Vol.7 No.6
ISSN: 1597-5037
COLLEGES OF EDUCATION ACADEMIC STAFF UNION (COEASU) JOURNAL 2026

RECYCLING PLASTIC WASTES INTO INTERLOCK BLOCKS FOR SUSTAINABLE CONSTRUCTION

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ABSTRACT

Plastic waste poses a major environmental challenge due to its persistence and poor disposal practices. This study reviews the conversion of plastic waste into interlocking blocks for sustainable construction. It examines plastic waste generation trends, recycling methods, and material performance. Mechanical recycling remains the most widely used approach, involving sorting, washing, shredding, melting, and moulding. Findings from recent studies show that plastic-based interlocking blocks exhibit high compressive strength, low water absorption, and good durability. The addition of sand improves structural stability and load-bearing capacity. These blocks also offer thermal insulation benefits and reduced weight, which lowers transportation and labour costs. Environmental assessment indicates reduced carbon emissions compared to conventional materials such as cement and clay bricks. Despite these advantages, challenges such as fire resistance, long-term durability, and lack of standard regulations remain. The study highlights the potential of plastic waste recycling as a viable strategy for waste management and sustainable construction.

Keywords: *plastic waste, plastic recycling, interlock blocks, sustainable construction, waste management.*

INTRODUCTION

Plastic waste has emerged as a major global environmental problem due to its high production rate, persistence, and poor disposal practices. It accumulates in landfills, waterways, and natural ecosystems, causing harm to wildlife and human health. Global plastic production exceeds hundreds of millions of tons annually, however a significant portion remains unmanaged, highlighting inefficiencies in current waste

management systems (Henry *et al.,* 2025). As of 2023, global plastic production reached approximately 413.8 million tons, reflecting an average annual growth rate of 4% over the preceding decade (Lakas *et al.,* 2025). About 300 million tons of plastic are produced globally each year, of which only about 25% only is recycled (Boris, 2025).

The accumulation of plastic waste poses serious environmental problems worldwide. Nigeria has an annual production rate of about 32 million tons of solid waste, that is 67% of the total solid waste produced in Sub-Saharan Africa (Edem, 2026). The problem of Municipal Solid Waste (MSW) demands urgent global attention (Sakr & Abouzeid, 2025). Domestic waste disposal is considered as the main causes of environmental pollution and it can be associated to various health issues. Proper waste management and disposal of household waste is a major concern to general public (Tariq & Silva, 2022).

Plastic waste generation in Nigeria continues to rise, with limited recycling infrastructure (Ibrahim *et al.,* 2025). Plastic waste has become a serious environmental and public health concern due to rapid increase in population and massive industrialization have led to a significant increase in waste generation (Sajib *et al.,* 2025; Tariq & Silva, 2022).

Plastics are widely applied in packaging, construction, transportation, medical equipment, and various other sectors because of their flexibility and durability. However, despite these advantages, plastics exhibit a major drawback, namely their high resistance to degradation. A single plastic bag may take approximately ten to twelve years to decompose, while a plastic bottle, with a more complex and thicker polymer structure, may require up to 20 years. Styrofoam, which is commonly used as food packaging, may require up to five centuries to fully degraded (Dilthey, 2022).

Polyethylene Terephthalate (PET) bottles, which make up between 30 and 40 per cent of plastic waste, are among the most popular pollutants. However, new recycling opportunities have lately emerged; industry and academia are increasingly concentrating on creative solutions. Solid-state poly-condensation (SSP) is one method that has gained popularity recently. It aims to recycle PET from bottles from bottle to bottle by re-grading recycled polymer (Paolo & Mantia, 2026).

The construction industry contributes heavily to environmental degradation through high resource consumption, energy use, and waste generation. Conventional materials such as cement, clay bricks, and concrete require intensive processing and emit large amounts of carbon dioxide. The cement industry is one of the largest sources of carbon dioxide emission, CO_2 emission index of Portland cement ranges from 800 to 950 kg CO_2 per tonne of cement (Yamusa *et al.*, 2023). This creates a need for alternative materials that reduce environmental impact while maintaining structural performance (Yadav *et al.*, 2024).

Literature Review

Plastic waste has emerged as a persistent environmental issue due to its non-biodegradable nature and increasing global production. Studies report that a large proportion of plastic waste is either landfilled, incinerated, or improperly disposed, leading to pollution of land and water systems (Sakr & Abouzeid, 2025). This challenge has driven research into sustainable waste management strategies, including the conversion of plastic waste into construction materials (Sasahara *et al.*, 2024).

