Nature Environment and Pollution Technology
An International Quarterly Scientific Journal
p-ISSN: 0972-6268 (Print copies up to 2016)
e-ISSN: 2395-3454
Vol. 24 | No. S1 | pp. 355-362 | 2025
Original Research Paper
https://doi.org/10.46488/NEPT.2025.v24iS1.027
Open Access Journal

Utilization of Plastic Waste and Dry leaves in Brick Manufacturing

P. Muthupriya[1]† and B. Vignesh Kumar[2]
[1]Department of Civil Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil Nadu, India
[2]Department of Civil Engineering, Dr. N.G.P. Institute of Technology, Coimbatore, Tamil Nadu, India
†Corresponding author: P. Muthupriya; drmuthupriya@gmail.com

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 15-05-2024
Revised: 14-06-2024
Accepted: 18-06-2024

Key Words:
Plastic waste
Dry leaves
Compressive strength
Sustainability
Brick manufacturing

ABSTRACT

The utilization of plastic waste and dry leaves in bricks is a sustainable approach to reducing environmental pollution and managing waste. This study aims to investigate the feasibility of incorporating plastic wastes and dry leaves into the manufacturing of bricks, as well as the potential benefits of using such bricks. The study involves the collection of plastic wastes and dry leaves, sorting and cleaning them before mixing them with clay, sand, and cement in varying proportions. The mixtures are then compressed and molded into bricks, which are allowed to dry and cure before being tested for their physical and mechanical properties. To create plastic soil blocks, the soil was added to the molten plastic paste along with dry leaves in the following ratios: 1.5:1.5:0.5 (plastic, soil, and dry leaves, respectively). Results of the study showed that the inclusion of plastic wastes and dry leaves in brick production can lead to significant improvements in properties such as compressive strength, water absorption, and durability. Furthermore, the use of such bricks can help to reduce the amount of plastic waste and dry leaves in the environment, and also provide a sustainable alternative to traditional bricks that use finite natural resources. In conclusion, the utilization of plastic wastes and dry leaves in bricks is a promising approach toward sustainable construction. Further research is needed to optimize the proportions of the materials used and to investigate the long-term durability of the bricks under different environmental conditions.

INTRODUCTION

Plastic waste is a growing environmental challenge, with large quantities accumulating in landfills and marine ecosystems. In landfills, this waste contributes to the emission of harmful greenhouse gases like methane and carbon dioxide, which accelerate climate change. In marine environments, plastic pollution endangers aquatic life, increasing the risks of entanglement, ingestion, and suffocation for countless species. More than 1,500 species in terrestrial and marine settings have been found to consume plastics, according to research.

Innovative approaches are needed to address these issues sustainably. One such solution is the incorporation of plastic waste and dry leaves into brick production. This method not only diverts plastic from landfills and oceans but also provides an opportunity to reduce the reliance on traditional, resource-intensive brick-making materials. The global production of plastic and the accumulation of plastic waste have been escalating at an alarming rate, resulting in environmental pollution and ecological damage.

Plastic waste and dry leaves can be used as alternative materials in the production of bricks, which can have environmental and economic benefits. Plastic waste, which is a major contributor to pollution and environmental degradation, can be collected and shredded into small pieces to create a material that can be mixed with traditional brick-making materials such as clay or cement. The resulting bricks can be more durable and weather-resistant than traditional bricks and also have the potential to reduce the amount of plastic waste that ends up in landfills and oceans. Dry leaves, which are a common agricultural waste product, can also be used in the production of bricks. When mixed with clay or other materials, they can improve the insulation properties of the bricks and also reduce the amount of energy needed to fire them. Combining plastic waste and dry leaves in brick production can create a sustainable solution that helps reduce waste and provides an alternative to traditional building materials. However, more research and development are needed to ensure the durability and safety of these alternative bricks and to optimize their production processes.

Recycling waste has the dual benefits of conserving natural resources and ensuring safe, effective disposal of waste. The goal of this research is to create bricks with structural performance that is either the same or better than that of traditional clay-fired bricks by using waste materials, such as waste plastic and dry leaves. A variety of tests, including compressive, splitting tensile, flexural, density, efflorescence, and water absorption, were used to evaluate the manufactured brick's mechanical and physical characteristics. By converting the building sector from a linear to a circular economy, waste material utilization can make it more sustainable. Additionally, lowering pollution levels would guarantee a safe environment for coming generations.

