IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 10, June 2026
Impact Factor: 8.2

Development and Performance Evaluation of Eco-Friendly Construction Bricks Utilizing Low-Density Polyethylene (LDPE) Waste

Tejas Prakash Thorat, Harshad Jitendra Shiledar, Sahil Santosh Kapote
Kartikey Kishor Patil, Dr. Pratap R. Sonawane
Matoshri College of Engineering & Research Centre, Eklhare, Nashik

Abstract:. *The accumulation of plastic waste, particularly High-Density Polyethylene (HDPE), Polyethylene Terephthalate (PET), and thin films below 50 microns, represents a profound ecological and humanitarian hazard. Improper terrestrial disposal severely depletes soil fertility, while massive marine dumping destroys aquatic life and alters seawater quality. To address this urgent crisis, this study investigates an efficient, sustainable, and highly economical solution: recycling waste plastic as a primary binding modifier in construction bricks. By integrating Low-Density Polyethylene (LDPE) waste packets and bags with river sand and minimal cement, alternative composites were fabricated and evaluated. The resulting "Eco-Bricks" demonstrate superior mechanical properties over conventional clay and cement bricks, highlighting a major decrease in water absorption and an increase in compressive strength. This technology offers a resource-efficient, low-cost paradigm for structural engineering and municipal solid waste mitigation.*

Keywords: *High-Density Polyethylene*

I. INTRODUCTION

Plastic is a synthetic, non-biodegradable polymer capable of enduring thousands of years before environmental decomposition, exacerbating severe terrestrial and aquatic pollution. Within municipal solid waste (MSW) streams, plastic volumes expand rapidly, with consumption rates doubling every decade. Polyethylene (PE) represents one of the largest volumetric fractions of this discarded stream. Concurrently, the conventional brick manufacturing industry relies heavily on earth-based clay extraction, causing severe agricultural soil depletion, land degradation, and heavy atmospheric pollution via greenhouse gas emissions during kiln-firing operations. To counter both resource depletion and landfill overcrowding, this research effectively channels waste plastics into the structural brick manufacturing process. Cleaned PE bags are thermalized and blended with fine sand aggregates at explicit ratios. This process minimizes the overall cost of building materials—making housing more affordable for low-income demographics—while imbuing the matrices with beneficial thermal and acoustic insulation properties. By re-engineering malleable synthetic compounds into load-bearing blocks, this project provides a viable ecological pathway to turn a major environmental pollutant into a resilient construction asset.

II. LITERATURE REVIEW

Prior academic endeavors highlight diverse applications of waste recycling within structural matrices:

Fired Clay Incorporation: Kadir and Sarani (2012) confirmed that recycling waste into fired clay bricks enhances porosity and thermal conductivity, though a trade-off is sometimes observed in mechanical strength.

Bituminous and Pavement Engineering: Amit et al. (2012) and Jain et al. (2011) successfully utilized chopped plastic waste as a modifier for bitumen mixtures. They verified that a 0.3% to 0.4% polymer dosage increases asphalt mix rigidity, moisture damage prevention, binding efficiency, and water resistance.

Concrete Aggregates: Ganesh et al. (2014) replaced conventional coarse concrete aggregates with 10%, 20%, and 30% recycled plastic (PP and PET), maintaining core structural integrity within specific limits.

Plastic-Soil/Quarry Masonry: Maneeth et al. (2014) and Puttaraj et al. (2018) synthesized plastic-soil bricks using quarry waste and 60% to 80% molten plastic binders. Their results proved highly successful, achieving uniform finishes, low water absorption, and high compressive capabilities compared to local laterite stone.

Thermal Compounding: Dinesh et al. (2016) demonstrated that compounding HDPE and PE bags with sand cuts production expenses and limits air pollution caused by trailside waste burning. Similarly, Velmurugan et al. (2019) engineered electric nichrome-wire heating mechanisms operating up to 700°C to uniformly melt PE blocks with fly ash and river sand.

The incorporation of recycled municipal and industrial solid wastes into civil engineering building elements has emerged as a crucial approach to addressing resource depletion and environmental pollution. Extensive research has been conducted globally to test the viability of combining thermoplastic matrices with conventional aggregates like sand, soil, cement, and bituminous blends.

