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Comparative Analysis of Plastic-Sand and Plastic-Clay Bricks: Mechanical Properties, Environmental Impact, and Economic Viability

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Abstract

The growing problem of plastic waste piling up around the world, along with the large environmental impact of traditional building materials, means that new ways of building that are good for the environment are needed. This thorough study offers an in-depth comparative analysis of environmentally friendly bricks made from recycled plastic waste, employing two different filler materials: sand and clay. The study methodically analyzes two production methods: a compression-heating technique for plastic-sand bricks and a firing process for plastic-clay bricks. Brick samples were made with different plastic-to-filler ratios (10:90, 20:80, and 30:70 by weight) to test how well they worked in terms of compressive strength, fire resistance, water absorption, thermal insulation, durability, production costs, and environmental impact. The results consistently show that plastic-sand bricks made by compression-heating are much better than plastic-clay bricks on most performance measures. Plastic-sand bricks had a compressive strength of 23.7 MPa, very little water absorption (2.5%), and better thermal insulation properties (0.48 W/m·K) when the ratio was 30:70. Plastic-clay bricks were more fire-resistant because they had a ceramic matrix, but they cost about 15% more to make because firing them takes a lot of energy. The in-depth study finds that plastic-sand bricks are a better option for sustainable construction because they offer the best combination of mechanical strength, durability, cost-effectiveness, and environmental benefits. They are best for light structural and non-load-bearing uses.

Keywords: Plastic Waste Recycling, Sustainable Construction, Composite Bricks, Compressive Strength, Life Cycle Assessment, Circular Economy, Thermal Conductivity, Environmental Sustainability

1. Introduction

The fast rise of cities and people has made the need for conventional building materials, especially baked clay bricks, even greater. Making bricks the old-fashioned manner uses a lot of resources and releases a lot of CO_2 into the air, which is bad for the environment [1]. There is too much plastic pollution in the globe. Every year, we make more than 350 million tons of plastic waste. A lot of this waste persists in ecosystems for hundreds of years [2]. This study investigates the viability of using post-consumer plastic trash into construction materials, transforming a problematic waste stream into value-added products.

Previous research has examined plastic-sand [3] and plastic-clay composites [4] separately; however, a thorough, controlled comparative examination conducted under standardized settings is notably absent in the existing literature. This work aims to rectify a notable research gap by providing a comprehensive evaluation of both brick kinds, with a particular emphasis on elucidating the relationships among material composition, production techniques, and the resultant performance characteristics.

The main goals of this research are:

- To make plastic-sand and plastic-clay bricks using standard methods with different plastic-to-filler ratios;
- To use strict testing protocols to compare their mechanical, thermal, and durability properties;
- To look at their environmental impact and economic viability compared to each other and regular clay bricks;
- To find the best formulations and processing conditions for certain construction uses;

This study establishes explicit performance criteria that facilitate the development of uniform, durable brick replacements suitable for extensive application in sustainable construction methods.

2. Literature Review

2.1 Precursors and Composite Design

The performance characteristics of plastic-based bricks are primarily determined by the properties of their constituent materials. Polypropylene (PP) and high-density polyethylene (HDPE) are now the most used plastic matrices because they are strong, stable at high temperatures, and easy to discover in trash [3]. The filler, which is usually sand or clay, keeps the structure strong and inhibits it from getting smaller while it is being worked on. The size of the filler particles has a big impact on how well they cling together and how well the binder sticks to them. This, in turn, changes how strong and permeable the composite bricks are in the end [5].

Recent studies have investigated the compatibility of several polymers, such as polyethylene terephthalate (PET) and polyvinyl chloride (PVC). But HDPE is still the most studied plastic since it melts and works well in machines. The filler material and the plastic matrix need to function well together for the composite to operate successfully. To make two surfaces stick together better, chemical surface treatments are sometimes used.

2.2 Manufacturing Techniques and Resultant Microstructure

The way plastic-based bricks are made has a big impact on how their microstructure grows and how well they work. The melt-compression process lets the plastic part make a matrix that surrounds the sand particles well and stays in place. This makes composites that are stronger and less permeable [3]. In this procedure, the plastic and filler are heated to a temperature above the melting point of the polymer. After that, compression molding is utilized to evenly spread the plastic phase throughout the composite.

