The OCEM Journal of Management, Technology and Social Sciences

Volume 2, Issue 2, 103-114
ISSN Print: 2705-4845
Issue online: 2705-48

A Review of Plastic Bricks as a Construction Material

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Received: November 20, 2022

Revised: December 21, 2022
Accepted: January 05, 2023
Published: January 29, 2023

How to cite this paper:
Shrestha, M.N., Kandel, J, KC, P, Bhatta, A, Paudyal, S, Poudel, A & Adhikari, B.P (2022). A Review of Plastic Bricks as a Construction Material

The OCEM Journal of Management, Technology & Social Sciences, 2(2), 103-114

Originality: This paper is original and has not been published anywhere else

Paper type: Research paper
J.E.L. Classification: I (2), I (29)

Abstract

Plastic brick is the form of brick manufactured from the combination of non-recyclable waste plastic with other constituents (sand, aggregate, cement, water, stone dust, fly ash, etc.) This study aimed to examine the research findings on transforming waste plastic into bricks that might be used to replace traditional bricks. Different journal articles were reviewed entitled the transformation of waste plastic into bricks to replace traditional clay bricks. Different open-access journal articles were searched to fit the topic of this study. The results indicate that the concrete blocks made with plastic bottles have 57% higher compressive strength and which was cited seventy-nine times by the other researchers (n = 79) "Use of recycled plastic water bottles in concrete blocks". The results further show that the compressive strength and other properties can be increased significantly when plastic is used as a binder with sand. But when it is used as filler, it produces competitive strength as ordinary bricks and can be used without any restrictions or hesitation. The main reflection of this review is to conduct primary research on a large scale to find an innovative model to transform waste plastic into environmentally friendly bricks. The implication of this study would be beneficial to students, future researchers, the Engineering Department of Oxford College of Engineering and Management, Gaindakot 2 in Nawalparasi district and young academicians.

Keywords: *Plastic bricks, Construction materials, Conventional Bricks, filler, binder*

1. INTRODUCTION

Plastic bricks are the types of bricks that are manufactured using plastic waste. These bricks are not only cost-effective and eco-friendly but also have low water absorption value and high compressive strength and will not have problems like efflorescence in future. Plastic waste is increasing due to an increase in pollution, organization, and development. Since the rate of plastic production is projected to double the value every ten years, a more sustainable and safer way is needed to be taken (Prasanth, Gopalakrishnan, G Thanigainathan & Kathiravan, 2018, Kulkarni, Ravekar, Rama Rao, Waigokar & Hingankar, 2022. Plastic brick gives better temperature resistance than conventional brick even after 30 minutes of heating in the corners and the centre of the modal brick (Shrimali and Shikhar, 2017).

Bricks made by recycling soft plastic waste had high pressure withstand capacity and were very lightweight compared to conventional bricks. (Kognole, Shipkule and Survase, 2019) Plastic replaced the clay as a binder, which was much cheaper than ordinary brick, and water absorption capacity was zero percent when crushed waste (0.75 kg) and red soil (2 kg) were mixed. (Kumar, Biswas and Nath, 2020) Bricks made from plastic waste have minimal water absorption compared to conventional bricks (Prasanth, Gopalakrishnan, Thanigainathan, and Kathiravan, 2018). The water absorption capacity of fly ash bricks decreases from 12.714% to 1.8% when plastic waste significantly increases to the fly ash (Belay Wendimu, NeguseFurgasa, & Mohammed Hajji, 2021). The bricks made of plastic met the standard referred by the ASTM and Ethiopian, but it was not recommended on using in the places like kitchens, chimneys and walling purposes because of its low melting capacity. (Manas, 2022) reveals that water absorption and compression strength are more than ordinary bricks (Kadhone, Rajput, Deshmukh, Narkhede & Dhivare, 2022). Plastic bottles had beneficial use on optimization in energy by reducing the degradation of the environment with sustainable waste management. The primary objective of this study was to analyze an efficient way to effectively utilize waste plastic which is a more significant threat to the sustainment of ecological balance, give the knowledge of replacing the traditional construction brocks and compare the properties of the bricks with other construction material.

