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A REVIEW ON UTILIZATION OF PLASTIC WASTE MATERIALS IN BRICKS AS A CONSTRUCTION MATERIAL

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ABSTRACT

In less than a century, the world has become inundated with plastic. With an annual production surpassing 359 million tons, the convenience and durability of plastics have come at a steep environmental and health cost. This study explores the potential of repurposing plastic waste as a sustainable building material. By incorporating recycled plastic into brick formulations, we aim to reduce environmental pollution and promote a more sustainable construction industry. Through comprehensive comparative analyses, including tests for scratch resistance, porosity, and water absorption, we evaluated the performance of these innovative plastic-based bricks. Our findings demonstrate that these bricks can offer comparable or even superior properties to traditional clay bricks, while significantly reducing the ecological footprint of the construction sector.

Keywords:

Plastic waste, conventional bricks, compressive strength, filler, binder.

I. Introduction

The globalization era has witnessed a dramatic increase in plastic waste generation, posing significant environmental threats to wildlife, humans, and agricultural land. The persistent nature of plastic pollution remains a major challenge. The pervasive use of plastics in sectors such as agriculture, automotive, electronics, and construction has reshaped our modern world. However, the environmental consequences of plastic waste, particularly the 5% found in municipal solid waste, are alarming. By repurposing plastic waste into bricks, a cornerstone of the construction industry, we can mitigate plastic pollution and pave the way for a more sustainable future. Plastic consumption has surged nearly 180-fold since 1950, reaching a staggering 400.3 million tons in 2022..[1] The escalating demand for plastic, driven by rapid urbanization, economic growth, and population explosion, is set to exacerbate the plastic waste crisis. This alarming trend, characterized by exponential growth in plastic production, poses a significant threat to the environment and human health.. The migration of people to urban areas is accompanied by a rise in plastic consumption. Furthermore, economic prosperity often drives increased production and consumption of plastic products, exacerbating the issue of plastic waste. The Central Pollution Control Board (CPCB) of India classifies plastic waste as any plastic item that has become obsolete or is no longer functional. While the U.S. is projected to consume plastic at a rate 2.7 times higher than India in 2023, this disparity is expected to diminish substantially over the next few decades. India's plastic consumption is poised to quadruple between 2023 and 2053, resulting in a 4.5fold increase in plastic waste generation. Figure 01 Projects the expansion of plastic consumption in the United Nations, India, China, and Canada between 2023 and 2060, as per OECD data.



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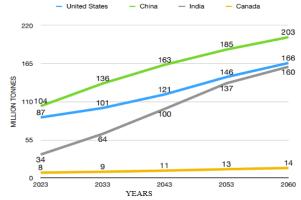


Fig: 01: Forecast of plastic consumption

Sand and gravel extraction, essential for construction and infrastructure, has become a significant environmental concern. These resources, often sourced from rivers, deltas, and coastlines, are critical for producing concrete, asphalt, and other building materials. However, the extraction process is frequently unregulated, leading to severe environmental degradation. In many regions, over-exploitation of sand and gravel has caused the depletion of riverbeds, erosion of coastlines, and disruption of aquatic ecosystems. Moreover, the illegal sand trade has become a booming industry, driven by the increasing global demand for construction materials, further exacerbating environmental harm.

Given these environmental challenges, sustainable alternatives are urgently needed. One such solution is plastic sand, an innovative material that has emerged as a promising substitute for traditional sand in construction. Plastic sand is made by incorporating plastic waste into construction materials, offering a more eco-friendly and sustainable option compared to conventional sand. Unlike traditional sand-cement concrete, which is difficult and expensive to recycle, plastic sand can be easily repurposed and recycled, addressing both waste management and construction needs.

Research has shown that using plastic waste in construction materials can have several advantages. For instance, incorporating plastic waste into fly ash bricks significantly reduces their water absorption capacity. In one study, the water absorption of fly ash bricks was reduced from 12.714% to just 1.8% by incorporating plastic waste. This reduction not only enhances the durability of the bricks but also makes them more efficient in terms of moisture resistance.

Further studies have highlighted the potential of plastic-based bricks, demonstrating that they offer superior water absorption and compressive strength compared to traditional bricks. Manas (2022) found that plastic-based bricks exhibited enhanced performance, suggesting that plastic waste can be used to produce high-quality building materials.