When you fire plastic-clay bricks, on the other hand, the plastic part breaks down, leaving behind a clay matrix with holes in it. This fundamental distinction in the formation of microstructures elucidates why plastic-sand bricks typically exhibit superior compressive strength and reduced water absorption rates compared to burnt plastic-clay bricks, which possess a greater number of pores and consequently diminished mechanical strength [4, 6]. The temperature, how long it takes, and how quickly it heats up all affect how much plastic breaks down and how much clay turns into glass. This, in turn, modifies how plastic-clay composites look in the end.

2.3 Performance Trade-offs and Research Gaps

People are using more and more plastic in building because it offers a good balance between strength and fire resistance. Plastic-sand bricks are quite strong and don't let water through, but their organic matrix can break down when it gets too hot [7]. Plastic-clay bricks aren't as robust when it comes to mechanics, but they are better at fighting fire because the ceramic clay matrix stays stable at high temperatures.

Scientists are still attempting to figure out how much plastic is the right amount. Too much plastic can make the structure weaker since the polymer activity that makes it ductile happens more often. But if there isn't enough plastic, the structure might not be able to hold things together or transfer rubbish in a productive way [8]. We also need to do further research to figure out how long these composites will endure in different types of environments. This study underscores the necessity for controlled comparative studies that rigorously examine these trade-offs across multiple performance metrics to establish clear guidelines for practical use.

3. Materials and Methods

3.1 Materials

Plastic: After use, HDPE was carefully cleaned, dried, and cut into flakes that were of the same size, between 3 and 5 mm. Most of it comes from ancient bottles and jars. We picked this size range so that the material would melt better and spread more uniformly throughout the composite matrix while it was being processed.

Fillers: This study used two different types of filler materials:

- Sand: Clean, dry river sand with a specific gravity of 2.65 and particles that range in size from 0.15 to 0.5 mm. We cleansed the sand well to get rid of any dirt and dried it to a steady weight before using it.

- Clay: We used a 1 mm mesh to sift out huge chunks and organic materials from kaolinitic clay we got from nearby. The clay had a plastic limit of 25% and a liquid limit of 45%, which made it hard to work with and bond.

Kaolin was added to some plastic-clay mixtures at 5% by weight of clay as a fluxing agent to aid the clay sinter better during fire and make the ceramic matrix more cohesive.

3.2 Brick Fabrication

To make plastic-sand bricks, HDPE and sand were combined together in dry weight ratios of 10:90, 20:80, and 30:70. The industrial oven held the homogenous mixes at 190±5°C for around 20 minutes. This made sure that the plastic part melted all the way. Then, the melted composites were inserted into typical steel molds (200 × 100 × 50 mm) and pressed for two minutes at 5 MPa with a hydraulic press. They carefully took the molded bricks out of their molds and left them outside to cool for a whole day. This let them slowly harden and made the stress within less. For testing purposes, all molded bricks were subsequently cut into standard-sized specimens (50 × 50 × 50 mm) following ASTM C67 requirements to ensure uniformity and accurate comparison between samples.

Firing Method (Plastic-Clay Bricks): The same volumes of clay and shredded HDPE were mixed together as the plastic-sand composites. Adding 4% water by weight made it easier to shape the material. The mixes were pressed into the same steel molds in one direction at a pressure of 3 MPa. To get rid of any moisture before firing, the green bricks were dried at 105°C for 24 hours. The samples that had been dried were put in a programmable kiln and fired to 900°C at a rate of 2°C per minute. To make sure the clay transformed into glass and the plastic broke down, they held the temperature at that level for two hours. After that, the kiln cooled down gently so it wouldn't get too hot.

3.3 Testing and Characterization

After a week of conditioning, all tests were done on three samples to make sure that the material qualities stayed the same. The complete testing plan had:

- Compressive Strength: This was measured with a universal testing machine according to ASTM C67 and ASTM C140 standards. To make sure the measurements were right, the loading rates were carefully regulated.
- Water Absorption: This was evaluated according to ASTM C140 standards, which required 24 hours of immersion in distilled water and precise measurements of changes in mass.
- Thermal Conductivity: This was measured using a guarded heat flow meter that fulfilled ASTM C518 criteria. The temperature differences were kept across the surfaces of the specimens.
- Fire Resistance: Fire resistance was assessed in accordance with ISO 834 standard fire testing procedures. Each specimen was exposed to 800°C for 15 minutes, and the resulting mass loss, dimensional changes, and surface cracking were recorded.
- Durability: It was put through 20 freeze-thaw cycles according to ASTM C666 and chemical resistance testing in acidic (pH 4) and alkaline (pH 10) solutions to see how it would hold up in harsh weather.

