a replacement for aggregate materials to improve waste management practices and sustainability. The research used Chenab sand as its main fine aggregate alongside the binding agent OPC performed through the experiment. Fly ash received addition to the mixture for the purpose of enhancing the bricks' resistance and overall operational performance.

#### 3.1.1. Plastic Waste

**Figure 1: Waste plastics bottles**

Plastics served as the central focus of this investigation. Waste management facilities in the local area provided PET together with HDPE and PVC along with LDPE and PP plastics for recycling purposes as shown in figure 1.

Plastic collection started by obtaining materials from different locations including town sites and waste management sites and recycling facilities. Both the production timeline and material selection process followed consistent categories (PET, HDPE, PVC, LDPE, PP) for controlling the materials that would create bricks.

Plastics received cleaning procedures to eliminate all visible dirt and external pollutants from their surface. The researchers shredded cleaned materials as shown in figure 2 through a commercial machine that converted them into uniform pieces to simplify their integration during brick preparation steps.

**Figure 2: Waste plastics shredding**

The analysis of plastic shredding by sieve size determined the distribution of particles. Sieve analysis graph is given in figure 3. The materials transited three sieve levels to measure how much plastic material remained on each filter. Research results produced a grading for plastic that aligned with fine aggregate grading standards defined in ASTM C136.

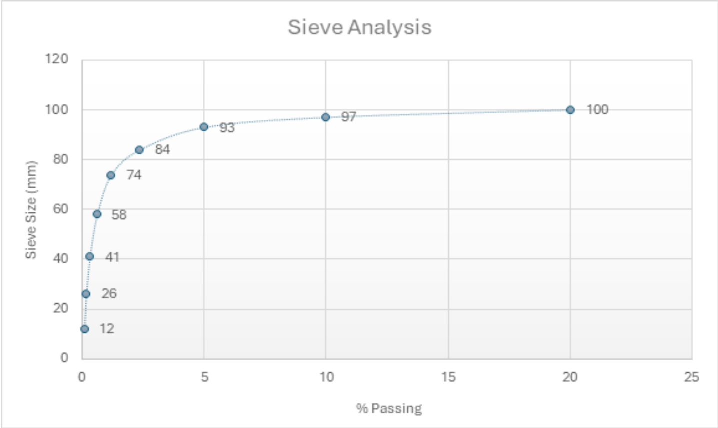



**Figure 3: Sieve analysis graphical representation**

The analysis of the sand and plastic mixture's Fineness Modulus (FM) required combining the percentage of material retained on standard sieves then dividing it by the sieve count. The FM calculated 3.17 evaluates aggregate mixture grading while enabling prediction of workability in the final product.

### 3.1.2. Sand

The experimental setup used Chenab Sand as its binding agent that is shown in figure 4. The Chenab River supplies this sand as its original source from a significant South Asian water tract. Brick manufacturing requires Chenab sand because of its particular characteristics which fit the manufacturing process requirements.

The optimized particle distribution for strong brick formation exists because Chenab sand has medium to coarse grains which measure between 0.3 mm and 0.6 mm in size. Physically the sediments mostly have a rounded to sub-rounded shape that results in stronger brick bonds. The bulk density of Chenab sand falls between 1.4 to 1.6 g/cm³ that supports brick strength and durability. The bricks exhibit controlled water and air absorption because of their measured porosity levels between 30-40% which influences heat resistance properties and performs well across different environmental conditions.

**Figure 4: Chenab sand**

### 3.1.3. Cement (OPC)

The brick structure received strengthened durability through its incorporation of the binding agent Ordinary Portland Cement (OPC). The cement possesses density between 1500-1560 kg/m³ and specific gravity at 3.15 and setting times extending from 30 minutes (initial) to 10 hours (final). The chemical composition of OPC features calcium silicates combined with aluminates and ferrites together with minor amounts of additional compounds. Alika's OPC exists as a combination of 60-70% $CaCO_3$ together with 17-25% $SiO_2$ and 3-8% $Al_2O_3$ to perform reliably as a structural material.