\2.1 Environmental Imbalances and Waste Characterization

Conventional brick manufacturing heavily depletes high-quality topsoil, resulting in irreversible agricultural land damage and greenhouse gas accumulation through kiln-firing operations. Concurrently, the accumulation of non-biodegradable polymers like low-density polyethylene (LDPE), high-density polyethylene (HDPE), and thin-film bags under 50 microns disrupts natural soil fertility profiles and marine aquatic life. Researchers highlight that structural mechanical recycling—encompassing the sequence of clean collection, sorting, thermal melting, and compression molding—presents a highly practical avenue for developing alternative sustainable structural elements.

2.2 Fired Clay Matrix Modifications

Initial research directions focused on incorporating waste materials into traditional kiln-fired clay systems. Abdul Kadir and Sarani (2020) demonstrated that modifying fired clay matrices with industrial or agro-waste alternatives introduces porous microstructures within the finished units. This structural porosity effectively lowers the overall dry bulk density and enhances thermal insulation properties, making the bricks valuable for lightweight non-load-bearing masonry, even though it can reduce the maximum compressive threshold if mixed at higher percentages.

2.3 Polymer-Modified Bitumen and Pavements

The optimization of civil pavement structures using polymeric waste modifiers has been widely studied. Amit et al. (2012) and Jain et al. (2011) evaluated the performance of flexible top-layer bitumen binders modified with shredded polymeric packaging waste (WPPM) and HDPE strips. This adjustment enhances resistance to moisture damage, limits surface rutting, and cuts water absorption, showing that thermoplastic binders provide a clear waterproofing barrier inside granular composites.

2.4 Recycled Polymeric Concrete Aggregates

To address aggregate depletion, researchers have tested replacing coarse or fine mineral aggregates with structural plastic particles. Ganesh et al. (2014) conducted mechanical replacement trials utilizing recycled polypropylene (PP) and polyethylene terephthalate (PET) flakes at substitutions of 10%, 20%, and 30% by total aggregate mass within traditional concrete structures. While higher substitute volumes can alter the baseline workability, smaller ratios maintain the necessary structural and flexural parameters without compromising standard design limits.

2.5 Plastic-Soil and Multi-Composite Bricks

Direct compounding of molten waste polymers with mineral quarry dust or local soils has proven to be an effective strategy for creating alternative structural units. Maneeth et al. (2014) and Puttaraj et al. (2020) developed alternative

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 10, June 2026
Impact Factor: 8.2

sand-soil composites using varying weight percentages of recycled PET and PP matrices as the primary binding agents. Their findings demonstrated that using a polymer matrix to replace traditional hydraulic binders yields bricks with smooth surface finishes, excellent dimensions, high edge stability, and adequate compressive capacities that match or exceed local natural stone alternatives. Furthermore, Dinesh et al. (2016) and Velmurugan (2019) advanced thermal manufacturing by using specialized electrical nichrome-wire heating mechanisms to consistently melt polyethylene films at temperatures around 700°C. Compounding these melted matrices with river sand and fly ash aggregates produces dense, highly durable bricks. The resulting materials display low water absorption and uniform mechanical strength under severe testing, confirming their long-term potential as alternative building units for low-cost infrastructure applications.

III. MATERIALS AND METHODOLOGY

3.1 Materials Characterization

Sand: Natural river sand was utilized as the fine aggregate, sieved to a particle size below 2.36 mm. Sieve analysis indicated a fineness modulus of 2.2.

Water: Portable water free from organic matter, acids, and deleterious salts was preserved for curing and washing operations.

Waste Plastic: Low-Density Polyethylene (LDPE) sourced from industrial, factory, and food packaging waste was isolated. LDPE exhibits high branching, a density of 0.91−0.94 g/cm3, an amorphous condition with high transparency, a melting point of ∼115∘C, and high chemical resistance to acids and alkalis.

3.2 Production Flow and Processing

The manufacturing process follows a structured sequence: Collection → Batching → Burning → Mixing → Moulding → Curing → Testing.

Batching and Sorting: Collected plastics are segregated, stripped of foreign debris, dried to eliminate moisture, and weighed according to pre-set mix ratios.

Thermal Melting: Shaved plastic fragments are introduced into a closed vessel and heated uniformly between 90°C and 150°C to melt the polymer while containing volatile off-gases.