This research aims to explore sustainable alternatives in brick manufacturing by incorporating waste materials such as plastic and dry leaves. The primary objective is to reduce dependence on soil, a key resource in traditional brick production, thereby conserving natural resources. Another goal is to lower construction costs by developing cost-effective bricks using readily available waste materials. Additionally, the study aims to effectively utilize agricultural residues, specifically guava dry leaves, by analyzing their properties and integrating them into the brick-making process. Furthermore, the research seeks to introduce innovative construction materials that advance sustainable practices in civil engineering.

Swinnerton et al. (2024) highlighted in their study on plastic waste that the use of small-scale recycling plants to manufacture plastic-waste bricks is expanding globally. This approach provides an opportunity not only to remove plastic waste from landfills and the environment but also to foster economic opportunities and development, particularly in underserved communities with mismanaged solid waste facilities. However, the rapid expansion of these facilities, coupled with the lack of control measures or consistency in manufacturing procedures, highlights the urgent need to improve understanding of their occupational health and environmental impacts.

LITERATURE REVIEW

The utilization of dry leaves and plastic waste in the manufacturing of bricks has been gaining significant attention in recent years as a sustainable approach to waste management. Several studies have investigated the feasibility and potential benefits of incorporating plastic waste into bricks, and the following is a literature review of some of these studies.

Ram & Singh (2017) investigated to study the feasibility of using plastic waste in the manufacturing of bricks. The study involved mixing varying amounts of plastic waste with clay and then firing the resulting bricks at different temperatures. The authors evaluated the physical and mechanical properties of the bricks, including compressive strength, water absorption, and density. The study found that the addition of plastic waste had a positive impact on the properties of the bricks, including increased compressive strength and reduced water absorption. Overall, the article provides valuable insights into the potential of using plastic waste in brick production and highlights the importance of exploring sustainable alternatives to traditional building materials.

Jadhav & Nimbalkar (2018) investigated to explore the feasibility of using plastic waste as a raw material in the manufacturing of bricks. The study found that the addition of plastic waste had a positive impact on the properties of the bricks, including increased compressive strength and reduced water absorption. The authors noted that the use of plastic waste in brick production can be an effective strategy for reducing environmental impact and promoting sustainable development.

El-Mohr et al. (2019) studied the utilization of sawdust and waste plastic in the manufacturing of eco-friendly fired bricks. It is observed that the addition of sawdust and waste plastic in the clay mixture resulted in a reduction in the water absorption capacity and an increase in compressive strength. Also found that the incorporation of sawdust and waste plastic in fired bricks improved their thermal insulation properties. It is suggested that the use of sawdust and waste plastic in the manufacturing of fired bricks could provide a sustainable solution for waste management and reduce the environmental impact of conventional brick manufacturing. The study highlights the potential of fired bricks as a sustainable alternative to conventional clay bricks, and the addition of sawdust and waste plastic further improves their properties and sustainability. Nampoothiri et al. (2019) investigated the effect of adding plastic waste to fly ash bricks, which are a type of sustainable brick made from industrial waste. The researchers found that adding up to 5% plastic waste to fly ash bricks improved their compressive strength and reduced their water absorption capacity.

Agrawal & Bhakar (2020) examined the various methods of recycling plastic waste and discussed the advantages and disadvantages of using plastic waste in brick-making. It discusses the potential environmental and economic benefits of using plastic waste in brick-making, including the reduction of waste in landfills and the creation of low-cost building materials. The review concludes that using plastic waste in brick-making has the potential to be a sustainable solution for both waste management and building construction.

Khatib et al. (2020) investigated the feasibility of using plastic waste in the production of interlocking paving blocks. The researchers found that adding up to 10% plastic waste to the blocks improved their compressive strength and reduced their water absorption capacity.

Kumar et al. (2020) investigated the utilization of agricultural waste and plastic waste in the manufacturing of eco-friendly bricks. It was found that the addition of agricultural waste (rice husk ash and sugarcane bagasse ash) and plastic waste in the clay mixture resulted in a reduction in the water absorption capacity and an increase in compressive strength. They also found that the incorporation of agricultural and plastic waste in bricks improved their thermal insulation properties. The authors suggested that the use of agricultural and plastic waste in the manufacturing of bricks could provide a sustainable solution for waste management and reduce the environmental impact of conventional brick manufacturing.

