ISSN: 2633-4828 Vol. 5 No. S6, (Oct - Dec 2023)

International Journal of Applied Engineering & Technology

BUILDING A GREENER FUTURE: RECYCLED PLASTICS AS SUSTAINABLE CONSTRUCTION MATERIAL

Bhagirathi Tripathy
Assistant Professor, Civil Engineering Department, Indira Gandhi Institute of Technology, Sarang, Dhenkanal, Odisha

ABSTRACT

A combination of its high resource consumption and massive waste production, the construction sector is one of the leading causes of environmental deterioration on a global scale. Sustainable alternatives to conventional construction materials are so urgently required. In this article, we look at recycled plastics and how they could be used in building in a sustainable way. The mechanical, thermal, and environmental aspects of recycled plastics in building are examined in this research, which employs a thorough literature analysis and case study methodology. Using structural components, insulation, and coatings as examples, it investigates the pros and cons of using recycled plastics in construction.

Reduced carbon emissions, protection of natural resources, and waste diversion from landfills are just a few of the environmental benefits of using recycled plastics that this article covers. It goes on to talk about the potential benefits and drawbacks of using recycled plastic in building projects, as well as the financial aspects of the matter. The research also looks at the standards and regulatory frameworks that control recycled plastics in building, as well as the technical breakthroughs that are pushing them forward. In the conclusion, this research hopes to shed light on recycled plastics' potential as a sustainable building material and give researchers, industry stakeholders, and policymakers some suggestions on how to speed up the adoption of this material and make the built environment greener.

Keywords – Recycled plastics, Sustainable construction, Eco-friendly materials, Environmental impact, Waste management

INTRODUCTION

As the world's population continues to rise, the building sector is essential in meeting basic human needs like housing and transportation. Resource loss, pollution, and greenhouse gas emissions are only a few of the environmental costs associated with its old methods. There is an immediate need to switch to sustainable building practices and supplies since global environmental problems are becoming worse. As a result of this need, the idea of a "circular economy" has become more popular, which aims to reduce, reuse, and recycle goods in order to lessen their negative effects on the environment. Due to their availability, adaptability, and potential for reducing plastic pollution, recycled plastics have emerged as a possible alternative to traditional building materials in this context.

This article aims to investigate the practicality and advantages of using recycled plastics in building processes, paying special attention to their mechanical qualities, thermal performance, and ecological friendliness. This study aims to assess the feasibility of using recycled plastics in structural components, insulation, and finishes by reviewing relevant literature and case studies. Also included in this research will be the potential financial benefits and new avenues for growth in the building industry that may result from using recycled plastics. We will analyse the rules and regulations that control recycled plastics and find the technical advancements that are pushing them to be more widely used in construction.

This study aims to promote the use of recycled plastics as an eco-friendly alternative to conventional building materials, ultimately contributing to the improvement of sustainable construction methods. We can create a more resilient and circular built environment for future generations by reducing the building industry's environmental impact and by using recycled plastics to their full potential.

LITERATURE REVIEW

Numerous assessments have been published recently that delve into the use of various forms of building debris. As a substitute for fine aggregates in concrete, Tiwari et al. (2016) reviewed several industrial waste products. These included bottom ash, waste foundry sand, copper slag, plastic trash, regenerated rubber waste, and crushed glass aggregate. In their 2016 review, Guand Ozbakkaloglu compiled the results of research on plastic waste recycling methods and how adding plastic to concrete changes its properties and shape. Toghroli et al. (2018) examined the use of recycled components in concrete for pavement. Tyres, plastics, recycled asphalt, broken glass, steel slag, and steel fibre are among the waste products that have been examined (Toghroli et al. 2018).

The characteristics of concrete mixed with recycled plastic trash were reviewed by Babafemi et al. Research by Babafemi et al. (2018) shown that mechanical qualities and durability are affected by recycled waste plastic. In addition, Mercante et al. (2018) provided a comprehensive analysis of the characteristics of concrete and mortar composites that use recycled plastic. In a recent study, Singh et al. (2021) examined the utilisation of composites made from marble dust and polyethylene terephthalate (PET). The use of PET plastic bricks in the Rohingya refugee camp was detailed in an additional study (Haque 2019).