Additionally, experiments by Ibrahim Almeshal on the use of plastic waste as a partial replacement for sand in concrete have shown promising results. By gradually increasing the proportion of plastic waste, up to 50%, the resulting concrete was lighter, yet maintained or even improved its mechanical strength. These findings suggest that plastic waste can be used not only as a sand replacement but also as an additive that enhances the properties of concrete, making it a viable option for sustainable construction. While the benefits of plastic waste in construction materials are clear, further research is necessary to optimize its use. Studies should focus on determining the ideal proportion of plastic waste for various construction applications, including brick and concrete formulations, to ensure both mechanical strength and long-term durability. Such research could pave the way for more sustainable building materials, reducing reliance on sand extraction while addressing the growing global plastic waste problem.

II. Literature Review

Authors &	Topics of the	Main	Key Findings	Future Scope
Publication Years	articles	Objective		



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Narkhede, Aadeshof Bricksplastic wastesignificantlymaterials, as wellDhivare, Prof. J. Aand determineimproved brickas conduct a	Ushikesh	Manufacturing	made with	by weight	proportions and
	Narkhede, Aadesh		plastic waste	significantly	materials, as well
-	Dhivare, Prof. J. A		-	•	as conduct a
	,2022 [9]			properties,	



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		the optimal	suggesting an	comprehensive
		PET dosage.	optimal dosage.	economic analysis.
Sahani, Kameshwar	Mechanical	To investigate	The study revealed	Future research
Joshi, Bhesh Raj	Properties of	the physical	that a 1:4 mortar	could explore
Khatri, Kabiraj	Plastic Sand	and	ratio yielded	different mix
Magar, Abiraj Thapa	Brick	mechanical	optimal	proportions and
Chapagain, Sabin	Containing	properties of	compressive	materials, as well
Karmacharya,	Plastic Waste	plastic sand	strength.	as conduct a
Nabanita,2022,[10]		bricks with	Importantly, all	comprehensive
		plastic-to-sand	brick samples,	economic analysis.
		ratios of 1:3,	irrespective of	
		1:4, and 1:5.	mortar ratio,	
			showed zero water	
			absorption and	
			efflorescence.	
Turkeswari	Reusing	To assess the	The study found	Future research
Uvarajan, Paran	plastic waste	recent	that incorporating a	should focus on
Gani, Ng Chuck	in the	applications	limited amount of	fire resistance,
Chuan & Nur Hanis	production of	of recyclable	PW can improve	flexural strength,
Zulkernain,2022,[11]	bricks and	plastic waste	compressive	leaching, and skid
	paving blocks:	(PW) as a raw	strength and reduce	resistance to fully
	a review	material and	water absorption,	assess performance
		aggregate in	but excessive PW	and durability.
		brick and	content can	5
		paving block	negatively impact	
		production.	overall strength.	
Al-Sinan, Mazen A.	Using Plastic	To explore	The study	Future research
Bubshait, Abdulaziz	Sand as a	recent	concluded that	could explore
A.,2022,[2]	Construction	advancements	plastic sand bricks	various plastic
,	Material	in using	offer a promising,	types and
	toward a	plastic-sand	sustainable, and	proportions, as
	Circular	mixtures in	cost-effective	well as long-term
	Economy: A	construction.	building material.	performance.
	Review		e unung muteriun	periormanee.
Aneke, Frank	Strength and	To develop	WM-bricks	Future research
Ikechukwu	durability	and assess the	showed significant	could explore
Shabangu,	performance	performance	improvements in	different plastic
Celumusa,2021, [12]	of masonry	of waste	tensile (70.15%)	waste types and
	bricks	masonry	and compressive	sand aggregates.
	produced with	bricks made	(54.85%) strength	suite aggregates.
	crushed glass	with PET	compared to	
	and melted	plastic waste	traditional clay	
	PET plastics	and recycled	bricks.	
	i Ei piusiico	crushed glass.	oriens.	
Belay Wendimu,	Suitability and	To assess the	The study found	Future research
Tarekegn	Utilization	feasibility of	that Plastic Waste	should focus on
Neguse Furgasa,	Study on	using HDPE	Bricks met	improving the fire
Beneyam	Waste Plastic	plastic waste	Ethiopian and	resistance of
Mohammed Hajji,	Brick as	for brick	ASTM standards	plastic waste
Bonsa,2021,[3]	Alternative	production.	for compressive	bricks.
D0115a,2021,[3]	Alternative	production.	101 compressive	UTICKS.