### 3.1.4. Fly Ash

The inclusion of fly ash from power plant coal combustion byproducts used in brick-production was possible because this material has strong pozzolanic properties that improve resulting material performance. The spherical characteristics of fly ash particles along with their 1-150 microns dimensions boost both workability and density values in clay products. The chemical components of fly ash deactivate as silicon dioxide ($SiO_2$) along with aluminium oxide ($Al_2O_3$) and ferric oxide ($Fe_2O_3$). Fly ash comprises two classifications: Class F (low calcium) and Class C (high calcium) however researchers applied the environmentally advantageous Class F for its enhanced cement-like qualities and sustainability advantages.

### 3.2. Methodology

The research used multiple sequential stages to measure the longevity and functional value of recycled plastic bricks. The methodology involved waste collection followed by brick formation before performing mechanical and physical property testing.

#### 3.2.1. Fixing the proportion of material:

Fix the quantity of cement, fly ash and use the water as per requirements. The only variable is sand replacement with waste plastics. The following table 1 show the relative adjustment of the material.

**Table 1: Mix Proportion**

| ID# | Proportion (%) | | | | Volume (m3) | | | | Weight (KG) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FA | C | S | WP | FA | C | S | WP | FA | C | S | WP |
| **Control** | 40 | 20 | 40 | 0 | 0.03 | 0.015 | 0.03 | 0 | 21.26 | 21.87 | 49.21 | 0 |
| **B1 5%** | 40 | 20 | 35 | 5 | 0.023 | 0.011 | 0.02 | 0.003 | 15.95 | 16.4 | 32.29 | 3.9 |
| **B2 10%** | 40 | 20 | 30 | 10 | 0.023 | 0.011 | 0.017 | 0.006 | 15.95 | 16.4 | 27.68 | 7.8 |
| **B3 15%** | 40 | 20 | 25 | 15 | 0.023 | 0.011 | 0.014 | 0.009 | 15.95 | 16.4 | 23.07 | 11.7 |
| **B4 20%** | 40 | 20 | 20 | 20 | 0.023 | 0.011 | 0.011 | 0.011 | 15.95 | 16.4 | 18.45 | 15.61 |
| **Total weight** | | | | | | | | | 85.06 | 87.47 | 150.7 | 39.01 |

#### 3.2.2. Preparation of Brick Molds

Factory carpenters produced wooden and iron moulds which served as tools for preparing bricks inside the building. The moulds possessed precise edges and polished surfaces so production would achieve optimized consistency during the moulding operation. The production used stationary and mobile moulds which adapted to different operational requirements. The moulded bricks followed standard proportions of 9 inches length combined with 4.5 inches width and 3 inches height.

#### 3.2.3. Procedure for Casting the Bricks

Waste plastics including PET along with HDPE and PVC and LDPE and PP were collected from recycling centres before being sorted and shredded. The production team washed the shredded plastic before drying it to remove all impurities. The mixture obtained through ingredient blending underwent casting into standard-shaped moulds after a procedure that avoided bubble formation. A careful removal of the bricks from their moulds during cooling enabled complete maintenance of their original dimensions and quality attributes. A systematic manufacturing method produced plastic bricks that met both durability and consistency requirements.

## 4. Results and Analysis:

### 4.2. Compressive Strength Test:

Researchers used the ASTM C67 test method as shown in figure 5 to measure brick compressive strength, determining its breaking point through maximum load capacity. They tested samples with varying waste plastic proportions at 7, 14, and 28 days after preparation, assessing individual samples with a total cross-sectional area of 40.5 in².