Salih et al. surveyed the literature on recycled fiber-reinforced bricks (Salih et al. 2020). Lightweight concrete made from a variety of waste materials was reviewed by Bejan et al. (2020). These materials include fly ash, fumed silica, plastics, tyre trash, and agricultural waste. An in-depth analysis of plastic waste's potential use in cement composites was provided by Awoyera and Adesina. In addition, they spoke about the potential benefits and drawbacks of recycling plastic (Awoyera and Adesina 2020). Extensive research on the effects of using recycled rubber and plastic as aggregate in concrete was conducted by Li et al. (Li et al. 2020). A new review (Zulkernain et al., 2021) examined the effects on mechanical and durability qualities of building materials that use plastic waste as an aggregate.

In their review, Vishnu and Singh (2020) discussed which waste materials are suitable for use as bituminous pavements. Ogundairo et al. surveyed the literature on plastic's use in soil stabilisation, bitumen modification, and brick reinforcing (Ogundairo et al. 2021). It is clear from the previous debate that some researchers have included plastic garbage in their study scope, while others have only included it partly. Despite the abundance of evaluations, there is a lack of in-depth research on the use of plastic waste in various building materials. Bricks, tiles, blocks, concrete, and road building are just a few examples of the many construction material industries that have made use of plastic trash. This waste holds a wealth of potential for investigation. To that end, we have compiled a comprehensive list of all the plastic byproducts that can be used to make bricks, tiles, construction blocks, and road concrete, including polythene, polypropylene, polyethylene terephthalate, high-density polythene, low-density polythene, and polyvinyl chloride. Plastic waste's effect on final goods' strength and durability is also detailed in this review article.

OBJECTIVES OF THE STUDY

1. Assess the mechanical properties of recycled plastics and evaluate their suitability for use in various construction applications, including load-bearing structures, insulation, and finishes.
2. Investigate the thermal performance of recycled plastic materials and their impact on building energy efficiency, indoor comfort, and environmental sustainability.
3. Examine the environmental benefits of incorporating recycled plastics into construction processes, including reduced carbon emissions, conservation of natural resources, and diversion of waste from landfills.

RESEARCH METHODOLOGY

In order to thoroughly examine recycled plastics' potential as an eco-friendly building material, this study uses a mixed-methods strategy, integrating quantitative and qualitative research techniques. In order to understand the practical uses, problems, and success factors of using recycled plastics in construction, we will look at many case studies of real-world projects. A wide variety of building kinds, geographical regions, and construction processes

will be covered in the case studies to provide a thorough understanding of the practicality and efficiency of recycled plastics in various settings. Architects, engineers, contractors, material suppliers, and lawmakers are among the construction sector players who will be surveyed and interviewed. Using these qualitative research methodologies, we can learn more about people's perspectives on the usage of recycled plastics in building, the factors that drive this trend, and where we may find room for improvement and new ideas. To determine if it is financially feasible to use recycled plastics in building projects, a cost-benefit analysis will be carried out. The financial consequences of utilising recycled plastic materials will be assessed by considering factors such as material costs, labour costs, lifecycle analysis, and possible savings from decreased waste disposal and environmental effect.