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	Construction Material		strength (Class A and SW grade), but	
			their low fire	
			resistance and	
			melting point limit	
			their use in	
			applications like	
			kitchens or	
			chimneys.	
Murthi, P.	Development	To assess the	The study found	By varying the
Bhavani, M.	of relationship	compressive	that using bricks	percentage of rice
Musthaq, Md	between	strength of	with a 1:5 mortar	husk ash,
Saqlain	compressive	brick	mix increased	innovative cement-
Jauhar, Md Osman	strength of	masonry.	masonry strength	rice husk ash
Devi, V. Rama,2020,	brick masonry		to 3.288 MPa.	blended masonry
[13]	and brick		Even with strong	mortars can be
	strength		bricks and weak	developed
			mortar, masonry	-
			strength remained	
			relatively high.	
Erande, Dikshita	Manufacturing	To assess the	The test results	Future research
Mohite, Tejashree	of Paver	compressive	showed that bricks	could explore
Sayyed, Aafreen	Block by	strength and	made with a 1:1:1	different paver
Patil, Kiran	using Waste	water	ratio of plastic	block shapes and
Khaire, Chaitanya	Plastic	absorption of	waste, quarry dust,	mix designs.
Chaitanya Khaire,		plastic paver	and sea sand had a	
,2020,[14]		blocks.	compressive	
			strength of 12.27	
			N/mm².	
Kumar, Rishabh	A review on	To summarize	The authors	The review can be
Kumar, Mohit	utilization of	research on	summarize the	expanded to
Kumar, Inder	plastic waste	using plastic	research	include more
Srivastava,	materials in	as a	methodology,	articles.
Deepa,2020,[15]	bricks	construction	experimental work,	
	manufacturing	material in	and positive	
	process	bricks.	impacts on	
			mechanical	
17 4		- F	properties.	
Kumar, Aman	A Study of	То	Plastic bricks	Future research
Biswas, Mainak	Manufacturing	manufacture	revolutionize	could explore
Nath,	Bricks Using	and analyze	traditional building	different plastic
Debarshi,2020,[16]	Plastic Wastes	bricks made	materials with a	dosages.
		with waste	compressive	
		LDPE and	strength of 5 MPa,	
		fine	low water	
		aggregates.	absorption of	
			1.5%, and significant cost	
			savings compared	
			to earthen bricks.	
			to cartifoli blicks.	



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Almeshal, Ibrahim	Eco-friendly	This study	Adding waste	Future research
Tayeh, Bassam A.	concrete	aims to	plastic to concrete	should investigate
Alyousef, Rayed	containing	investigate the	decreased	the impact of
Alabduljabbar,	recycled	use of PET as	workability and	different plastic
Hisham	plastic as	a partial sand	compressive and	particle sizes and
Mohamed,	partial	replacement	flexural strength,	shapes on brick
Abdeliazim	replacement	in concrete.	but significantly	properties.
Mustafa,2020,[5]	for sand		increased split	
			tensile strength by	
			10-85%.	

III. Objectives

- Review the state-of-the-art in brick production research.
- Synthesize key insights and conclusions from the literature.
- Determine the areas where current approaches for utilizing waste plastic in brick production require further development.

IV. Outcomes of present critical review

The key outcomes are as follows.

1. The research findings indicate that plastic sand bricks offer a more economical solution while addressing the pressing issue of plastic waste. Additionally, the study reveals a promising technique involving the heating, melting, and mixing of crushed recycled plastic with stone dust to produce bricks.

2. The analysis of multiple research papers indicates that incorporating plastic as a binding agent with sand significantly enhances the compressive strength and other properties of bricks. Conversely, when used as a filler, plastic produces bricks with comparable strength to traditional ones, enabling their unrestricted use. The results highlight the superior compressive strength of plastic sand bricks compared to conventional clay bricks, offering a sustainable and effective solution for construction.

3. The study underscores the need for further research to develop cost-effective methods for converting waste plastic into bricks and to enhance their durability and quality. The findings reveal a dearth of research on the physical properties of plastic-based bricks, emphasizing the need for in-depth investigation into concrete mix design and the feasibility of large-scale production to minimize costs. **Conflict of interest**

The authors declare no conflicts of interest, including financial or other relationships that may bias the work. All authors have made substantial contributions to this research and have approved the final manuscript. This work has not been previously published or submitted for publication elsewhere.

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