2. LITERATURE REVIEW

Table 1. *Literature review of waste plastic transformation into bricks*

Authors & Publication Years	Topics of the articles	Objective	Types of journals	Citations counts	Methods	Findings	Future Research
Chauhan, Kumar, Shankar Singh, Khan, Goyal, & Goyal (2019), UMundhe& Dhawale (2018).	1. Fabrication and Testing of Plastic Sand Bricks 2. Use of Waste Plastic as a Construction Material	To create masonry units to replace conventional bricks by recycling plastic.	*International Journal of Engineering and Applied Sciences*	8	Experimental method	The compressive strength of brick is more than conventional clay brick.	Further research is required for the fire resistance of bricks and to improve the quality durability.
Al-Sinan &Bubshait (2022)	Utilization of Plastic waste for Making Bricks	To solve plastic waste by creating bricks made from plastic.	*International Research Journal of Engineering and Technology*	23	Experimental method.	Plastic sand bricks are useful for construction and reduce environmental pollution.	Future research could focus on the cost-effective model of transformation of waste plastic into bricks
Lamba, Kaur, Raj &Sorout (2021) Ogundairo· Olukann, Akinwunmi & Adegoke (2021)	1. Recycling/ reuse of plastic waste as construction material For sustainable development: a review 2. A review of plastic waste as a sustainable resource in civil engineering applications	To use plastic waste as a constituent of construction material To produce high-durability and quality bricks as well as to achieve optimum balance in all aspects, especially in terms of cost and functionality	1. *Environmental Science and Pollution Research* 2. *I.O.P. Conference Series: Materials Science and Engineering*	17	Literature Review Method	Plastic waste may produce construction bricks, concrete blocks, road construction materials, and tiles.	Further research is required to determine the optimum proportion of plastic waste as a constituent of construction materials.
Al-Sinan & Bubshait (2022)	Using Plastic Sand as a Construction Material toward a Circular Economy: A Review	To look at the recent studies regarding the development of plastic sand bricks and the different percentages of plastic and sand used in the bricks.	Reviewed article	4	Literature review method	The compressive strength of the brick increased by increasing the ratio of plastic to sand.	Required further investigation on the types of plastic used and the flammability used in resistance to fire, also, their ick of standard code ta o the definite proportion of sand and plastic use in construct use of the rick.
Kumar Biswas & Nath (2020)	A Study of Manufacturing Bricks Using Plastic Wastes Plastic in Bricks Application	To study the properties of the brick manufactured using plastic waste.	. *International Journal of Trend in Scientific Research and Development*	24	Experimental study	The bricks produced are lightweight, have a smooth surface and fine edges, do not have cracks, and have high crushing strength.	Future research has to focus on finding cost-effective methods to transform the waste plastic into bricks

Authors & Publication Years	Topics of the articles	Objective	Types of journals	Citations counts	Methods	Findings	Future Research
Yusof (2018)	Plastic in Brick Application	To outline the utilization of municipal plastic waste in construction industries	*Trends in Civil Engineering and its Architecture*	2	Literature review method	Plastic waste can be substituted either partially or completely in brick production.	Require further investigation on increasing the durability and quality of bricks
Al-Sinan and Bubshait, (2022)	Using Plastic Sand as a Construction Material toward a Circular Economy: A Review	To look at the recent studies regarding the development of plastic sand bricks and the different percentages of plastic and sand used in the bricks.	*Journal of substantiality and development*	4	Literature Review Method	Plastic brick can be used as an alternative to ordinary brick, which shows competitive results in terms of physical properties (e.g., compressive strength)	More research is required on the physical issue (fire resistance, commercial aspects of plastic brick)
Safinia & Alkalbani (2016)	Use of recycled plastic water bottles in concrete blocks	To research the use of plastic water bottles in concrete blocks.	*Procedia Engineering*	80	Experimental Method	The results show, Concrete blocks made with plastic bottles have 57% higher compressive strength.	Further research is required for concrete mix design and the feasibility of production in the industry to reduce cost.
Velmurugan (2019)	Rebuilding of Plastic Waste to Pavement Bricks	To recycle rich plastic for the concrete block.	*International Research Journal of Engineering and Technology*	6	Experimental Method	The result shows that the best ratio to construct the plastic brick is 30% plastic and 70% sand.	Future research could examine the cost-effective methods of transforming waste plastic into bricks
Sahani et al., (2022)	Mechanical Properties of Plastic Sand Brick Containing Plastic Waste	To utilize unused plastic to prepare plastic sand bricks.	*Advances in Civil Engineering*	35	Experimental Method	The results show that the best ratio to prepare plastic sand brick is 1:4, which has the maximum compressive strength and split tensile strength.	The future researcher may be interested in finding cost-effective methods of transforming waste plastic into bricks
User (2019)	Utilization of Waste Plastic in the Manufacturing of Paver Blocks	To the properties of plastic-made brick.	*International Research Journal of Engineering and Technology*	24	Experimental methods	Plastic sand bricks provide more advantages compared to continental brick in terms of cost efficiency, ultimately removing plastic waste.	On further research, the manufacturing cost could be reduced by replacing river sand with fly ash, quarry dust, or other waste products.