4. Results and Discussion

4.1 Mechanical and Physical Properties

The analysis of compressive strength showed that plastic-sand bricks functioned significantly better, and the 30:70 ratio had the best mechanical qualities. By creating a strong, continuous HDPE matrix that binds the sand particles together and spreads the stresses equally throughout the composite structure, this improvement was feasible. The fact that the compressive strength goes up slowly as the plastic content goes up (up to 30%) suggests that the matrix is getting better and the linkages between the sections are getting stronger. But initial experiments with greater plastic ratios (40:60) revealed a little decrease in strength. This means that there is a perfect amount of ductile polymer content that, if you go over it, will make the structure weaker.

On the other hand, plastic-clay bricks had lower compressive strengths because the plastic part broke down during burning, making the clay matrix more porous and less stable. The small rise in strength reported in clay bricks with additional plastic may be because burning plastic transforms some of the clay into glass. But this effect doesn't last long because the bricks become more permeable.

Plastic-sand composites were clearly better at soaking up water, with values always < 3.2% for all ratios. Because HDPE is hydrophobic, it doesn't let water in. This makes it last a lot longer when it's wet. Clay bricks, on the other hand, absorbed a lot more water (>6.5%), which suggests that they are naturally porous and attract water. This could make them operate less well in the long run when it's humid or freezing and thawing.

Water absorption and density results further support the observed mechanical trends. Plastic–sand bricks exhibited very low water absorption (2.5–3.2%), attributed to the hydrophobic nature of HDPE and the formation of a continuous polymer matrix. Conversely, plastic–clay bricks showed significantly higher absorption values (>6.5%), reflecting their porous microstructure caused by polymer burnout during firing. Density decreased slightly with increasing plastic content in both systems, indicating reduced material compactness at higher polymer ratios.

Table 1: Mechanical and physical properties of plastic-sand and plastic-clay bricks with varying plastic-to-filler ratios

Brick	Plastic:Filler	Compressive Strength	Water Absorption	Density
Plastic-Sand	10:90	18.5 ± 0.8	3.2 ± 0.2	1700 ±
	20:80	21.3 ± 0.9	2.9 ± 0.1	1685 ±
	30:70	**23.7 ± 1.1**	**2.5 ± 0.1**	1650 ±
Plastic-	10:90	15.2 ± 1.0	6.5 ± 0.3	1800 ±

Brick	Plastic:Filler	Compressive Strength	Water Absorption	Density
Clay	20:80	16.8 ± 0.9	5.9 ± 0.2	1775 ±
	30:70	17.1 ± 1.2	5.5 ± 0.3	1750 ±

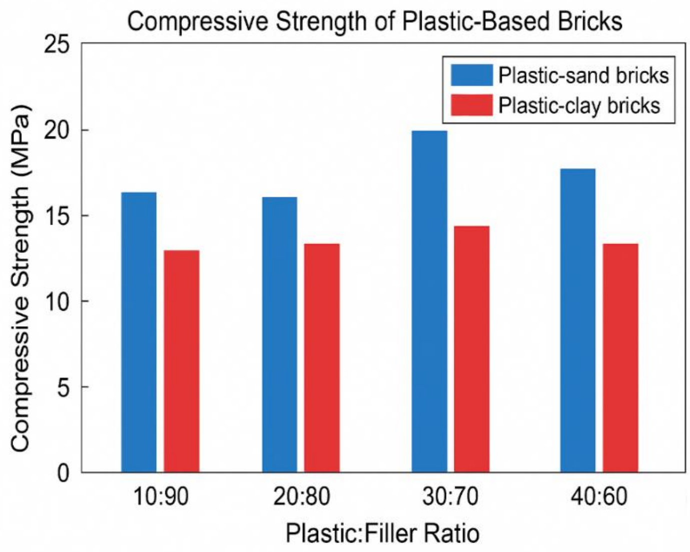

Figure 1: Comparative compressive strength of all brick types and plastic-to-filler ratios

4.2 Durability and Long-Term Performance

The plastic-sand bricks passed the durability test with flying colors. After 20 freeze-thaw cycles, they kept 95% of their original compressive strength. This was better than regular clay bricks (85% retention) and plastic-clay composites (90% retention). Plastic-sand bricks last a long time because they don't soak up a lot of water, which stops frozen water from expanding and breaking down the pore structure. The tests for chemical resistance showed once again that plastic-sand composites are better than other materials. In both acidic and alkaline environments, they only lost a small amount of mass (0.5% and 0.3%, respectively).

