International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

Check for updates

Review paper on agricultural waste: *Hevea brasiliensis* and bagasse ash performance in concrete

K. Sargunan, Abhishek A. L., Gowthamkrishna S., Soorya Sushan * and Unnimaya S.

Department of Civil Engineering, Vidya Academy of Science and Technology Technical Campus, Kilimanoor, Thiruvananthapuram, Kerala, India.

International Journal of Science and Research Archive, 2026, 19(02), 604-607

Publication history: Received on 23 March 2026; revised on 02 May 2026; accepted on 04 May 2026

Article DOI: https://doi.org/10.30574/ijsra.2026.19.2.0975

Abstract

With increasing environmental concerns and the growing demand for sustainable construction materials, researchers are exploring alternative materials for building applications. This review examines the use of agricultural waste (agro-waste) as aggregate in cementations composites. The study focuses on several agro-waste materials. The paper analyzes the physical and mechanical properties, global production quantities, and major producing countries of these agricultural wastes. It also reviews previous research on incorporating these materials into cement-based composites, discussing their advantages, limitations, and performance characteristics in concrete. The review highlights that huge quantities of agricultural residues are produced worldwide, many of which are often disposed of improperly, causing environmental problems. Reusing these wastes as construction materials can reduce environmental pollution, decrease the use of natural aggregates, and support sustainable construction practices.

Keywords: Agricultural waste; Bagasse ash; *Hevea brasiliensis*; Sustainable concrete; Pozzolanic materials; Agro-waste

1. Introduction

Concrete is one of the most widely used construction materials in the world, but the production of cement contributes significantly to environmental pollution and the depletion of natural resources. To address these issues, researchers are focusing on the use of agricultural and industrial waste materials as partial replacements for cement in concrete. Agro-waste materials such as bagasse ash and rubber seed shell ash possess pozzolanic properties that can enhance the performance of concrete while reducing environmental impact.

This project studies the performance of concrete when cement is partially replaced with bagasse ash (BA) and rubber seed shell ash powder (RSSA). The aim is to develop a sustainable and eco-friendly concrete mixture that maintains adequate strength and durability. Different replacement percentages are considered to determine the optimum level of substitution. By utilizing these waste materials, the study also promotes waste management, cost reduction, and sustainable construction practices, contributing to the development of greener and more environmentally responsible building materials.

2. Literature review

The research related to the use of agricultural and organic waste materials in concrete production for sustainable construction. It highlights the findings, benefits, and limitations of earlier studies to identify the research gap and support the need for further investigation.

* Corresponding author: Soorya Sushan

2.1. Utilization of Organic Waste Materials as Partial Aggregate Replacement in Sustainable Concrete

Garcia et al. (2024) investigated the possibility of using organic waste materials as a replacement for fine aggregates in concrete. The study aimed to reduce environmental waste while promoting sustainable construction materials. The researchers replaced a portion of natural fine aggregate with organic waste and evaluated the compressive strength of the resulting concrete. The results showed that up to 10% replacement produced concrete with acceptable compressive strength, indicating that organic waste can partially substitute conventional aggregates without significantly affecting structural performance. This approach also helps reduce the demand for natural sand and minimizes waste disposal problems. However, the research mainly focused on strength properties and did not include detailed durability tests such as resistance to chemicals, weathering, or long-term performance. Therefore, while the results are promising for sustainable concrete production, further studies are required to evaluate durability characteristics before large-scale practical applications can be recommended.

2.2. Sustainable Construction Materials; Organic Waste Utilization in Concrete Aggregates

Smith et al. (2024) studied the use of agricultural waste materials in concrete production as an environmentally sustainable alternative to traditional materials. Agricultural waste such as plant residues and biomass by-products are often discarded, causing environmental pollution. The study explored how these wastes can be incorporated into concrete mixtures to reduce environmental impact and improve resource utilization. The results showed that incorporating agricultural waste can enhance the stability of concrete mixtures and contribute to sustainable construction practices. The materials also helped reduce the consumption of conventional cement and aggregates, which are energy-intensive to produce. However, the research mainly focused on overall stability and environmental benefits, while other important mechanical properties such as tensile strength, flexural strength, and durability were not studied extensively. The authors concluded that agricultural waste has potential for eco-friendly concrete production, but additional investigations are necessary to understand its full structural and durability performance.