Recent literature highlights the growing interest in recycling plastic waste into bricks and interlocking blocks. Mechanical recycling remains the most widely adopted method due to its simplicity and cost efficiency. The process involves sorting,

cleaning, shredding, melting, and moulding plastic into construction units. Alternative methods such as chemical recycling and pyrolysis have also been explored, especially for mixed or contaminated plastic streams, although they require more complex technology and higher energy input (Achilias, 2025; Edem, 2026; Henry *et al.*, 2025; Paolo & Mantia, 2026).

Results from studies showed that plastic bricks and interlocking blocks exhibit compressive strength comparable to or higher than conventional clay bricks and concrete blocks. In some cases, strength improvements of up to 50% have been reported, depending on material composition and processing conditions. The addition of sand or other fillers further enhances mechanical performance and structural stability (Abadi *et al.*, 2026).

Thermal and durability properties of plastic interlocking blocks have also been widely studied. These materials demonstrate low thermal conductivity, which improves insulation performance in buildings. In addition, plastic blocks show high resistance to moisture, chemical attack, and weathering, contributing to longer service life and reduced maintenance costs. Their lightweight nature further improves ease of handling and reduces transportation and labour requirements (Achilias, 2025).

Environmental assessments confirm the sustainability benefits of using recycled plastic in construction. The production of plastic blocks requires less energy compared to conventional materials such as cement and fired clay bricks, resulting in lower carbon emissions. Moreover, the use of plastic waste in block production diverts significant volumes of waste from landfills and supports circular economy principles through reuse and recycling (Kafle *et al.*, 2025).

Case studies demonstrate practical applications of plastic interlocking blocks

in housing, road construction, and infrastructure development. These projects report reduced construction time, lower costs, and satisfactory structural performance under varying environmental conditions. The modular interlocking design enhances ease of assembly and reduces the need for skilled labour (Boris, 2025).

Despite these advantages, several challenges were identified. Fire resistance remains a critical concern due to the combustible nature of plastics. Long-term durability under UV exposure and temperature fluctuations also requires further investigation. In addition, the lack of standardized building codes and regulatory frameworks limits widespread adoption. Public perception and acceptance continue to influence the integration of plastic-based materials into mainstream construction (Marta, 2025).

Moreover, existing studies confirm that recycling plastic waste into interlocking blocks offers a viable and sustainable solution for both waste management and construction. Continued research is required to improve material performance, establish standards, and support large-scale implementation (Shukla *et al.*, 2025).

Plastic Waste Management

Plastic waste management remain a major challenge that requires a sustainable recycling solution. Plastic, a ubiquitous material in modern life, has become a major environmental burden owing to its continuous large scale production, its non-biodegradability, and improper disposal. The existing system for managing plastic waste is facing significant difficulties in dealing with the problems necessitating a comprehensive method to foster a more viable future (Minde *et al.*, 2024).

The conversion of plastic waste into interlocking blocks offers a practical waste management strategy. This approach diverts large volumes of plastic from landfills and open dumping, reducing

environmental pollution and pressure on waste disposal systems (Marta, 2025).

By transforming waste into construction materials, it supports resource recovery and reduces the burden on municipal waste infrastructure. Plastic-based construction materials also promote a circular economy model. Instead of linear disposal, plastic waste is reintroduced into production cycles, extending material life and reducing demand for virgin resources. This aligns with sustainable waste management principles focused on reuse, recycling, and material recovery (Yadav *et al.*, 2024).

Classification of plastics

Plastics are synthetic polymers grouped based chemical structure and recycling behaviour. The resin identification code RIC system classifies plastics into seven categories. The seven types of plastic are presented in the table below (Ramya *et al.*, 2024).

1. **Polyethylene Terephthalate (PET) -** soft drink, water and salad dressing bottles; peanut butter and jam jars; ice cream cone lids; small non-industrial electronics.
2. **High Density Polyethylene (HDPE) –** water pipes, gas and fire pipelines, electrical and communications conduits, five gallon buckets, milk, juice and water bottles, grocery bags, some toiletry bottles.
3. **Polyvinylchloride (PVC**) – stretch wrap for non-food items, sometimes blister packaging, non-packaging uses include electrical cable insulation, rigid piping and vinyl chloride.
4. **Low Density Polyethylene (LDPE)** – frozen food bags, squeezable bottles e.g. honey, mustard, cling films; flexible container lids.
5. **Polypropylene (PP)** – reusable microwaveable ware, takeaway containers; kitchen ware; yoghurt or margarine containers; disposable

cups and plates; soft drink bottle caps.