Yadav & Pandey (2020) conducted a study to investigate the potential of using waste plastic and biomass as raw materials for the production of eco-friendly bricks. The study involved mixing varying amounts of waste plastic and biomass with clay and then firing the resulting bricks at different temperatures. They evaluated the physical and mechanical properties of the bricks, including compressive strength, water absorption, and density. The study found that the addition of waste plastic and biomass had a positive impact on the properties of the bricks, including increased compressive strength and reduced water absorption. The article also discusses the environmental benefits of using waste plastic and biomass in brick production, including reducing waste and emissions associated with traditional brick production.

Dubey et al. (2021) investigated the utilization of plastic waste in the manufacturing of geopolymer bricks. Geopolymer bricks are an eco-friendly alternative to conventional clay bricks and are manufactured using industrial by-products such as fly ash, slag, and metakaolin. It was found that the addition of plastic waste in the geopolymer mix resulted in a reduction in the water absorption capacity and an increase in compressive strength. Also found that the incorporation of plastic waste in geopolymer bricks improved their thermal insulation properties. It is suggested that the use of plastic waste in the manufacturing of geopolymer bricks could provide a sustainable solution for waste management and reduce the environmental impact of conventional brick manufacturing. The study highlights the potential of geopolymer bricks as a sustainable alternative to conventional clay bricks, and the addition of plastic waste further improves their properties and sustainability.

Han et al. (2021) investigated the effect of sawdust on the thermal properties of biomass plastic bricks and found that the addition of sawdust to the plastic mixture resulted in a reduction in the thermal conductivity and an increase in the thermal resistance of the bricks. Also found that the incorporation of sawdust in biomass plastic bricks improved their thermal insulation properties. It is suggested that the use of sawdust in the manufacturing of biomass plastic bricks could provide a sustainable solution for waste management and improve the thermal insulation properties of the bricks. The study highlights the potential of biomass plastic bricks as a sustainable alternative to conventional clay bricks, and the addition of sawdust further improves their thermal properties and sustainability.

Singh et al. (2021) investigated the use of dry leaves and plastic waste as partial or complete substitutes for traditional materials used in brick production. The authors also highlighted some of the challenges associated with using these waste materials, such as the need for proper sorting and processing of the waste, as well as the need for additional testing to ensure that the resulting bricks meet the necessary standards for strength and durability. Overall, the article provides a comprehensive overview of the potential benefits and challenges of using dry leaves and plastic waste in brick production, and it can serve as a valuable resource for researchers and practitioners interested in sustainable building materials.

The literature review explores the utilization of dry leaves and plastic waste in the manufacturing of bricks. Several studies have shown that incorporating dry leaves and plastic waste into brick production can lead to the production of eco-friendly and sustainable building materials. Dry leaves, when added to clay soil, can enhance the thermal insulation and reduce the weight of the bricks. Plastic waste, on the other hand, can improve the durability and strength of the bricks while also reducing the amount of plastic waste in the environment. Research has also shown that the addition of dry leaves and plastic waste can affect the mechanical, thermal, and physical properties of the bricks. However, the optimal mix proportions of the materials and the effects of aging on the properties of the bricks require further investigation. Additionally, the economic viability of producing these bricks on a large scale also needs to be considered. Overall, the literature suggests that the utilization of dry leaves and plastic waste in brick manufacturing can be a promising approach to creating sustainable building materials. However, more research is needed to fully understand the potential of this approach and to optimize the properties of the resulting bricks.

MATERIALS AND METHODS

This study explores the production of eco-friendly bricks using recycled plastic waste, dry leaves, and soil as primary materials. These materials are combined in specific proportions to create lightweight, durable, and sustainable construction materials that address plastic pollution and resource conservation.

Materials

Plastic waste: Plastic waste is being used in plastic bricks as a way to address the issue of plastic pollution and waste management. Plastics are durable and non-biodegradable materials, which means that they do not easily decompose and can persist in the environment for hundreds of years. By using plastic waste in plastic bricks, we can divert this waste from landfills and oceans, and repurpose it into a useful construction material. This not only helps to reduce the amount of plastic waste in the environment, but it also conserves natural resources by using plastic waste as a substitute for traditional building materials, such as concrete or bricks. Furthermore, plastic bricks can offer several advantages over traditional building materials. They are lightweight, durable, and easy to manufacture. They can also provide good insulation and can be made in a range of sizes and shapes to suit different construction needs. Using plastic waste in plastic bricks is a sustainable solution that addresses both the issue of plastic waste and the need for affordable building materials.