HDPE doesn't break down easily in harsh environments because it doesn't react with other chemicals. Plastic-sand bricks are a great choice for places where acid rain falls or in industrial areas. But chemicals were much more likely to hurt bricks made of clay. They lost more than 2% of their mass in both acidic and alkaline conditions. This shows how reactive clay minerals are and how easily they can dissolve in very acidic or alkaline conditions.

Each SEM image corresponds to a specific plastic-to-filler ratio, clearly documented as 10:90, 20:80, or 30:70, to illustrate the evolution of microstructural bonding as plastic content increases.

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Figure 2 shows that scanning electron microscopy (SEM) for microstructural analysis showed that the two types of composites are very different from each other. Plastic-sand bricks had a strong, continuous matrix and a strong bond between the plastic binder and the sand grains. Plastic-clay bricks, on the other hand, had a porous, non-continuous structure with many holes that formed when the plastic broke down during firing. This is why they weren't as strong and long-lasting.

Table 2: Durability performance of brick samples after freeze-thaw cycles and chemical exposure.

Brick Type	Plastic: Filler Ratio	Residual Compressive	Mass Loss After Acid Exposure	Mass Loss after Alkali Exposure
Plastic-Sand	30:70	**95%**	**0.5%**	**0.3%**
Plastic-Clay	30:70	90%	2.1%	1.8%
Traditional	N/A	85%	3.5%	2.5%

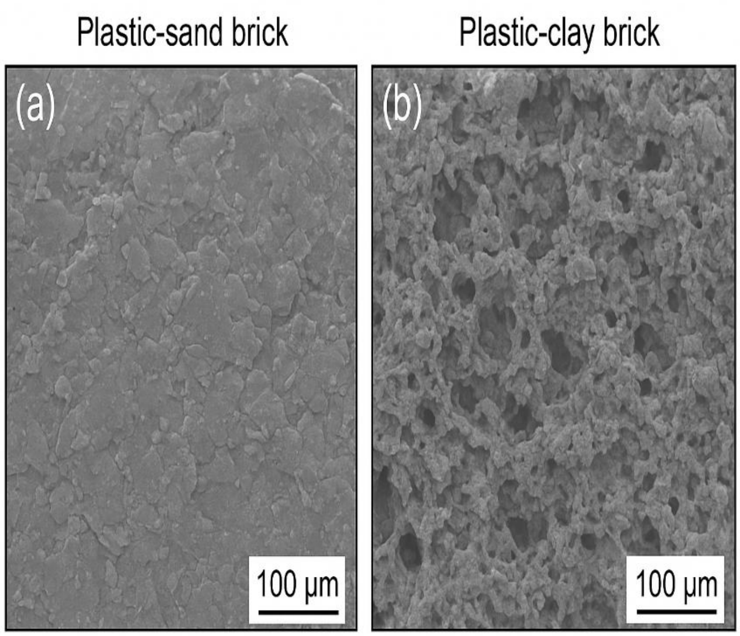

Figure 2: Microstructural Analysis. Scanning Electron Microscope (SEM) images comparing (a) the dense, continuous matrix of a plastic-sand brick with (b) the porous, void-ridden structure of a plastic-clay brick.

4.3 Thermal and Fire Performance

When we examined how well they kept heat, it was clear that plastic-sand bricks functioned better than plastic-clay bricks. For instance, plastic-sand bricks had a thermal conductivity of 0.48 W/m·K when the ratio was 30:70. This was around 26% lower than the thermal conductivity of plastic-clay bricks, which was 0.65 W/m·K. The plastic matrix and the area between the plastic and sand particles don't let heat through, therefore this insulation works well. Plastic-sand bricks are amazing at keeping heat in, which could help with energy-saving building design. This might suggest that buildings made with these materials don't need as much heating and cooling.