The results reveal a clear trend as shown in figure 6. The bricks show reduced compressive strength when researchers incorporated higher levels of waste plastic in the raw materials. Laboratory results indicated that bricks containing no waste plastic achieved maximum compressive strength followed by decreasing strength values at increasing plastic composition. The control bricks achieved 2105.92 psi compressive strength following 28 days of saturation while samples containing 5, 10, 15 and 20 percent waste plastic demonstrated decreasing strength patterns at 1859.44 psi, 1706.86 psi, 1644.73 psi and 1552.89 psi respectively.

**Figure 5: Compressive Strength Test Setup**

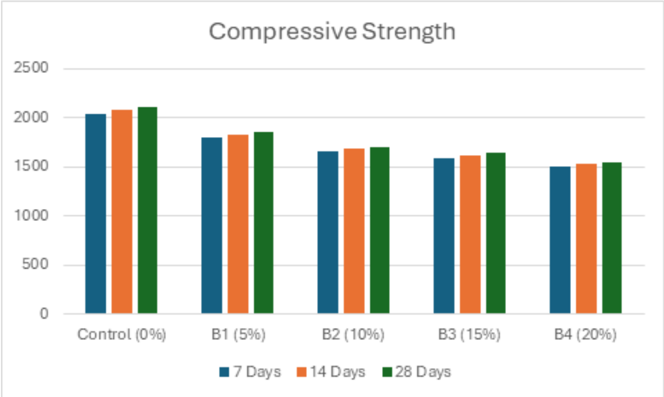



**Figure 6: Bar graph showing comparison of compressive strengths**

The structural weakness of recycled plastics combined with their lower mass accounts for their reduced compressive strength relative to traditional virgin materials. Structural integrity suffers from both the presence of dirt and grease impurities and the inferior strength properties of recycled plastics found within waste plastic samples.

Numerical data indicates waste plastic bricks possess viability as sustainable construction materials yet their compressive strength requirements need specialized evaluation for field applications.

### 4.3. Water Absorption Test

The water absorption test evaluates brick durability by assessing freezing resistance and weathering behavior. Bricks with less than 7% water absorption show superior freezing resistance. The size of brick pores directly affects water absorption, with bricks exhibiting less than 3% water absorption classified as vitrified. The ASTM D570 protocol is used to determine water absorption values. Test samples were evaluated using five different solution-to-brick ratios.

An increased amount of plastic waste in brick materials enhances their ability to absorb water. The combination of bricks with 20% plastic waste achieved maximum water absorption of 11% which surpassed traditional standards. The water absorption measurements performed on the bricks comply with different construction situation requirements. The addition of 5% plastic components decreased brick water absorption to 7% which enhanced the resistance to water as shown in figure 7. The sustainable advantage of plastic-based bricks exists because they meet the criteria for constructing non-load-bearing structures and environments that need low absorption rates.