Dry leaves: Dry leaves, often discarded as agricultural waste, were integrated into the brick-making process. Although traditionally used as natural soil conditioners or fertilizers, dry leaves can also serve as a lightweight filler in eco-friendly brick production. The dry leaves were shredded into small particles and mixed with plastic waste and soil. This combination contributes to the sustainability of the bricks by adding organic matter and improving their insulation properties.

Dry leaves are versatile materials that can be used in various construction applications, such as insulation in walls or ceilings and as lightweight fillers in concrete or bricks. The organic matter in dry leaves also introduces nutrients that enhance the soil's fertility when used in combination. However, careful consideration was given to the proportion of dry leaves used in the mixture to ensure proper compression and structural integrity of the bricks. Additionally, it's important to ensure that the plastic waste used is clean and free from contaminants that could affect the quality of the final product. While using dry leaves in combination with soil and plastic waste to create eco-friendly bricks is an innovative approach, it requires careful attention to the materials used and the production process to ensure that the resulting bricks are safe, durable, and sustainable.

Soil: Soil was used as an essential component to provide stability and structural strength to the bricks. It was mixed with water to achieve a clay-like consistency before being combined with shredded plastic waste and dry leaves. Soil plays a key role in binding the materials together, ensuring that the final product is strong, durable, and suitable for construction.

Table 1: Composition of Materials.

Percentage	Composition of Materials
70-80%	Shredded Plastic Waste (such as HDPE, LDPE, PET, or PP)
20-30%	Sand
10%-5%	Dry Leaves

Mix proportion: The materials were mixed in the proportions given in Table 1 to achieve the desired properties:

Constructional suitability of waste plastic, dry leaves, and dirt combined to make bricks. The waste plastic is correctly batched and heated from below while also containing dry leaves and soil. To create plastic soil bricks, the soil was added to the molten plastic paste in the following ratios: 1.5: 1.5: 0.5 (plastic, soil, and dry leaves, correspondingly). The shredded plastic waste and filler material should be mixed thoroughly and evenly and then melted together in a high-temperature extruder machine. The resulting molten mixture is then extruded through a die to create plastic brick-shaped molds, which are cooled and then cut to the desired size and shape. It's important to note that the specific mix proportion for plastic bricks may vary depending on the desired strength, durability, and other properties of the final product.

Methods

Method of Casting Bricks

The materials used for casting plastic bricks were sourced from various suppliers (Figs. 1, 2 and 3). The plastic waste was collected from AS Plastic Company, located in Peelamedu, Coimbatore, Tamil Nadu. The soil was collected from the ground, where it was carefully graded to meet the required specifications. The dry leaves used in the brick-making process were obtained as guava dry leaves powder from ARS Herbal (an online shopping platform). The procedure for preparing these materials, mixing them, and casting the bricks is detailed below.

Fig. 1: Grinded Plastic.

Fig. 2: Soil.

Fig. 3: Guava Dry Leaves.

Materials Preparation

1. **Plastic waste:** The collected plastic waste was shredded into small pieces to facilitate proper melting and mixing with other materials. This shredded plastic was used as the primary binding agent in the brick-making process, helping to repurpose plastic waste into a sustainable building material.
2. **Soil:** The soil was collected from the ground and subjected to grading to meet specific size requirements. Only soil passing through a 4.75 mm sieve and retaining particles greater than 600 microns was considered. This ensures that any soil particles smaller than 600 microns or larger than 4.75 mm, which could create voids and lumps and weaken the final brick structure, were removed. Proper soil grading ensures that the bricks have adequate structural integrity.
3. **Dry leaves:** The dry leaves used in the brick production were sourced from guava trees. These leaves were shredded into a fine powder and used in combination with plastic and soil to create a composite material that could be formed into bricks.

Manufacturing of Bricks

Mixing Process: The plastic waste, soil, and dry leaves were carefully measured and mixed. These materials were then thoroughly blended to ensure uniform distribution of all components (Figs. 4 & 5) before moving on to the next step of the manufacturing process.