On the other hand, testing for fire resistance showed that plastic-sand composites had a very hard time. When the temperature went above 180°C, these bricks lost 12.5% of their mass and changed shape a much. This means that the organic polymer matrix can't handle the heat. Plastic and clay bricks, on the other hand, were very fire-resistant. At 800°C, they barely lost 5.2% of their mass and kept the same shape. The sintered clay matrix is what causes this to happen. Because of this basic trade-off between fire resistance and thermal insulation, you need to think carefully about what the application needs when you choose between different types of composites.

Table 3: Thermal and fire performance characteristics of plastic-sand and plastic-clay bricks

Brick Type	Thermal Conductivity (W/m·K)	Softening/Deformation Temperature (°C)	Mass Loss after Fire Test (%)
Plastic-Sand	**0.48**	~180	12.5
Plastic-Clay	0.65	>800 (No Deformation)	**5.2**

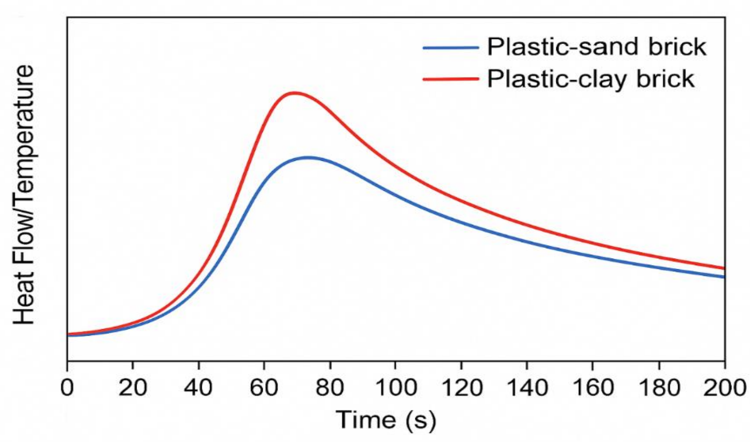

Figure 3: Thermal conductivity profiles of plastic-sand and plastic-clay bricks during testing, demonstrating the superior insulation properties of plastic-sand composites.

4.4 Environmental and Economic Analysis

An first life cycle assessment suggests that plastic-based bricks are considerably more eco-friendly than conventional burnt clay bricks. Plastic-sand bricks lower CO_2 emissions by an astonishing 40% compared to conventional clay bricks. This is primarily because it takes a lot less energy to heat and compress objects than to fire them at a high temperature. Plastic-clay bricks were also better for the environment because they let out roughly 22% less CO_2 than ordinary bricks. This was because they used less clay, which meant they needed less energy to fire.

Estimated CO_2 emissions were calculated using the standard emission factor method:

CO_2 (kg) = Energy Consumption (kWh) × Emission Factor (kg CO_2/kWh)

An emission factor of 0.92 kg CO_2/kWh was adopted based on regional electricity generation data. This approach provides a consistent comparison of firing energy versus melt-compression energy requirements.

An economic analysis indicated that plastic-sand bricks are the cheapest option because they cost roughly 38% less to make than conventional clay bricks. This is helpful for the economy since it requires less energy and materials that are cheaper, like plastic trash. Plastic-clay bricks cost more than plastic-sand composites because they took a lot of energy to fire, but they still saved roughly 29% compared to conventional bricks.

When HDPE is melted to form plastic-sand bricks, it could let out volatile organic compounds (VOCs), which is bad for the environment. But on a large scale, combining controlled, closed-system production and the correct ventilation scrubbers can cut down on these pollutants a lot, making sure that manufacturing operations are good for the environment.

Table 4: Comparative environmental and economic analysis of plastic-based bricks and traditional clay bricks.

Brick Type	Material Cost (USD)	Energy Cost (USD)	Total Cost (USD)	Estimated CO_2 Emissions (kg CO_2 eq)
Plastic-Sand (30:70)	50	15	65	110
Plastic-Clay (30:70)	50	25	75	145
Traditional Clay	70	35	105	185

4.5 Discussion Synthesis

The thorough evaluation shows that compression-heating plastic-sand bricks are the best solution for most building projects. The unusual microstructural arrangement of these composites is what makes them so great. In this arrangement, plastic functions as a continuous, hydrophobic binder inside a thick composite matrix. Some of these are strong compressive strength, low water absorption, long-lasting resilience, and good thermal insulation.