6. **Polystyrene (PS)** – egg cartons; disposable cups, trays and cutlery; foam from containers; packing peanuts and package cushioning.
7. **Others (Polycarbonate or ABS)** – beverages bottles, baby milk bottles. Non-packaging uses for polycarbonate uses; compact disc, "unbreakable" glazing, electronic apparatus housing, lenses (including sunglasses), instrument panels

Plastic Recycling process

The steps involved in recycling of plastic as reported by (Ramya *et al.*, 2024).

• **Collecting To initiate recycling**: the initial step involves collecting consumer goods from households, businesses, and companies. Government entities and private firms commonly undertake this task, offering convenient options for businesses to participate. Another approach is to transport plastic waste to centralized collection points such as recycling bins or facilities. These collection points vary in scale, ranging from simple roadside bins to complex municipal solid waste (MSW) landfill sites with designated areas for sorting recyclable and non-recyclable materials. The recycling process of plastics is shown in Fig. 1.

• **Sorting**: In the plastic recycling process, sorting constitutes the second crucial step. Since plastics come in various types, they must be separated accordingly. Sorting can be based on different characteristics such as colour, thickness, and intended use. Recycling centres utilize machines to carry out this sorting process. It is imperative as it enhances the efficiency of the plants and helps prevent contamination in the final recycled products.

• **Washing**: A critical stage in plastic recycling involves washing to eliminate contaminants that could disrupt the process

and ensure the recycled plastic's purity. This washing process effectively removes labels, adhesives, as well as dirt and food residues. It is necessary to strive for minimal contamination before collection to streamline this washing process.

• **Shredding**: The plastic is shredded into smaller pieces and then processed further. These smaller plastic pieces can be utilized for various purposes, such as creating tarmac compound or sold as a valuable material. Breaking down the plastic material into smaller pieces helps in detecting any remaining contaminants. Certain pollutants, like metals, cannot be removed through washing. However, these remaining contaminants can be separated with the aid of magnet.

• **Identification and separation of plastics:** During this phase, the quality of plastics undergoes testing, and they are sorted based on their density. Verification is conducted by observing the buoyancy of plastic particles in a water container, which helps assess their density. Also, the width of plastic components is determined by passing the shredded plastic through an air channel.



Figure 1: The recycling process of plastics. Source (Ramya *et al.*, 2024).

Application of recycled plastic waste in construction

According to research conducted by (Achilias, 2025), after the plastic melted completely (5−10 min), the appropriate amount of sand was added and stirred to ensure even distribution. The mixture was stirred every 5 min until fully blend:. Used motor engine oil was applied to the moulds to prevent sticking and to facilitate easy

removal of the blocks. The hot plastic-sand mixture was poured into 6 cm × 6 cm × 3 cm moulds, pressed to eliminate air pockets, and left to cool at room temperature for solidification. Figure 2 shows a flow diagram summarizing the entire experimental process.

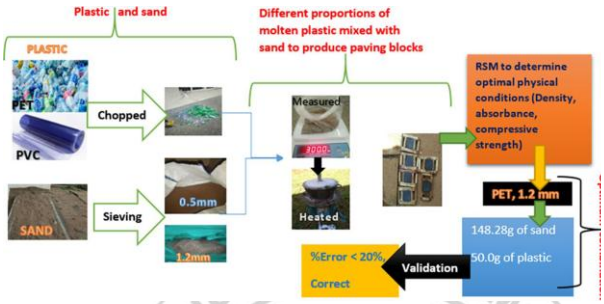

Figure 2: Flow diagram of the experimental process for paving block production. Source (Achilias, 2025).

Conclusion

In conclusion, recycling plastic waste into interlocking blocks provides a practical solution to both environmental pollution and construction material demand. The process reduces landfill accumulation and supports resource recovery. Plastic blocks show strong mechanical performance, durability, and cost efficiency. Their lightweight nature improves handling and reduces construction time. Energy consumption and carbon emissions are lower compared to traditional building materials. However, issues related to fire resistance, UV stability, and regulatory standards limit large-scale adoption. Future work should focus on improving material properties, developing safety standards, and increasing public acceptance. Large-scale implementation will strengthen sustainable construction practices and promote a circular economy.