Molding: Once the materials were properly mixed, the mixture was poured into a mold to form the shape of the bricks. The mold used measured 190 mm × 90 mm × 90 mm, a standard size according to IS 1077:1992, which is commonly used for traditional clay bricks (Fig. 6). This size ensures consistency in the final product and facilitates ease of handling during construction. The mixture was poured into the mold as quickly as possible to prevent it from cooling and hardening before the molding process was complete.

After the mixture was poured into the mold, it was compacted using a vibrating table to remove any air pockets and to ensure that the mixture filled the mold. The compaction process is crucial for achieving optimal strength and durability in the final brick. Once compacted, the mold was left to set, allowing the brick to cool and harden over time.

Curing: Curing is an essential step in ensuring that the plastic bricks achieve maximum strength and durability. After about 30 minutes of setting, the brick was mechanically removed

Fig. 4: Melting.

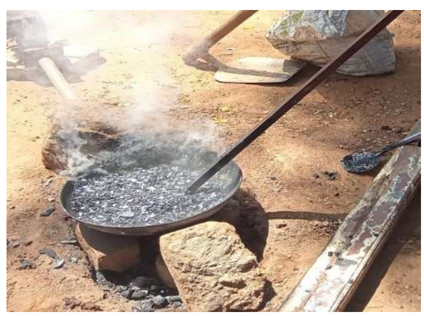

Fig. 5 Mixing.

Fig. 6: Moulding.

Fig. 7: Curing.

Fig. 8: Plastic Bricks.

from the mold. The bricks were then left to cool down for 1 to 1.5 hours before being fully hardened (Fig. 7). This cooling process is crucial as it allows the materials to solidify and the structure of the brick to stabilize (Fig. 8).

Testing and Evaluation of Bricks

After manufacturing, a series of tests were performed to evaluate the properties and performance of the plastic bricks. Three bricks were cast for each test to ensure consistent results. The following tests were carried out:

Water absorption test: A brick is taken and it is weighed dry. It is then immersed in water for 24 hours. It is weighed again and the difference in weight indicates the amount of water absorbed by the brick. According to standard guidelines, the water absorption should not exceed 20% of the dry weight of the brick.

The specimen is dried in a ventilated oven at a temperature of 105°C to 115°C till it attains substantially constant mass. The specimen is cooled to room temperature and its weight (W1) specimen too warm to touch shall not be used for this purpose. The dried specimen is immersed in clean water at a temperature of 27+2°C for 24 hours. The specimen is removed and wipe out any traces of water with a damp cloth and weigh the specimen after it has been removed from water (W2). Water absorption, % by mass, after 24-hour immersion in cold water is given by the formula,

$$W = {}^{w1\text{-}w2}/_{w1} \times 100$$

Compressive strength test: The compressive strength of the brick was tested by placing it in a compression testing machine. The brick was subjected to pressure until it broke., According to BIS: 1077-1957, the maximum crushing strength of a brick should be 3.50 N/mm². Bricks with a crushing strength of 7–14 N/mm² are graded as ‘A,’ while those with strength above 14 N/mm² are classified as ‘AA’. The ultimate compressive strength was calculated by dividing the ultimate load by the area of the brick’s cross-section.

Hardness: The hardness of the brick was tested by attempting to scratch its surface with a fingernail. If no impression was left on the surface, the brick was considered sufficiently hard.

Efflorescence test: The soluble salts if present in bricks will cause efflorescence on the surface of the bricks. To find out the presence of soluble salts in brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry sunshade. The absence of grey or white deposits on its surface indicates the absence of soluble salts. If the white deposit covers about 10% surface, the efflorescence is said to be slight and considered moderate, while the white deposit covers about 50% surface. If grey or white deposits are found on more than 50% of the surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted to powdery mass.

Shape and size: The bricks were closely examined to ensure they adhered to standard size and shape. Ten bricks were selected at random and stacked to measure the uniformity of length, width, and height. The bricks were required to be rectangular with sharp edges to meet the required quality standards.

Soundness test: The soundness of the brick was tested by striking two bricks against each other. The brick should not break, and a clear ringing sound should be produced if the brick is of good quality.

RESULTS AND DISCUSSION

After casting the bricks, they are analyzed for use in construction. Various tests are carried out to check the properties of the bricks and the results of that test are analyzed. The following discusses the outcomes of each test conducted.