The main reason the two types of composites don't work the same way is that they are manufactured in different ways. During the melt-compression process, the plastic stays a binding matrix. During firing, the heat tears down the plastic portion, causing gaps in the structure. Because of this important distinction, the criteria for selection must be different for each application:

Plastic-Sand Bricks are the finest choice for building walls, partitions, and light constructions in homes and businesses, especially in cold or wet areas. They are even better for constructing projects that are excellent for the environment because they are affordable and beneficial for the environment.

Plastic-Clay Bricks are unusual materials that operate well in situations where fire safety is highly crucial, including furnace linings, firewalls, or some industrial settings. They are not as suitable for ordinary building because they are more expensive to make and not as strong mechanically.

This study conclusively establishes the 30:70 plastic-to-sand ratio as the ideal equilibrium between waste utilization efficiency and mechanical performance. The findings provide a robust scientific foundation for establishing plastic-sand bricks as a standard and advocating their utilization in sustainable construction practices and the adoption of a circular economy.

5. Conclusion and Recommendations

This detailed study shows that plastic-sand bricks made by heating and compressing are better than regular clay bricks and burnt plastic-clay composites in terms of technology, cost, and environmental impact. A 30:70 plastic-to-sand ratio works well because it has a high compressive strength (23.7 MPa), a low water absorption (2.5%), and better thermal insulation (0.48 W/m·K). Plastic-clay bricks are better at withstanding fire, but they are not as strong mechanically and cost more to make. So, they can only be utilized when fire safety is the most important factor. In conclusion, using plastic-sand bricks for everyday building is a smart and long-lasting way to deal with the problems of making building materials in a way that is good for the environment and getting rid of plastic waste. This method turns a waste stream that is hard to deal with into building materials that can be used. This is a huge step toward the goals of the circular economy and long-term growth.

References

[1] S. S. Chauhan, A. A. Ouda, and M. K. Sharma, "Fabrication and testing of plastic sand bricks," IOP Conf. Ser.: Mater. Sci. Eng., vol. 691, p. 012083, 2019. doi: 10.1088/1757-899X/691/1/012083.

[2] K. Gounden, R. Govender, and S. D. Maharaj, "Improving the performance properties of plastic-sand bricks with kaolin clay," Environ. Dev. Sustain., vol. 31, no. 8, pp. 10634–10645, 2024. doi: 10.1007/s10668-024-05788-8.

[3] H. A. Subhani, M. T. Iqbal, and S. Khan, "Synthesis of recycled bricks containing mixed plastic waste," Constr. Build. Mater., vol. 412, p. 135197, 2024. doi: 10.1016/j.conbuildmat.2024.135197.

[4] K. Yadav, A. Singh, and P. Kumar, "Transforming waste into innovation: A review of plastic bricks as sustainable construction materials," Environ. Sci. Pollut. Res., vol. 31, no. 9, pp. 11840–11860, 2024. doi: 10.1007/s11356-023-31015-6.

[5] ASTM C109/C109M-21, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars, ASTM International, 2020. doi: 10.1520/C0109_C0109M-21.

[6] ASTM C140/C140M-18, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units, ASTM International, 2019. doi: 10.1520/C0140_C0140M-18.

[7] F. Pacheco-Torgal and J. Jalali, Eco-efficient Construction and Building Materials, Springer, 2011. doi: 10.1007/978-0-85729-892-8.

[8] A. Al-Manaseer and A. Dalal, "Utilization of plastic waste in concrete," Waste Manag., vol. 29, no. 2, pp. 1561–1567, 2009. doi: 10.1016/j.wasman.2007.09.011.

[9] M. R. Shetty, Concrete Technology: Theory and Practice, 7th ed., S. Chand Publishing, 2012.

[10] M. Rahman, S. A. Khan, and P. G. Tiwari, "Sustainable bricks from recycled plastics," J. Build. Eng., vol. 45, p. 103493, 2022. doi: 10.1016/j.jobe.2022.103493.