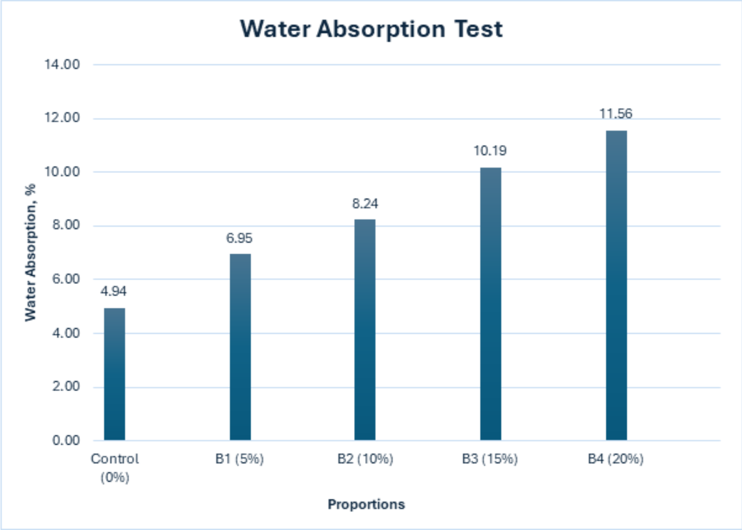
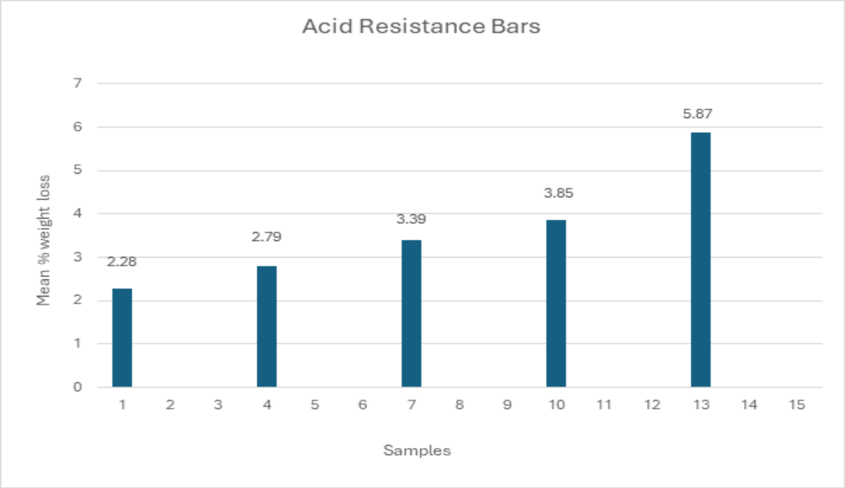



**Figure 7: Bar Chart Representation of Water Absorption Test Results**

### 4.4. Acid Resistance Test

A vital tool exists for evaluating how bricks withstand acid exposure and that is the acid resistance test. Businesses need this test to determine how well their materials resist acid damage in chemical plants and polluted areas. Testing at Adama Technologies exposes bricks to highly concentrated nitric and sulfuric acid solutions according to their established requirements and the calculations for this test are done. The extent of acid resistance test prolongation directly corresponds to the amount of plastic waste materials added to brick compositions. The acid resistance quality of bricks decreases as plastic amounts rise within ceramic products as shown in figure 8. The use of plastic waste as sustainable construction material shows potential although proper management protocols need existence to preserve long-term durability during exposure to acids. Future investigations need to determine the optimal plastic waste percentage for bricks which fulfills performance standards.

**Figure 8: Bar graph of Acid Resistance Test Results**




### 4.5. Efflorescence Test

Building bricks containing soluble salts inside will develop white surface patches when tested through the efflorescence test. Bricks need a vertical water immersion procedure that starts below the end surface by 25 mm. A temperature-controlled outdoor area operating at 20°C to 30°C provides space for gradual evaporation to take place. The sequence of evaporation procedures begins after distilled water with identical measurable amounts is applied to the bricks during their conclusion of primary drying.

The brick examination confirmed no appearance of white spots indicating no efflorescence on the bricks as shown in figure 9.

**Figure 9: Image illustrating the efflorescence test**

### 4.6. Thermogravimetric Analysis (TGA) Test

**Figure 6: TGA testing machine**

Waste plastic bricks derived from recycled plastics undergo analysis through the method known as Thermogravimetric Analysis (TGA). The weight loss measurement obtained by TGA devices (as shown in figure 10) under prescribed conditions reveals comprehensive information about the thermal characteristics of bricks. Both weight change and thermal decomposition patterns can be monitored as commercial waste plastic bricks heat inside a TGA furnace. Researchers use the results to evaluate how stable the bricks remain when exposed to heating conditions in their intended operational environments. The decomposition behavior of waste plastic bricks under various environmental settings can be observed through TGA testing methods to determine their usage performance. Testing this information aids the improvement of both brick structural lifespan and functional performance.