Water absorption test: The results, as shown in Table 2**,** indicate that both sample 1 and sample 2 exhibited 0% water absorption**.**

Table 2: Water Absorption test.

S.No	Composition	Water Absorption
1.	Sample 1	0%
2.	Sample 2	0%

Fig. 9: Water absorption test.

Plastic soil bricks do not absorb water hence water absorption of plastic soil bricks is 0% (Fig. 9). Khan et al. (2018) investigated the effect of adding different types of plastic waste, including polyethylene terephthalate (PET) and low-density polyethylene (LDPE), on the properties of fired clay bricks. They found that adding 2-4% PET waste improved the compressive strength of the bricks while adding 2-6% LDPE waste resulted in increased water absorption capacity.

Compressive strength test: The compressive strength test measures the load-carrying capacity of the bricks and is crucial for determining their suitability in load-bearing applications (Fig. 10). The test results are presented in Table 3**,** showing the maximum load each specimen could withstand before failure, along with the corresponding compressive strength.

The average compressive strength of the plastic soil bricks was found to be 9.74 N/mm². This is comparable to the compressive strength of conventional bricks, which typically ranges between 5 N/mm² and 15 N/mm². Jadhav & Nimbalkar (2018) evaluated the physical and mechanical properties of the bricks, including compressive strength, water absorption, and density. The study found that the addition of plastic waste had a positive impact on the properties of the bricks, including increased compressive strength and reduced water absorption.

Table 3: Compressive strength test.

Samples	Load Taken By Specimen	Compressive Strength
Specimen 1	130 kN	7.6 N/mm^2
Specimen 2	160 kN	9.5 N/mm^2
Specimen 3	210 kN	12.28 N/mm^2
Average	166.67 kN	9.74 N/mm^2

Fig. 10: Compressive strength test.

Nampoothiri et al. (2019) found that adding up to 5% plastic waste to fly ash bricks improved their compressive strength and reduced their water absorption capacity. El-Mohr et al. (2019) investigated and reported that the addition of sawdust and waste plastic in the clay mixture resulted in a reduction in the water absorption capacity and an increase in compressive strength.

Efflorescence Test: A sample of the plastic brick is taken and its dimensions are measured accurately. The brick is placed in a glass container and covered with distilled water.

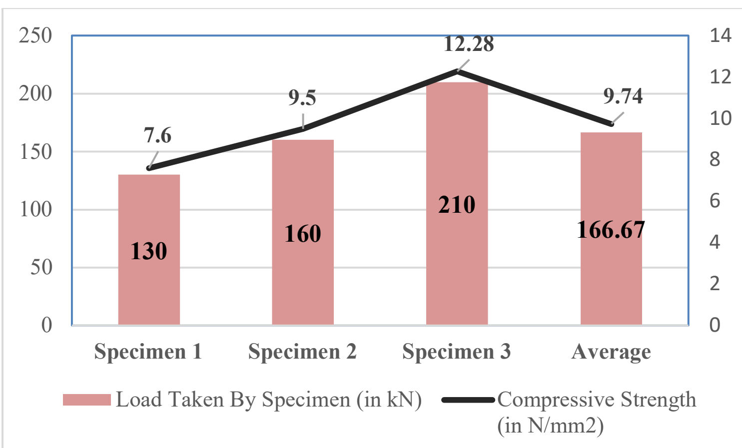

Fig. 11: Comparison of compressive strength.

Fig. 12: Efflorescence Test.

The container is sealed and allowed to stand for 28 days. After 28 days, the container is examined for any signs of efflorescence. If efflorescence is present, the extent of efflorescence is recorded. Since bricks don't contain any soluble salts, they don't develop any white or grey color deposits after being submerged in water for 24 hours and dried in the shadow. No efflorescence: No visible deposits on the surface of the brick (Fig. 12).

Hardness test: The hardness of the plastic soil bricks was assessed by attempting to scratch the surface using a fingernail. No impressions were left on the surface, suggesting that the bricks were sufficiently hard. While this method provides a basic indication of hardness, a more precise measure would require specialized instruments such as a Rockwell or Vickers hardness tester. Nevertheless, the absence of scratches indicates that the bricks are hard enough for construction purposes.