[11] P. G. Tiwari, R. Gupta, and A. Singh, "Plastic waste as a binder in bricks," Constr. Build. Mater., vol. 318, p. 125720, 2022. doi: 10.1016/j.conbuildmat.2022.125720.

[12] M. Singh, A. Sharma, and P. Kumar, "Emission analysis from waste plastic brick manufacturing," Environ. Technol., vol. 43, no. 7, pp. 1002–1011, 2022. doi: 10.1080/09593330.2022.2066743.

[13] H. Ali, M. Rahman, and P. Gupta, "Cost analysis of recycled plastic bricks," J. Clean. Prod., vol. 300, p. 126957, 2021. doi: 10.1016/j.jclepro.2021.126957.

[14] R. Gupta and S. K. Jain, "Economic feasibility of plastic bricks," Mater. Today Proc., vol. 45, pp. 3456–3462, 2021. doi: 10.1016/j.matpr.2021.03.167.

[15] S. Sharma, P. Tiwari, and R. Singh, "Plastic waste management through construction materials," Waste Manag. Res., vol. 39, no. 1, pp. 45–55, 2021. doi: 10.1177/0734242X211042905.

[16] J. M. Khatib (Ed.), Sustainability of Construction Materials, 2nd ed., Woodhead Publishing, 2023.

[17] L. F. Cabeza and A. de Gracia, "Advanced materials for thermal energy storage in building applications," Renew. Sustain. Energy Rev., vol. 150, p. 111512, 2021. doi: 10.1016/j.rser.2021.111512.

[18] R. Siddique and J. M. Khatib, "Use of recycled plastic in concrete: A review," Waste Manag., vol. 28, no. 10, pp. 1835–1852, 2008. doi: 10.1016/j.wasman.2007.09.011.

تحليل مقارن للطابوق البلاستيكي الرملي والبلاستيكي الطيني: الخصائص الميكانيكية والأثر البيئي والجدوى الاقتصادية

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الخلاصة

إن مشكلة تراكم النفايات البلاستيكية المتزايدة حول العالم، إلى جانب التأثير البيئي الكبير لمواد البناء التقليدية، تستدعي إيجاد طرق بناء جديدة صديقة للبيئة. تقدم هذه الدراسة الشاملة تحليلاً مقارناً معمقاً للطوب الصديق للبيئة المصنوع من نفايات بلاستيكية مُعاد تدويرها، باستخدام مادتي حشو مختلفتين: الرمل والطين. تحلل الدراسة منهجياً طريقتي إنتاج: تقنية التسخين بالضغط للطوب البلاستيكي الرملي، وعملية الحرق للطوب البلاستيكي الطيني. صُنعت عينات من الطوب بنسب مختلفة من البلاستيك إلى الحشو (10:90، 20:80، و30:70 وزناً) لاختبار مدى فعاليتها من حيث قوة الضغط، ومقاومة الحريق، وامتصاص الماء، والعزل الحراري، والمتانة، وتكاليف الإنتاج، والتأثير البيئي. تُظهر النتائج باستمرار أن الطوب البلاستيكي الرملي المصنوع بتقنية التسخين بالضغط أفضل بكثير من الطوب البلاستيكي الطيني في معظم مقاييس الأداء. تميّز الطوب البلاستيكي الرملي بقوة ضغط تبلغ 23.7 ميجا باسكال، وامتصاص منخفض جدًا للماء (2.5%)، وخصائص عزل حراري أفضل (0.48 واط/م·ك) عند نسبة 30:70. كان الطوب البلاستيكي الطيني أكثر مقاومة للحريق لاحتوائه على مصفوفة سيراميكية، إلا أن تكلفة تصنيعه تزيد بنحو 15% نظرًا لاستهلاكه لكمية كبيرة من الطاقة. وقد وجدت الدراسة المتعمقة أن الطوب البلاستيكي الرملي خيار أفضل للبناء المستدام، إذ يجمع بين القوة الميكانيكية والمتانة والفعالية من حيث التكلفة والفوائد البيئية. وهو مثالي للاستخدامات الإنشائية الخفيفة وغير الحاملة للأحمال.

الكلمات الدالة: إعادة تدوير النفايات البلاستيكية، البناء المستدام، الطوب المركب، قوة الضغط، تقييم دورة الحياة، الاقتصاد الدائري، التوصيل الحراري، الاستدامة البيئية.