Our review study can create a platform for scholars who might be interested in plastic waste management. The review essay about bricks is significant since it can potentially increase readers' or students' understanding. It provides information on the various processes used in various countries to convert plastic waste into bricks. Among other things, it provides a concept for lowering or regulating the environmental pollution caused by plastics. The main thing that attracted us to this topic was the current context that the entire world is facing regarding plastic waste management. With a limited understanding of waste management, we realized that the waste plastic might be turned into many other construction materials without creating environmental deterioration.

Objective

- To analyze the highly cited articles on the related topics of bricks
- To find key models of the transformation of waste plastic into bricks.
- To analyze the review's main findings, which are based on the literature in Table one.
- To find the research gaps in the models used in converting the waste plastic into bricks
- To compare the properties of bricks with other construction materials.

Scope of the study

- To give new knowledge, replace the binding material of ordinary brick with plastic.
- To enhance the knowledge of how to minimize the cost of bricks compared to ordinary bricks.
- To find efficient ways of managing the non-degradable plastic waste
- To compare the properties of bricks with other construction materials.

Research questions

- What are the highly cited articles on the related topics of bricks?
- What are the key models of the transformation of waste plastic into bricks?
- What are the main findings of the review based on Table one?
- What research gaps exist in the models used to convert waste plastic into bricks?
- What are the different methods of comparing the properties of bricks with other construction materials?

3. METHODS AND MATERIALS

Different articles on converting waste plastic into bricks were studied by reviewing the abstracts of the papers. After that, a few paragraphs of each article give us a general introduction to their problem area. Then, we moved to the last paragraph before the heading "Method," which is usually the first major heading in the text of a research article (Galvan, 1987). This paragraph is a traditional way for researchers to state their specific hypotheses, research questions, or research purposes. Then, we scanned the rest of the article, highlighting all headings and subheadings by scanning the text in each subsection. Our purpose at this point was to get an overview.

It should be noted that by adhering to this rule, we pretreated, which is a method that is frequently suggested by reading specialists as the first step in reading a technical paper. Prereading provided an overview of a report's goal and contents, which helped us focus on the big picture as we worked through the specifics of a research report from start to finish. As recommended in the following guideline, the knowledge we gathered through prereading also assisted us in categorizing the articles (Galvan, 1987). We extract several journals from different sites of google. Our review is primarily based on published materials that examine recent or current literature that can cover a wide range of subjects at different levels of completeness and comprehensiveness of bricks. This literature has concluded research findings on transforming waste plastic into bricks. Our review has primarily focused on authors & publication years, the topic of the reviewed articles, objectives, citation counts, methods used in the articles, findings, and the future recommendation of research on this topic of this review.

4. RESULTS

After looking through numerous papers, articles, reviews and conference papers, we found that the plastic goods being discarded can be turned into different construction materials that can be utilized as binders and fillers for solid and interlocking bricks and tiles. The results highlighted that the compressive strength of brick is more than conventional clay bricks (Chauhan et al. (2019). The result of this study is supported by the study of Murthi et al. (2020), who found that the compressive strength of brick is more than conventional clay brick.

Research question 1. ***What are the highly cited articles on the related topics of plastic bricks?***

The results indicate that the concrete blocks made with plastic bottles have 57% higher compressive strength, and it was cited 79 times. The results further highlighted that the best ratio to prepare plastic sand brick is 1:4, which has the maximum compressive strength and split tensile strength and was cited 35 times. Similarly, the review concludes that Plastic sand bricks provide more advantages than continental bricks in terms of cost efficiency, which also ultimately removes plastic waste and is cited 24 times. The results also highlight that crushed recycled plastic heated until hot melted and mixed with stone dust to mould brick and was cited 23 times (see Table 1).

Research question 2. ***What are the key models of the transformation of waste plastic into bricks?***

The results highlight that the key models of transforming waste plastic into bricks use plastic as a partial filler or a binder material. In a plastic filler process, a small percentage by weight of the plastic was mixed with sand or aggregate with cement, and when plastic was used as a binder, a maximum proportion of sand could be used with sand in brick production (see Table 1).

Research question 3. ***What are the main findings of the review based on Table one?***

The review of different journals finds that the compressive strength and other properties can be increased significantly when plastic is used as a binder with sand. But when it is used as a filler, it produces competitive strength as ordinary bricks and can be used without any restrictions or hesitation. The results highlighted that the compressive strength of brick is more than conventional clay brick, and plastic sand bricks are useful for construction and reduce environmental pollution. Additionally, the results show that plastic waste may produce construction bricks, concrete blocks, road construction materials, and tiles, and further reveal that the compressive strength of the brick increased by increasing the ratio of plastic to sand.

