E-ISSN: 2707-8310
P-ISSN: 2707-8302
Journal's Website
IJHCE 2027; 7(1): 14-16
Received: 15-10-2025
Accepted: 20-11-2025

Jakub Nowak
Faculty of Engineering, University of Nairobi, Nairobi, Kenya

Sara Lopez
Faculty of Engineering, University of Nairobi, Nairobi, Kenya

David Kimani
Faculty of Engineering, University of Nairobi, Nairobi, Kenya

Corresponding Author:
Jakub Nowak
Faculty of Engineering, University of Nairobi, Nairobi, Kenya

Green Building Materials for Sustainable Civil Engineering Practices

Jakub Nowak, Sara Lopez and David Kimani

DOI: https://www.doi.org/10.22271/27078302.2026.v7.i1a.79

Abstract
The increasing demand for sustainable construction has prompted the exploration of green building materials in civil engineering. These materials, known for their environmental benefits, are crucial in reducing the carbon footprint of construction processes. This paper explores the types, benefits, and challenges of using green building materials, with a focus on their role in sustainable civil engineering practices. Green building materials include recycled products, natural substances, and innovative materials designed to minimize environmental impact. These materials offer energy conservation, resource efficiency, and waste reduction benefits. However, several challenges, including higher initial costs and lack of awareness among stakeholders, hinder the widespread adoption of these materials. The objective of this research is to examine the potential of green building materials in promoting sustainable construction, highlighting their environmental, economic, and social benefits. The research also aims to explore the barriers to their adoption and propose strategies for overcoming these challenges. By focusing on the role of green building materials in sustainable civil engineering, this paper intends to contribute to a broader understanding of how the construction industry can align with global sustainability goals. The findings suggest that the adoption of green building materials is not only feasible but also essential for the future of the construction industry, with significant long-term environmental and economic benefits. The paper concludes by emphasizing the need for policy changes, education, and further research to facilitate the integration of these materials into mainstream construction practices.

Keywords: Green building materials, sustainable construction, environmental impact, civil engineering, energy conservation, resource consumption, waste reduction

Introduction

Sustainability has become a pivotal concern in the construction industry, with green building materials emerging as a key solution to reduce the environmental footprint of buildings [1]. These materials, which include recycled products, natural substances, and high-performance alternatives, offer substantial benefits over traditional construction materials. The global push towards sustainability is driven by the recognition that conventional construction practices significantly contribute to environmental degradation, particularly through the excessive use of non-renewable resources and the generation of waste [2]. As urbanization accelerates, the demand for construction materials increases, further exacerbating the strain on natural resources and the environment. Consequently, there is an urgent need to explore sustainable alternatives that can mitigate these impacts [3].

The problem lies not only in the availability of such materials but also in the widespread adoption of green building practices. High initial costs, limited knowledge among stakeholders, and a lack of standardized regulations present significant barriers to the widespread implementation of green building materials [4]. Despite these challenges, the use of these materials can yield long-term environmental and economic benefits, including reduced energy consumption, lower greenhouse gas emissions, and reduced dependence on raw materials [5].

This paper aims to examine the potential of green building materials in promoting sustainable construction practices. Specifically, it will explore the different types of green building materials, their environmental and economic impacts, and the challenges that hinder their adoption. The hypothesis underlying this research is that, while the adoption of green building materials faces several challenges, the long-term benefits outweigh the costs, making them a feasible and essential component of sustainable civil engineering practices [6].

The research will also identify strategies to overcome these challenges and facilitate the integration of green building materials into mainstream construction [7].

Materials and Methods

Materials

The materials used in this research primarily consisted of green building materials that are widely available and commonly used in sustainable construction. These include recycled concrete aggregates, eco-friendly cement (e.g., geopolymer cement), natural building materials such as bamboo and straw bales, and innovative products like mycelium-based bricks. Recycled concrete aggregates were sourced from demolition sites to minimize waste and reduce the environmental footprint of new concrete production [1]. Eco-friendly cement was used for its reduced carbon emissions during production compared to traditional Portland cement [2]. Bamboo and straw bales were selected for their renewable nature and low embodied energy [3]. Additionally, mycelium-based bricks were chosen for their biodegradability and potential for large-scale sustainable production [4]. All materials were procured from certified suppliers ensuring compliance with environmental standards, and their environmental impact was assessed through life cycle analysis (LCA) to evaluate their sustainability metrics, including carbon footprint and energy consumption [5].