Recommendations

1. To invest in recycling infrastructure: to set up collection, sorting and processing facilities and support local recycling plants to ensure steady raw material supply.
2. Launch public awareness campaign: to educate communities on the benefit of plastic recycling in construction and to increase acceptance through demonstration projects

3. Develop standards and policies: government should establish clear building codes for plastic-based blocks and regulate production and usage.

REFERENCES:

Abadi, I., Samadikun, B. P., & Huboyo, H. S. (2026). Utilization of Plastic Waste (HDPE , PET , and PP) as Paving Block Mixture Materials. 5(8), 10616–10628.

Achilias, D. S. (2025). Thermo - chemical recycling of plastics as a sustainable approach to the plastic waste issue. Euro-Mediterranean Journal for Environmental Integration, 0123456789. https://doi.org/10.1007/s41207-025-00800-7

Boris, T. (2025). Sustainable construction using recycled plastic bricks : A novel approach Sustainable construction using recycled plastic bricks : A novel approach. https://doi.org/10.1088/1742-6596/3060/1/012013

Edem, T. (2026). Innovative Utilization of Plastic Waste for Eco- Friendly Construction : an Empirical Assessment of Nigeria ' s Recycling Industry and Eco-Friendly Building Applications.

Henry, R., Saphina, K., Emirant, B., Amabayo, B., & Akoba, R. (2025). Performance evaluation of the paving blocks moulded with plastic waste as a binding material.

Ibrahim, A., Uwajeh, P. C., Umar, I., & Iyendo, T. (2025). Exploring the Potential of Recycled Plastic Waste as a Sustainable Building Material in Architecture. 2(2), 241–249.

Kafle, S., Karki, B. K., & Sakhakarmy, M. (2025). A Review of Global Municipal Solid Waste Management and Valorization Pathways. 1–27.

Lakas, W., Sathorn, S., & Laosuwan, S. (2025). DEVELOPMENT OF A PLASTIC WASTE-MODIFIED ASPHALT MODEL FOR SUSTAINABLE ROAD. 12(1), 8–13.

Marta, D. J. (2025). Mitigation of waste threats to the environment through plastic waste management. 4(2), 88–104.

Minde, P., Kulkarni, M., Patil, J., & Shelake, A. (2024). Comprehensive review on the use of plastic waste in sustainable concrete construction. Discover Materials. https://doi.org/10.1007/s43939-024-00126-1

Paolo, F., & Mantia, L. (2026). Mechanical Recycling Processes of Polyethylene Terephthalate (PET) in the Framework of Circular Bottle- - To- - Bottle Manufacturing. https://doi.org/10.1002/app.57954

Ramya, L., Thilagasree, C. S., Jayakumar, T., Peter, A. K., Akhir, E. A. P., Ferrara, M., & Ahmadian, A. (2024). An appropriate artificial intelligence technique for plastic materials recycling using bipolar dual hesitant fuzzy set. 1–28.

Sajib, S. K., Islam, A., Sultan, M. T., & Subo, R. H. (2025). Sustainable Management of Plastic Waste in Chittagong City : An Overview of Recycling Practices and Integration with SDGs. December, 12–14.

Sakr, N., & Abouzeid, M. (2025). Recycling of Plastic Waste in the Construction Industry.

Sasahara, C., Alencar, M. V., Elliff, C. I., & Turra, A. (2024). Municipal solid waste governance : development and application of an index embodying the Global South context. October, 1–14. https://doi.org/10.3389/frsus.2024.1409418

Shukla, S., Khan, R., & Roccaro, P. (2025). Plastic Waste Recycling is Insufficient to Mitigate Plastic Pollution : the Need for a Paradigm Shift.

Tariq, M. H., & Silva, B. D. (2022). Awareness and willingness to participate in domestic waste disposal in Mumbai Region. 6(May), 5163–5173.

Yadav, K., Singh, A., Nazir, O., & Sharma, B. R. L. (2024). Discover Civil Engineering Transforming waste into innovation : a review of plastic bricks as sustainable construction materials. Discover Civil Engineering. https://doi.org/10.1007/s44290-024-00040-8

Yamusa, Y. B., Liman, M. L., Bilkisu, D., & Walliyullah, Y. (2023). REPLACEMENT OF CEMENT WITH PLASTIC WASTE BAGS IN THE PRODUCTION OF PAVING INTERLOCK BLOCKS. 1–10.

KNOWLEDGE FOR SERVICE
2026