It was found that the bricks produced are lightweight, have a smooth surface and fine edges do not have cracks, and have high crushing strength. Plastic waste can be substituted either partially or completely in brick production. It was found that plastic

brick can be used as an alternative to ordinary brick, which shows competitive results in terms of physical properties (e.g., compressive strength). The results indicate that the concrete blocks made with plastic bottles have 57% higher compressive strength. Finally, the result shows that the best ratio to construct the plastic brick is 30% plastic and 70% sand, and also shows that the best ratio to prepare plastic sand brick is 1:4, which has the maximum compressive strength and split tensile strength (see Table 1).

Research question 4. ***What research gaps exist in the models used to convert waste plastic into bricks?***

The results highlight a research gap in examining the fire resistance of bricks to improve the quality durability and could focus on the cost-effective model of transforming waste plastic into bricks. There is also a research gap in determining the optimum proportion of plastic waste as a constituent of construction materials. There is also a research gap on what types of plastic could be used and the flammability used in resistance to fire, also, their ick of standard code ta o the definite proportion of sand and plastic use in construct use of the rick. There is a research gap in finding cost-effective methods to transform waste plastic into bricks, and increasing the durability and quality of bricks has to be conducted. The results indicate that a research gap was to conduct more research on the physical issue (fire resistance, commercial aspects of plastic brick). It is also expected to do further research on concrete mix design and the feasibility of production in the industry to reduce costs. There is a research gap in examining how the manufacturing cost could be reduced by replacing river sand with fly ash, quarry dust, or other waste products (see Table 1).

Research question 5. What are the different methods of comparing the properties of bricks with other construction materials?

The results highlighted that plastic usage in our daily life had increased significantly due to urbanization as it is an advantageous and popular material. The only disadvantage is non-biodegradability. This study summarizes the work done by authors to use plastic as construction material in bricks. The recyclable properties of plastic waste can be utilized to recycle this waste and produce a new product having a lesser negative impact on the environment. One of the options to recycle plastic waste is to form bricks of plastic by mixing plastics with sand which can be used to replace traditional bricks.

The results indicate that various authors performed a comparative study with brick made up of other materials by using various testing methods. For example, scratch test, compressive test, apparent porosity, water absorption, apparent porosity test, soundness test, and efflorescence test and analyzed that further research in this field can enrich the strength, quality and durability of these masonry bricks. These bricks absorb less water compared to conventional bricks, which is also incredibly significant in the view of environmental sustainability. The results highlighted that using waste materials in construction materials had shown enormous potential. Although some properties may decrease when the waste fibres are added, the slightly lower properties compared to the cost and energy saved could be a sustainable and environmentally beneficial trade-off. In some cases, the processing cost for recycling and utilizing the waste materials may be higher than the typical cost of virgin materials, which limits their appeal for usage (see Table 1).

5. DISCUSSION AND CONCLUSION

When crushed waste plastic (0.750 kg) was melted and mixed with river sand (2kg), a brick's compressive strength and water absorption capacity were 97.5k N/m^2 and 3%, respectively**.** But on mixing the red soil (2 kg) with crushed and melted waste plastic (0.750 kg), the compressive strength and water absorption capacity of a brick obtained were 26 kN/m^2 and 0%, respectively (Kognole, Shipkule & Survase, 2019). The average compressive strength and split tensile strength of a plastic sand brick of ratio 1:3,1:4, and 1:5 are 9.72 N/mm^2 and 737.486 MPa, 12.28 N/mm^2 and 804.53 MPa,3.39 N/mm^2 and 654.25 MPa respectively. The compressive and split tensile strength increases with a reduction in the percentage of plastic from 25% to 20%. Sahani et al., (2022)

Our review found that the transformation of waste plastic into bricks primarily focused on environmentally friendly solutions, which eventually reduce the cost of production and manage our community's waste plastic. Future research is expected to examine the topic of this study to foreground the understanding of the different models of transforming conventional brick into plastic brick. We are reflected for the future primary study based on the cost-effective experimental model to convert waste plastic into bricks.

ACKNOWLEDGEMENT

We want to recognize our family members' love and affection in the article's writing. Our seniors kept telling us; we are a writer." It was very inspiring for our writing. Our teachers and department always inspire us to go ahead. We express our sincere thanks to the Department of Civil Engineering. We would also like to acknowledge the help of the RMC of OCEM for the continuous support of our paper.

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