TGA evaluated weight variations in bricks comprising different plastic waste ratios from 0% to 20% through temperature-based examinations. The 0% plastic waste control sample showed weight loss at 27.75°C before reaching steady weight equilibrium at 3.18 mg until 777.6°C. The 5% plastic waste brick experienced a slow initial weight decrease which was followed by abrupt mass loss amounting to 1.65 mg between 27.72°C and 167.8°C until reaching a stable weight of 3.52 mg at 852.9°C. During the interval from 27.72°C to 567.9°C the 10% plastic waste sample experienced a fast weight loss of 7.38 mg before reaching its final weight loss total of 8.84 mg at 939.8°C. The steady weight reduction pattern of the 15% plastic waste started at 345°C then settled at 10.69 mg by 939.8°C. A final weight of 10.75 mg occurred at 939.8°C in the 20% plastic waste sample assessment. Weight measurements show that increased plastic volume leads to increased substance loss during thermal exposure while showing lower thermal stability. TGA curves are shown in figure 11,12,13,14 and 15 for controlled sample, 5% waste sample, 10% sample, 15% sample and 20% sample respectively.

TGA data shows mass loss during heating increases directly with plastic waste amounts in brick samples. The test exhibits abrupt mass decreases while maintaining distinct temperature ranges. Bricks without plastic waste (Sample CS) exhibit moderate thermal stability, with slower and smaller changes in mass. Brick samples containing more plastic waste show enhanced mass degradation while simultaneously showing steeper slopes on TGA measurement curves which reveals reduced thermal stability performance. Brick thermal properties change due to plastic waste inclusion since higher plastic contents lead to more rapid thermal degradation.