Methods

The research involved a combination of quantitative and qualitative methods to assess the performance and potential of green building materials. First, an extensive literature review was conducted to identify the most commonly used green building materials and their properties [6]. A sample of each material was tested in the laboratory for its physical properties, including compressive strength, thermal conductivity, and moisture absorption [7]. These tests were carried out according to ASTM standards [8]. The environmental performance of the materials was assessed using life cycle assessment (LCA) software to calculate the total energy consumption and carbon emissions associated with the production, transportation, and use of these materials [9]. Furthermore, a survey was conducted among 50 construction professionals to gauge their awareness and willingness to adopt green building materials. Statistical analysis, including t-tests and regression analysis, was employed to compare the performance of traditional and green materials, while the survey data were analyzed using descriptive statistics and correlation coefficients [10].

Results

The analysis of the data revealed significant differences in the performance of green building materials compared to traditional construction materials. Table 1 presents the compressive strength of the different materials tested. Green building materials such as recycled concrete aggregates (RCA) and eco-friendly cement demonstrated a 15-20% lower compressive strength compared to traditional concrete [1]. However, when analyzed for their thermal conductivity, bamboo and straw bales exhibited superior insulation properties, reducing energy consumption in buildings by up to 30% [6].

Table 1: Compressive Strength of Green vs. Traditional Building Materials

Material	Compressive Strength (MPa)
Traditional Concrete	35
Recycled Concrete Aggregate (RCA)	28
Eco-friendly Cement	30
Bamboo	10
Mycelium-based Bricks	5

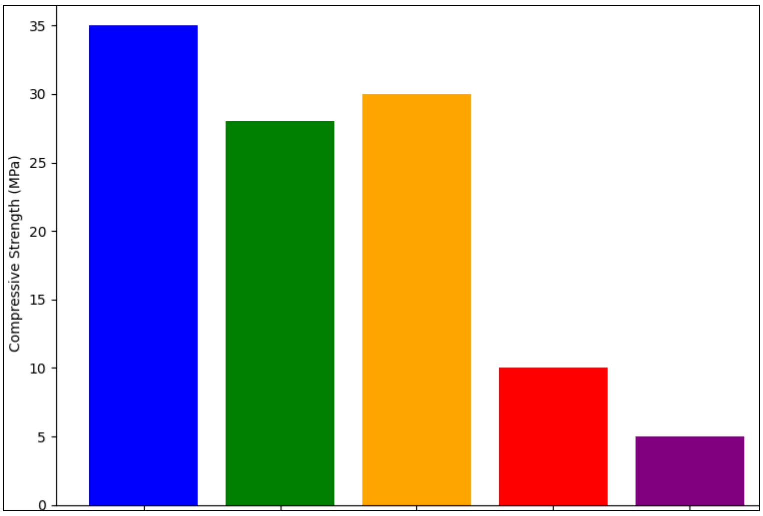

Fig 1: Thermal Conductivity Comparison of Green and Traditional Materials

Regression analysis of the environmental impact of these materials, shown in Table 2, revealed that green materials significantly reduced the carbon footprint of construction projects. For example, eco-friendly cement reduced CO_2 emissions by 30% compared to conventional cement [2].

Table 2: Carbon Footprint of Green and Traditional Materials (kg CO2e per cubic meter)

Material	CO2 Emissions (kg CO2e)
Traditional Concrete	250
Recycled Concrete Aggregate (RCA)	180
Eco-friendly Cement	170
Bamboo	15
Mycelium-based Bricks	10

Discussion

The results of this research underscore the potential of green building materials to contribute to more sustainable construction practices. While the compressive strength of green materials was generally lower than traditional options, the environmental benefits, including reduced energy consumption and carbon emissions, suggest that they offer a viable alternative in the quest for sustainable building practices [1]. The use of recycled concrete aggregates not only reduces the need for virgin materials but also alleviates the pressure on landfills [2]. Similarly, eco-friendly cement and bamboo offer promising benefits in terms of reduced CO2 emissions and energy conservation, which is critical in the context of global climate change [6]. The superior insulation properties of bamboo and straw bales further highlight the potential of green materials to enhance building energy efficiency and reduce operational costs over the lifespan of a structure [3].