Soundness test: The soundness test evaluates the bricks' ability to withstand sudden impacts without breaking. In this test, two bricks were struck together, and the sound produced was observed. A clear, ringing sound was heard, and neither brick broke. This indicates that the bricks are sound and can withstand the mechanical stresses they may encounter during handling and use in construction.

CONCLUSIONS

The utilization of plastic wastes and dry leaves in brick production is an innovative and sustainable approach that addresses two pressing environmental challenges: waste management and depletion of natural resources. The global production of plastic and the accumulation of plastic waste have been escalating at an alarming rate, resulting in environmental pollution and ecological damage. On the other hand, traditional brick production requires the extraction of finite natural resources, such as clay and sand, which contributes to land degradation and habitat loss. By incorporating plastic waste and dry leaves into brick production, it is possible to reduce the amount of plastic waste and dry leaves in the environment while conserving natural resources. In addition, this approach can enhance the physical and mechanical properties of the bricks, providing a durable and cost-effective alternative to traditional bricks. This study aimed to investigate the feasibility of using plastic wastes and dry leaves in brick production and to assess the physical and mechanical properties of the resulting bricks. The study explored the optimal proportions of plastic wastes and dry leaves that can be incorporated into the brick mix, as well as the effects of different variables on the properties of the bricks, such as curing time, temperature, and humidity. The results of this study contribute to the development of sustainable and innovative building materials that promote a circular economy and environmental stewardship.

REFERENCES

Agrawal, R. and Bhakar, M., 2020. Recycling of plastic waste in bricks: A review. *Journal of Materials Research and Technology*, 9(1), pp.854-864.

Dubey, R., Singh, S., Suresh, S. and Mukherjee, A., 2021. Sustainable management of plastic waste using geopolymer bricks. *Journal of Building Engineering*, 43, p.102616.

El-Mohr, M.A., Mahmoud, S.A. and Ragab, A.A., 2019. Eco-friendly fired bricks incorporating sawdust and waste plastic. *Construction and Building Materials*, 211, pp.1056-1065.

Han, X., Li, X., Li, S., Yang, S., Liu, S. and Huang, Q., 2021. Effect of sawdust on thermal properties of biomass plastic bricks. *Energy Reports*, 7, pp.3867-3872.

Jadhav, V.V. and Nimbalkar, S.S., 2018. Experimental investigation on utilization of plastic waste in manufacturing of bricks. *International Journal of Engineering Research & Technology (IJERT)*, 7(10), pp.265-270.

Khan, M.I., Rana, M.A. and Usman, M., 2018. Utilization of plastic waste for making hollow blocks and bricks. *Journal of Materials in Civil Engineering*, 30(7), p.04018166.

Khatib, J.M., Sadeek, S.A. and Issa, C.A., 2020. Experimental study on the use of plastic waste as aggregate in concrete. *International Journal of Civil Engineering and Technology*, 11(6), pp.490-498.

Kumar, M., Kumar, A., Kumar, A. and Singh, V., 2020. Utilization of agricultural waste and plastic waste in manufacturing of eco-friendly bricks. *Journal of Materials Research and Technology*, 9(1), pp.611-618.

Nampoothiri, S.V., Arunachalam, K. and Ramachandran, T., 2019. Studies on properties of fly ash bricks containing waste plastic. *Materials Today: Proceedings*, 18, pp.542-548.

Ram, A. and Singh, G., 2017. Use of plastic waste in the manufacturing of bricks. *International Journal of Innovative Research in Science, Engineering and Technology*, 6(2), pp.66-72.

Singh, V., Singh, A., Kumar, A. and Kumar, M., 2021. Experimental investigation on dry leaves and plastic waste incorporated fired bricks. *Journal of Building Engineering*, 44, p.103217.

Swinnerton, S., Kurtz, K., Neba Nforsoh, S., Crave, V. and Tsai, C., 2024. The manufacturing process and consequent occupational health and environmental risks associated with the use of plastic waste in construction bricks in small-scale recycling plants. *Journal of Cleaner Production*, 477, p.143818.

Yadav, M. and Pandey, K., 2020. Utilization of waste plastic and biomass for the production of eco-friendly bricks. *Journal of Materials Research and Technology*, 9(1), pp.474-485.

ORCID DETAILS OF THE AUTHORS

P. Muthupriya: https://orcid.org/0000-0002-3814-7185