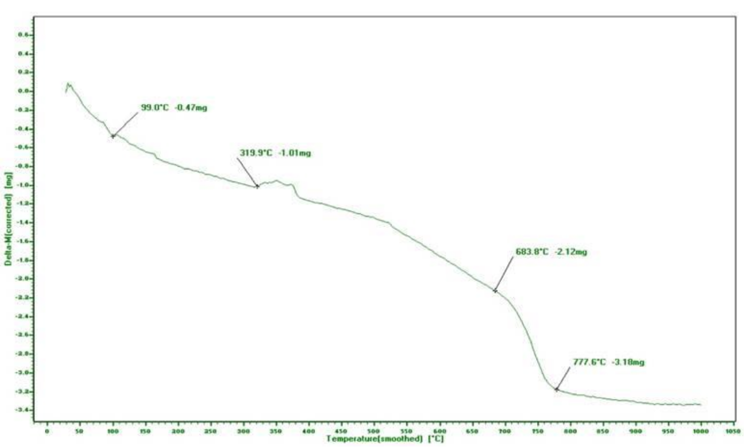



**Figure 11: TGA curve of sample CS**

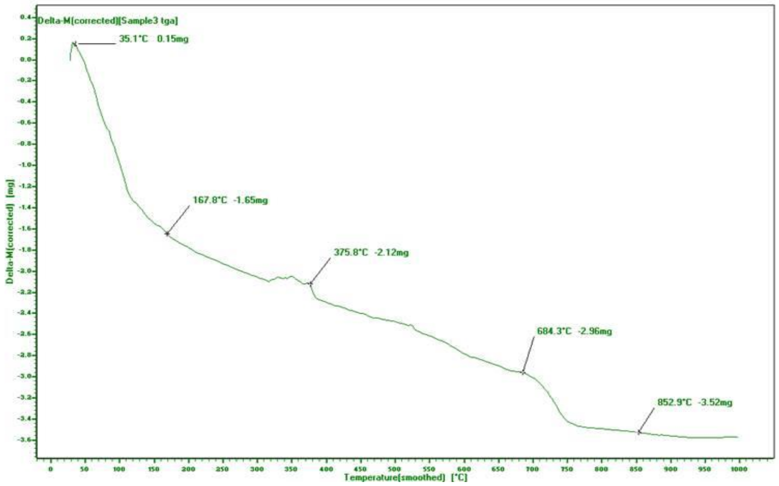



**Figure 12: TGA curve of sample 1 (5%)**

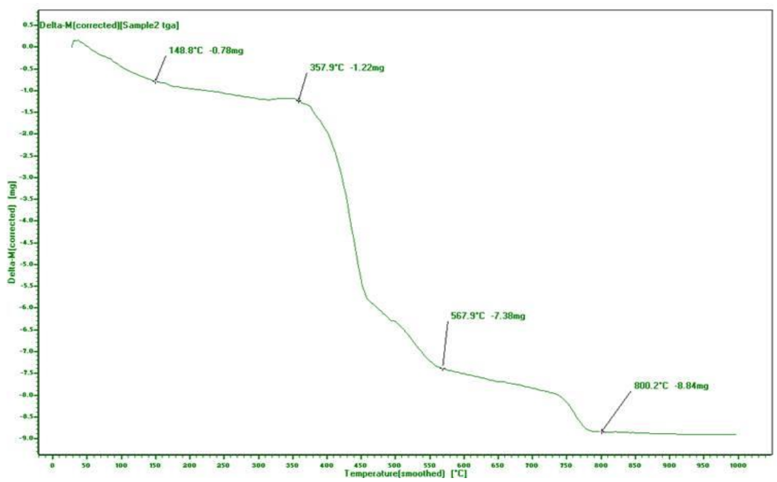



**Figure 13: TGA curve of sample 2 (10%)**

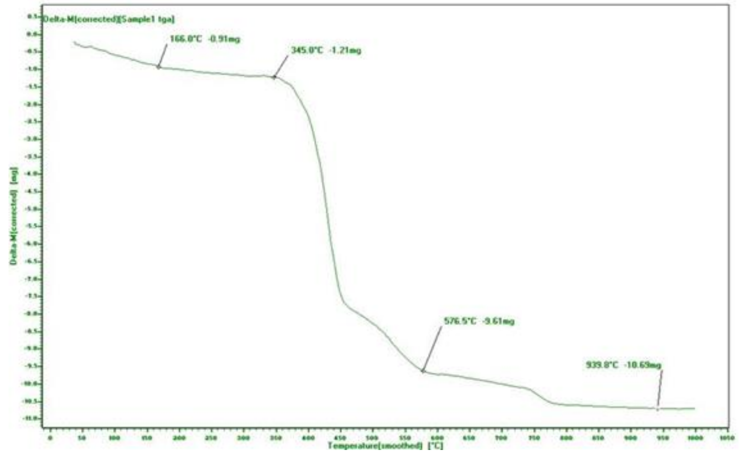



**Figure 14: TGA curve of sample 3 (15%)**

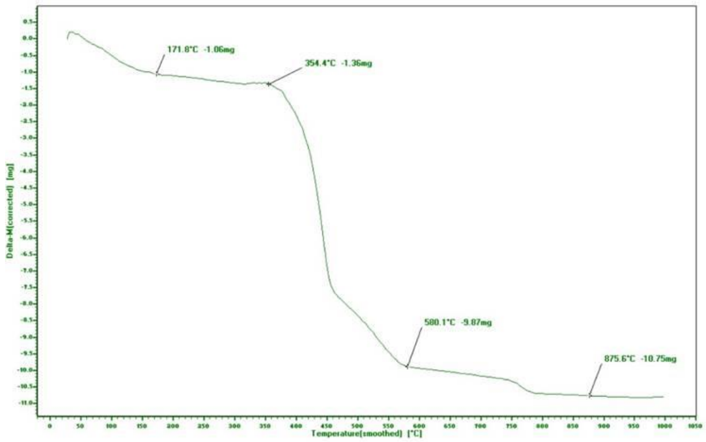



**Figure 15: TGA curve of sample 4 (20%)**

### 4.7. Environmental Impact

Conventional bricks, made by burning clay bricks, produce significant $CO_2$ emissions due to high energy consumption and factors like clay type, kiln type, and energy source. Each burned ton contributes between 500 and 900 kilograms of $CO_2$, resulting in an average of 1.3-1.6 kilograms of $CO_2$ throughout the brick's lifecycle. However, waste plastic bricks, produced through manual mixing without heat, eliminate $CO_2$ emissions, making them an eco-friendly alternative to traditional clay bricks.