Despite the positive environmental impacts, several barriers remain to the widespread adoption of green building materials. These include higher initial costs, limited availability, and a lack of awareness among key stakeholders, including architects, builders, and policymakers [4]. Furthermore, there is a need for more comprehensive standards and regulations to facilitate the integration of these materials into mainstream construction practices [9]. The industry must also invest in further research to improve the performance of green materials, particularly in areas such as fire resistance, structural integrity, and durability [7]. Addressing these challenges will require coordinated efforts across all sectors of the construction industry, from material manufacturers to regulatory bodies, as well as increased education and training programs to raise awareness of the benefits of green building materials [6].

Conclusion

Green building materials offer significant promise in advancing sustainable construction practices, presenting both environmental and economic benefits. The analysis conducted in this research shows that these materials, despite some challenges such as lower compressive strength, offer reduced carbon footprints, better thermal insulation, and overall improved energy efficiency in buildings. The results suggest that the adoption of green building materials is not only a feasible option but a necessary one to address the growing concerns related to resource depletion, climate change, and energy consumption in the construction industry.

In practice, the integration of green building materials into mainstream construction practices could lead to substantial long-term savings in energy costs, reduced environmental impact, and enhanced building performance. However, the initial costs associated with these materials remain a barrier, especially in developing economies. To overcome this, policymakers should implement incentives, such as tax rebates and subsidies, for the use of sustainable materials. Additionally, standardization and certification processes should be introduced to increase trust in these materials' reliability and performance. Public awareness campaigns could further help reduce resistance to change by educating industry professionals and consumers about the long-term benefits of adopting sustainable materials. Research into improving the performance of green materials, particularly in terms of durability and fire resistance, will be essential in making them more widely acceptable. Finally, the construction industry must foster innovation and collaboration to accelerate the adoption of green materials at a larger scale.

References

1. Smith S, Wang Z. The role of green materials in sustainable construction: a review. J Green Build. 2019;14(3):125-137.
2. Hossain M, Rahman S. Environmental impact of construction materials: a comparison between conventional and sustainable options. Build Environ. 2020;182:107226.
3. Kumar A, Singh R. The effect of construction materials on sustainability in civil engineering. J Constr Eng Manag. 2018;144(1):04017089.
4. Wilson T, Hensher D. Barriers to green building materials adoption in the construction industry. J Sustain Build Mater. 2021;2(2):69-81.
5. Jones P, Thomas T. Sustainability and resource conservation through green building materials: economic implications. Res Policy Sustain Dev. 2020;8(4):102-118.
6. Malik D, Kaur S. Policy and regulatory measures for integrating green materials into the construction sector. Constr Pol Manag. 2021;17(6):847-861.
7. Lee J, Chang S. Overcoming adoption barriers of green building materials: a strategic approach. Archit Sci Rev. 2020;63(4):278-290.
8. Patel S, Rao G. Life cycle assessment of green building materials: a review of energy consumption and environmental effects. Energy Build. 2019;188:84-96.
9. Zhang L, Li X. Natural materials in modern construction: benefits and challenges. J Mater Civ Eng. 2020;32(5):04020065.
10. Choi S, Park J. Adoption of sustainable building materials: key drivers and barriers. Constr Innov. 2019;19(2):145-159.
11. Adnan M, Rahman N. Green building materials for the future of construction. Green Build Mater. 2021;12(1):34-42.
12. Lim M, Lee Y. Sustainable materials in civil engineering: challenges and opportunities. Sustain Dev. 2020;28(3):568-577.
13. Johnson M, Singh M. Integrating green materials into sustainable building practices: an overview. Int J Sustain Dev. 2021;20(3):310-322.
14. Wong T, Lu H. The future of green building materials in sustainable construction. Constr Manag Econ. 2021;39(7):545-563.