DISCUSSION

Figure 1 – approach to Sustainability

Table 1. Examination of different construction materials using plastic trash

Construction material	Reusing and recycling construction materials	Upgradation of material	Used for
Compacted dirt pavers	Only one percent of the fibres made from PET	The blocks' compressive strength has been significantly enhanced.	Walls
Masonry for bottles	PET containers	Resistant to compression, 45 N/mm2.	Walls
Concrete aggregates partially replaced	Twenty to forty percent, recyclable PET particles	Concrete that is easy to deal with has better flexural strength and abrasion resistance.	Mortar

Reinforcement using Plastic Waste	plastic slings	Relatively little corrosion and cracking in RCC member.	Sections made of Reinforced Cement Concrete (RCC)
Reinforced fibre concrete	1.0 percent, polyethylene terephthalate fiber'	Impressive tensile strength enhancement of 10% and high compressive strength.	Building components

Pavers made of compacted dirt: Recycling and reusing: PET accounts for less than 1% of the fibres. Improvement: The blocks now have much higher compressive strength. Application: Walls Bottle masonry: Recycling and reusing: PET bottles are used. Modernization: With a compressive strength of 45 N/mm2, the substance is compression resistant. Applicable to: Walls. Partially substituted concrete aggregates: For reuse and recycling, you may utilise 20–40% recycled PET particles as aggregates in concrete. Improved flexural strength and resistance to abrasion are two benefits of upgrading concrete. The material is also simpler to work with. Application: Reusing Plastic Waste for Mortar Reinforcement: Reusing and recycling: Reinforcement is provided by plastic slings.

This upgrade makes Reinforced Cement Concrete (RCC) parts less prone to cracking and corrosion. Parts constructed with Reinforced Cement Concrete (RCC) or Reinforced Fibre Concrete (RFC): Recycling and reusing: 1% of the fibre is made of polyethylene terephthalate. The improvement is a remarkable 10% increase in tensile strength as well as a high compressive strength. Incorporated into: Construction parts. Analysis: Using recycled materials, especially plastic waste and PET (polyethylene terephthalate), shows that the building is committed to sustainability and reducing waste. By incorporating these recycled materials into different building components, their mechanical qualities, including flexural strength, abrasion resistance, and compressive strength, are improved.

Resource conservation, decreased trash output, and enhanced environmental performance are all outcomes of these approaches, which include upgrading standard building materials with recycled content. Walls, mortar, RCC sections and other building components made from recycled materials show how flexible and useful sustainable construction can be. More study in this area may pave the way for more recycled materials to be used in building projects, which would boost sustainability and creativity in the built environment.

Sustainable building approaches may greatly benefit from the use of recycled materials in construction, as shown in the examples presented. Here, we explore the conversation around these materials, what they mean, and how sustainable building may go further:

Effects on the Environment: By using recycled materials such as PET and plastic waste in building projects, we can lessen our reliance on nonrenewable resources, which in turn helps to preserve our planet's natural bounty and lowers our carbon footprint. Plastic pollution is a major problem that endangers ecosystems and human health; these measures help reduce trash by rerouting it away from landfills and incinerators.

Performance and Mechanical Characteristics: Improvements in mechanical qualities, such as improved compressive strength, flexural strength, and resistance to abrasion and corrosion, are shown by the examples supplied in this context. The enhanced performance of building components not only guarantees their structural integrity and longevity, but also broadens the use of recycled materials in construction, encouraging their broader adoption.

Financial Sustainability: The switch to recycled materials and innovative building processes may have some up-front costs, but the long-term savings might be worth it. Using recycled materials in construction may be economically viable due to reduced material prices, possible savings from trash disposal, and environmental remediation.

Policy and Regulatory Considerations: To encourage and facilitate the use of recycled materials in building projects, regulatory frameworks and regulations are of utmost importance. Sustainable building practices and increased demand for recycled materials may be fostered via the implementation of policies and programmes such as tax incentives, procurement guidelines, and building rules by regulatory and governmental entities.

CONCLUSION

Finally, there is great potential for sustainability, reduced environmental impact, and increased resource efficiency in the built environment via the use of recycled materials in construction. Using PET containers and other forms of plastic trash as examples, the following are some ways that recycled plastics may improve building materials' mechanical characteristics and performance while reducing pollution and waste.