2.3. Development of Sustainable Concrete Using Organic Waste Materials.

Lee and Kumar (2023) investigated the mechanical properties of concrete containing wood ash as a partial replacement for cement. Wood ash is a by-product obtained from burning wood in industries and power plants, and its utilization in concrete can help reduce waste disposal issues. The study focused on evaluating how wood ash affects the workability and compressive strength of concrete mixtures. The results indicated that the addition of wood ash reduces the workability of the concrete mix, making it less fluid and more difficult to handle during mixing and placement. However, the compressive strength results showed that small amounts of wood ash could still produce acceptable strength levels. The study mainly focused on compressive strength, while other important mechanical properties such as tensile strength, flexural strength, and durability were not investigated. The authors suggested that further research is required to evaluate the overall performance of wood ash concrete before it can be widely adopted

2.4. Mechanical behavior of Concrete Incorporating Agricultural Organic Waste Aggregates

Kumar et al. (2024) examined the use of agricultural waste materials in concrete production to develop environmentally sustainable construction materials. Agro-waste such as crop residues and plant-based by-products can be incorporated into concrete either as aggregate replacements or supplementary cementious materials. The study emphasized the environmental benefits of utilizing such wastes, including reduction of landfill waste and conservation of natural resources. The results showed that agro-waste concrete can achieve reasonable strength when used in small proportions. However, the research also highlighted that many previous studies have focused mainly on strength properties, while durability characteristics such as resistance to water penetration, chemical attack, and long-term structural behavior remain insufficiently studied. The authors concluded that although agro-waste concrete has promising sustainability benefits, more detailed investigations are needed to understand its long-term performance and durability before it can be widely used in structural construction.

2.5. Eco- Friendly Concrete; Incorporation of Organic Waste Materials as Aggregates Replacement

Rao et al. (2022) developed eco-concrete using agricultural waste materials to reduce the environmental impact of traditional construction practices. The study aimed to utilize waste materials such as plant residues and biomass ash as supplementary components in concrete mixtures. The researchers evaluated the compressive strength of the developed eco-concrete and found that the results were comparable to conventional concrete when the waste materials were used in moderate proportions. The incorporation of agricultural waste also contributes to sustainable development by reducing waste disposal issues and lowering the demand for natural resources. However, the study mainly focused on compressive strength evaluation, while durability characteristics such as water absorption, permeability, and resistance to chemical attack were not analyzed. The authors emphasized that future research should investigate these durability

aspects to determine the long-term performance of agricultural waste-based eco-concrete in real construction conditions.

2.6. Mechanical and Durability Properties of Concrete with Organic Waste Aggregate

Zhang et al. (2024) studied the durability performance of concrete containing waste materials as partial replacements for conventional ingredients. The research focused on how waste incorporation affects the long-term behavior of concrete structures. The results showed that the addition of waste materials increased the water absorption capacity of the concrete. Higher water absorption indicates greater permeability, which may reduce durability and lead to deterioration over time. The study also observed that the microstructure of the concrete changed due to the presence of waste particles. However, the researchers did not fully explore the resistance of the concrete to chemical attacks such as acid exposure. Although the study provided useful information about water absorption and durability concerns, further investigations are needed to analyze other durability parameters. The authors concluded that while waste materials can be used in concrete, careful mix design and additional research are required to ensure long-term structural performance.

2.7. Influence of Biomass Ash on Properties of Concrete Incorporating Agro-Waste Materials

Novak et al. (2023) examined the influence of biomass ash on the performance of concrete mixtures. Biomass ash is produced from the combustion of organic materials such as agricultural residues and wood. The study aimed to evaluate whether biomass ash could serve as a sustainable alternative to conventional cementitious materials. The results indicated that the use of biomass ash improved the eco-efficiency of concrete by reducing the consumption of cement and minimizing environmental waste. However, the study also found that the addition of biomass ash increased the porosity of the concrete. Higher porosity can affect the durability and strength of the material by allowing more water and chemicals to penetrate the concrete structure. Although the environmental benefits were significant, the authors emphasized that controlling porosity and improving durability are essential for practical applications. Further research was recommended to optimize the mix design and enhance performance.