### 4.8. Cost Analysis

The cost comparison between waste plastic bricks and conventional bricks is performed through cost evaluation as tabulated in table 2 and their graphical representation is represented in figure 16. Builder-supplied fee data is presented for both control specimens and plastic waste mixtures.

**Table 2: Comparison of cost of specimens and conventional brick**

| **Material** | **Rate** | **CS (Control Specimen)** | **B1 (5%)** | **B2 (10%)** | **B3 (15%)** | **B4 (20%)** |
|---|---|---|---|---|---|---|
| **Sand** | 60 Rs/cft | 1230g (0.00075 cft) – 0.045 Rs | 1076g (0.00065 cft) – 0.039 Rs | 922g (0.00055 cft) – 0.033 Rs | 769g (0.00045 cft) – 0.027 Rs | 615g (0.00040 cft) – 0.024 Rs |
| **Cement** | 22 Rs/Kg | 546g – 12.01 Rs | 546g – 12.01 Rs | 546g – 12.01 Rs | 546g – 12.01 Rs | 546g – 12.01 Rs |
| **Fly Ash** | 10 Rs/Kg | 531g – 5.31 Rs | 531g – 5.31 Rs | 531g – 5.31 Rs | 531g – 5.31 Rs | 531g – 5.31 Rs |
| **Plastic Shredding** | 25 Rs/Kg | — | 130g – 3.25 Rs | 260g – 6.50 Rs | 390g – 9.75 Rs | 520g – 13.00 Rs |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total Cost (Rs)** | — | 17.00 Rs | 21.00 Rs | 24.00 Rs | 27.00 Rs | 30.00 Rs |
| **Conventional Brick Cost** | — | 16.00 Rs | 16.00 Rs | 16.00 Rs | 16.00 Rs | 16.00 Rs |

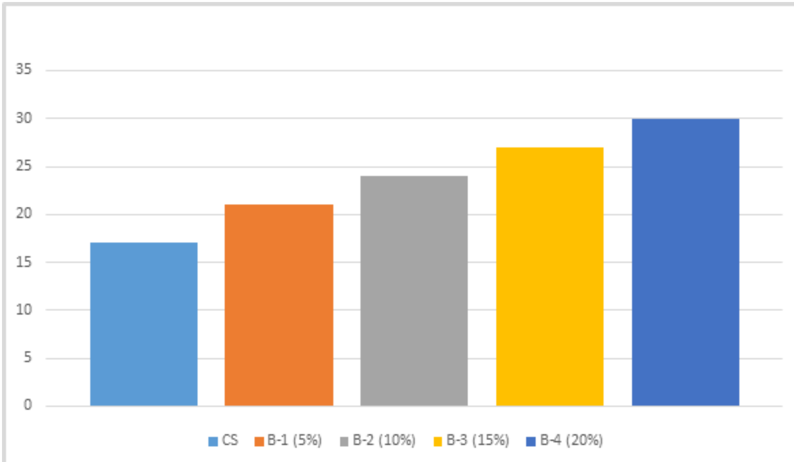



**Figure16: Graphical Representation of Rates of Different mix Proportions**

### 4.9. Comparison of Plastic Brick with Conventional Brick

Waste plastic bricks offer environmentally friendly solutions due to their $CO_2$-free production process, reducing the amount of $CO_2$ released in standard brick manufacturing. They also provide cost efficiency due to their lower initial expense with increased plastic usage. Waste plastic bricks exhibit lower water absorption and nil efflorescence, with similar compressive strength at plastic levels below 5%. They also provide better thermal insulation than conventional bricks, ensuring better indoor temperature stability. The insulation properties of waste plastic bricks make additional heating or cooling systems unnecessary, leading to higher energy efficiency. Conventional bricks have elevated thermal conductivity levels, requiring more energy for heating or cooling operations. A comparison of properties between conventional bricks and waste plastic bricks is tabulated in table 3.