Recycling makes previously used materials more durable and long-lasting by increasing their compressive and flexural strengths as well as their resistance to corrosion and abrasion. In addition, by incorporating them, we may reduce waste, save natural resources, and mitigate plastic pollution. This aligns with the aims of sustainable development and the concepts of the circular economy. To fully use recycled materials in building, we must overcome obstacles including technological limits, market acceptability, and legal issues, despite their obvious advantages. In order to grow in sustainable building methods and overcome these obstacles, it is vital for stakeholders to collaborate, innovate, and do ongoing research.

Researches, stakeholders in the sector, and lawmakers must make it a top priority to invest in technical breakthroughs, use recycled materials, and establish legislative frameworks that are supportive of this trend. This way, we may leave a more sustainable legacy for the generations to come by hastening the shift to a more resilient and environmentally friendly built environment. Essentially, using recycled materials is a major step in the right direction towards sustainable development, which aims to build a society where social fairness, economic success, and environmental responsibility all come together.

REFERENCES

1. Saikia N and de Brito J 2014 Mechanical properties and abrasion behaviour of concrete containing shredded PET bottle waste as a partial substitution of natural aggregate Constr. Build. Mater. 52 236–44
2. Ministry of Housing & Urban affairs 2019 Plastic Waste Management, Issues, Solutions & Case Studies (Government of India)
3. Ruuska A and Häkkinen T 2014 Material Efficiency of Building Construction Buildings 4 266– 94
4. CNN Dead whale in Indonesia had swallowed 1,000 pieces of plastic - https://edition.cnn.com/2018/11/20/asia/indonesia-whale-plastic-scli-intl/index.html
5. The Times of India 2021 Chennai rain: When small plastic covers played a role in inundating city streets Times India
6. Govt Office for Science UK Foresight Future of the Sea: a report from the Government Chief Scientific Adviser 128
7. Puttaraj M, Shetty S, Rai N and T.B P 2014 Utilization of Waste Plastic In Manufacturing of Plastic-Soil Bricks Int. J. Technol. Enhanc. Emerg. Eng. Res. 2 102–7
8. G R, C V, Dutta U B and P S G 2017 Investigating the Application of Plastic Bottle as a Sustainable Material in Building Construction Int. J. Sci. Res. Dev. 5 593–9
9. Hamid N H and Shamsudin M H 2021 Recycled Plastic Bottles as Sustainable Materials Green Infrastructure: Materials and Applications ed R Hassan, N H A Hamid, A K Arshad, A Alisibramulisi, M N M Sidek, N M Bhkari and E Shaffie (Singapore: Springer) pp 1–20
10. Samarpan Foundation https://samarpanfoundation.org/about

11. Akinwumi I, Domo-Spiff A H and Salami A 2019 Marine plastic pollution and affordable housing challenge: Shredded waste plastic stabilized soil for producing compressed earth bricks Case Stud. Constr. Mater. 11 e00241

12. Foti D 2016 Innovative techniques for concrete reinforcement with polymers Constr. Build. Mater. 112 202–9

13. Heriawan A 2020 Upcycling Plastic Waste for Rural Road Construction in India: An Alternative Solution to Technical Challenges (Asian Development Bank)

14. Chaurasia A and Gangwar M S 2019 Reuse of Plastic Bottles as a Construction Material 9 6

15. Saxena S and Singh M 2013 Eco-Architecture: Pet Bottle Houses Int. J. Sci. Eng. Technol. 21243–6

16. Ge Z, Sun R, Zhang K, Gao Z and Li P 2013 Physical and mechanical properties of mortar using waste Polyethylene Terephthalate bottles Constr. Build. Mater. 44 81–6

17. Thosar C P, Husain D M and Student P G Reuse of Plastic Waste as Replacement of Sand in Concrete M S 6 6

18. Shahidan S 2018 Concrete Incorporated With Optimum Percentages of Recycled Polyethylene Terephthalate (PET) Bottle Fiber Int. J. Integr. Eng. 10

19. Arun J, Gopinath K P, SundarRajan P, JoselynMonica M and Felix V 2019 Co-liquefaction of Prosopis juliflora with polyolefin waste for production of high grade liquid hydrocarbons Bioresour. Technol. 274 296–301