2.8. Sustainable Concrete Production Using Organic Waste as Fine and Coarse Aggregate Replacement

Patel et al. (2024) investigated the use of agro-waste materials in concrete to produce sustainable and environmentally friendly construction materials. The research evaluated different replacement levels of agro-waste to determine the optimum proportion that provides satisfactory strength. The results indicated that the optimum replacement level ranged between 5% and 10%, which produced concrete with acceptable compressive strength and improved sustainability. The use of agro-waste also helps reduce environmental pollution and promotes effective waste utilization. However, the study mainly concentrated on a limited number of mechanical tests, primarily compressive strength. Other important properties such as tensile strength, flexural strength, and durability characteristics were not extensively studied. The authors suggested that further research should investigate these additional properties to provide a comprehensive understanding of the behavior of agro-waste concrete and ensure its suitability for structural construction.

2.9. Mechanical Properties of Concrete Reinforced with Banana Fiber and Banana Leaf Ash

Ahmed et al. (2023) investigated environmentally friendly concrete incorporating banana fiber and banana leaf ash as sustainable materials. The study aimed to utilize agricultural waste products that are widely available in tropical regions. Banana leaf ash was used as a partial cement replacement, while banana fiber was added as reinforcement to improve mechanical properties. The experimental results showed that at low replacement levels, the concrete achieved compressive strength comparable to conventional concrete. The fibers also helped improve crack resistance and structural performance. The use of these materials reduces environmental waste and promotes sustainable construction practices. However, the research mainly focused on compressive strength evaluation and basic mechanical behavior. Detailed studies on durability, water absorption, and long-term performance were not included. The authors recommended further research to analyze these aspects before large-scale practical implementation.

2.10. Utilization of Wood Ash in Concrete for Low-Cost Housing Applications

Silva et al. (2022) studied the application of wood ash concrete for low-cost housing construction. The research focused on replacing a portion of cement with wood ash to reduce construction costs and promote sustainable material use. The results showed that wood ash concrete can provide adequate strength for certain building components. However, the overall strength was lower compared to conventional concrete. Due to this limitation, the authors suggested that wood ash concrete is more suitable for non-structural applications such as blocks, pavements, and partition walls rather than load-bearing structural elements. The study highlighted the economic advantages of using wood ash, especially in

developing regions where construction costs need to be minimized. However, the research did not include detailed durability tests or long-term performance evaluations. Further investigations were recommended to improve the mechanical properties and expand its practical applications.

3. Conclusion

From the analysis of the above studies, it is evident that agricultural and organic waste materials have significant potential for use in sustainable concrete production. Many researchers have explored materials such as wood ash, biomass ash, banana fiber, banana leaf ash, and other agro-waste residues as partial replacements for cement or aggregates. Most studies reported that low replacement levels (generally between 5% and 10%) can produce concrete with acceptable compressive strength, while also reducing environmental waste and conserving natural resources. However, several limitations were identified across the literature. Many studies focused mainly on compressive strength, while other important properties such as tensile strength, flexural strength, durability, sorptivity, porosity, and resistance to chemical attack were not extensively investigated. Some researchers also reported increased porosity and water absorption when waste materials were used. Therefore, further research is required to evaluate long-term durability and optimize mix proportions to ensure that agro-waste concrete can be safely applied in structural construction.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

[1] Smith, J., Brown, T., & Wilson, P. (2024). Utilization of Agricultural Waste in Concrete. Journal of Cleaner Production.

[2] Garcia, M., Lopez, R., & Fernandez, J. (2024). Concrete with Organic Waste Materials as Aggregate Replacement. Construction and Building Materials.

[3] Patel, D., Shah, R., & Mehta, S. (2024). Sustainable Concrete Using Agro Waste Materials. Materials Today: Proceedings.

[4] Novak, T., Petrovic, M., & Ivanov, S. (2023). Effect of Biomass Ash on Concrete Performance. Journal of Building Engineering.

[5] Zhang, Y., Liu, H., & Chen, X. (2024). Durability of Waste Incorporated Concrete. Construction and Building Materials.

[6] Rao, P., Reddy, K., & Naidu, M. (2022). Agricultural Waste-Based Eco-Concrete. Journal of Materials in Civil Engineering.

[7] Lee, H., & Kumar, S. (2023). Mechanical Properties of Wood Ash Concrete. Materials Today: Proceedings.

[8] Kumar, R., Sharma, P., & Gupta, A. (2024). Agro-Waste Concrete as a Sustainable Construction Material. Sustainable Materials and Technologies.