**Table 3: Comparison of specimens with conventional brick**

| Properties | Control Specimen (CS) | Plastic Brick B1 (5%) | Plastic Brick B2 (10%) | Plastic Brick B3 (15%) | Plastic Brick B4 (20%) | Conventional Brick |
|---|---|---|---|---|---|---|
| **Compressive Strength (psi)** | 2075.12 | 1832.61 | 1681.76 | 1620.57 | 1518.23 | 1700 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Water Absorption (%)** | 4.94 | 6.95 | 8.24 | 10.19 | 11.56 | 12-15 |
| **Efflorescence** | Nil | Nil | Nil | Nil | Nil | Prominent |
| **Cost (Rs)** | 17 | 21 | 24 | 27 | 30 | 16 |
| **Appearance** | Grey | Grey | Grey | Grey | Grey | Copper |
| **Weight (Kg)** | 3.8-4.0 | 3.5-3.7 | 3.3-3.5 | 2.9-3.1 | 2.6-2.9 | 3.2-3.5 |
| **Production** | Normal | Normal | Normal | Normal | Normal | Normal |
| **Texture** | Smooth | Smooth | Smooth | Smooth | Smooth | Smooth |

## 5. Conclusions & Recommendations

### 5.1. Conclusion

This investigation shows that plastic bricks hold substantial promise for building applications instead of typical brick usages. The 5% plastic waste mix performed optimally among all examination approaches. The results reflected a 7.8% rise in compressive strength making them suitable for reliably sustaining compressive loads. Premium quality plastic bricks at 5% mixed level showed water absorption levels that fell fifty percent below conventional brick standards. The high resistance against water absorption of these bricks provides exceptional protection against both waterlogging and salinity when used in building structures.

Plastic bricks demonstrated a distinctive advantage over conventional bricks by showing no signs of efflorescence which represents a typical brick defect. Plastic bricks gain both better durability and looks because of their ability to resist weather changes. The acid resistance performance of the 5% mix proved superior to other mixes because it demonstrated a mean weight loss of only 2.79%. Simple thermal resistance tests showed that plastic bricks generated minimal weight loss (13%) when exposed to 1000 degrees Celsius as the 5% mix composition demonstrated high tolerance to heat.

Plastic brick manufacturing generates zero carbon dioxide outputs which makes the production environmentally friendly. This material preparation approach meets global requirements for minimizing environmental impacts from construction elements. Plastic brick production faces a significant limitation because of their expensive cost structure. Regular construction projects may resist adopting 5% plastic bricks because their 130% higher cost than common bricks create barriers to widespread acceptance.

### 5.2. Recommendations

Waste plastic bricks (WPBs) offer sustainable and innovative construction materials, but their implementation requires further research and optimization. This study found that a combination of 5% plastic waste produced optimal performance outcomes. Future research should focus on calculating plastic waste ratios to improve performance strength and reduce economic impact. The cost of plastic bricks remains a significant barrier to their practical application. To make plastic bricks more affordable, researchers should explore affordable raw materials and optimize manufacturing techniques. Further tests should measure mechanical resistance, thermal stability, and physical durability properties. Environmental tests should evaluate the bricks' expected lifespan and their durability under various climatic elements. Scaling up plastic brick production is a priority, and feasibility studies should establish efficient manufacturing procedures and practical implementation methods. Researchers should also explore new additives and binders to minimize cement demands while maintaining quality standards. The construction industry should implement these solutions to maximize the utility of waste plastic bricks, which solve both sustainability requirements and the global plastic waste problem by saving environmental resources.

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### Declaration of Interest

The authors declare no conflict of interest.

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