Mixing and Moulding: Sifted river sand is mixed by hand using a trowel into the liquid polymer matrix at weight ratios of 1:3 and 1:4. A third ternary variant of cement, plastic, and sand at a 1:1:3 ratio was also fabricated. Due to the short setting times of molten polymers, rapid compounding is required before pouring into standard 20×10×10 cm brick moulds.

Demoulding and Curing: Specimens are cooled, demoulded after 24 hours, and immersed in a water curing tank to reduce internal thermal stress.

IV. EXPERIMENTAL TESTING AND RESULTS

4.1 Local Physical and Durability Appraisals

Hardness Test: Finger-nail scratching on the face of the brick left no surface impressions, verifying adequate outer hardness.

Structure and Homogeneity: Internal structural examination of a fractured specimen confirmed a uniform, homogeneous cross-section entirely free from voids or clay lumps.

Efflorescence Test: Immersing the bricks for 24 hours followed by shade drying revealed zero white or grey alkaline salt deposits, confirming the total absence of soluble salts.

Soundness Test: Striking two eco-bricks together produced a clear metallic ringing sound without structural cracking.

4.2 Mechanical Performance Evaluation

The standardized test configurations verified that increasing the plastic volume increases the compressive performance of the block. A plastic content range of 65%–70% was determined as optimum for structural workability.

Table 1: Performance Matrix of Plastic Eco-Bricks vs. Conventional Clay Bricks

S.No	Engineering Parameter Description	Plastic Modified Brick	Normal Burnt Clay Brick
1	**Water Absorption (%)**	1.26%	7.71%
2	**Soundness Properties**	Clear Metallic Ringing	Metallic Ringing
3	**Efflorescence Properties**	Zero Deposits	Zero Deposits
4	**Compressive Strength (MPa)**	6.13 MPa	4.72 MPa

The polymeric coating encapsulates the sand particles, preventing moisture ingress. This drops the water absorption rate down to 1.26%, which is significantly lower than the 7.71% observed in conventional clay bricks. Concurrently, the eco-brick achieves a compressive strength of 6.13 MPa, outperforming traditional burnt clay options (4.72 MPa).

V. CONCLUSION AND FUTURE SCOPE

This research highlights the successful development of high-performance "Eco-Bricks" synthesized from non-biodegradable LDPE waste streams. By replacing energy-intensive, resource-depleting clay blocks with a polymer-sand composite, this approach provides an efficient solution for municipal waste management. The fabricated blocks exhibit exceptional durability, zero efflorescence, minimal moisture absorption, and a 30% increase in compressive strength over standard burnt bricks. Future investigations will look at adjusting these mix designs to achieve higher compressive thresholds and exploring their lightweight, thermal-insulating, and cost-effective advantages in large-scale structural configurations.

REFERENCES

[1]. Abdul Kadir, A., & Sarani, N. A. (2020). Utilization of palm oil fuel ash in brick manufacturing for lightweight fired clay brick production. *International Journal of Sustainable Construction Engineering and Technology*, *11*(1), 136–150.

[2]. Amit, M., et al. (2012). Utilization of waste plastic in flexible pavement construction: A structural review. *Journal of Environmental Engineering and Waste Management*, *14*(2), 45–52.

[3]. Dinesh, S., et al. (2016). Studies on utilizing waste plastic in the manufacturing of bricks and paver blocks. *International Journal of Civil Engineering and Technology*, *7*(3), 112–119.

[4]. Ganesh, P., et al. (2014). Utilization of recycled plastic aggregates as a coarse replacement in structural concrete mixtures. *Journal of Cleaner Materials and Structures*, *22*(4), 301–311.

[5]. Jain, R., et al. (2011). Performance evaluation of waste polymeric packaging materials (WPPM) in modified bituminous road pavement mixtures. *International Journal of Pavement Engineering & Research*, *8*(1), 89–97.

[6]. Maneeth, P., et al. (2014). Utilization of waste plastic in the structural development of eco-friendly plastic soil bricks. *Journal of Civil Engineering and Environmental Solutions*, *5*(2), 76–83.

[7]. Puttaraj, S., et al. (2020). Mechanical and physical properties of eco-friendly structural tiles developed from recycled polymer binders and ash matrices. *Environmental Research, Engineering and Management*, *76*(2), 54–62.

[8]. Velmurugan, V. (2019). Rebuilding of plastic waste to pavement bricks. *International Journal for Research in Applied Science and Engineering Technology*, *7*(4), 927–931.