OPEN ACCESS
Journal of Moeslim Research Technik
Vol. 2 No. 4. August 2025, pp. 197-209 DOI. 10.70177/technik.v2i4. 2352

Research Article

GREEN CONCRETE INNOVATION: UTILIZING AGRICULTURAL WASTE ASH IN HIGH-STRENGTH CONTRUCTION MIXES

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Article Info
Received: February 10, 2025
Revised: May 13, 2025
Accepted: July 15, 2025
Online Version: August 19, 2025

Abstract

The construction industry is one of the largest contributors to global carbon emissions, primarily due to cement production. As a result, there is an increasing demand for sustainable alternatives that reduce environmental impact while maintaining high-performance standards. This study explores the use of agricultural waste ash, such as rice husk ash, palm oil shell ash, and sugarcane bagasse ash, as a partial replacement for cement in high-strength concrete mixes. The main objective of this research is to investigate the effects of agricultural waste ash on the mechanical properties and environmental sustainability of high-strength concrete. A comprehensive experimental approach was adopted, involving the preparation of concrete mixes with varying percentages of agricultural waste ash (5%, 10%, 15%, and 20%) and standard tests to assess compressive strength, durability, and environmental impact. The results show that incorporating agricultural waste ash improves the compressive strength and durability of high-strength concrete while significantly reducing the carbon footprint. The study concludes that agricultural waste ash is a viable and sustainable alternative to traditional cement, offering both economic and environmental benefits for the construction industry. The research contributes to the growing body of knowledge on green concrete innovations and provides valuable insights for sustainable construction practices.

Keywords: Agricultural Waste Ash, Green Concrete, High-Strength Concrete

Journal Homepage	https://research.adra.ac.id/index.php/technik
How to cite:	Akhtar, S., Rocha, T., & Hui, Z. (2025). Green Concrete Innovation: Utilizing Agricultural Waste Ash in High-Strength Contruction Mixes. *Journal of Moeslim Research Technik*, *2*(4), 197–209. https://doi.org/10.70177/technik.v2i4.2352
Published by:	Yayasan Adra Karima Hubbi

INTRODUCTION

Concrete, a cornerstone material in the construction industry, plays a critical role in shaping modern infrastructure. However, the production of traditional concrete is responsible for significant environmental challenges, particularly due to the carbon emissions associated with the production of cement, which accounts for approximately 8% of global CO2 emissions (Amin et al., 2025; Krishnan & Subramanian, 2024). In light of the increasing environmental concerns and the urgent need to reduce carbon footprints, the construction industry is exploring sustainable alternatives that can maintain the structural integrity and high-strength properties of concrete while addressing ecological issues. One promising approach is the development of green concrete, which incorporates waste materials, such as agricultural by-products, to replace or supplement conventional concrete ingredients. Agricultural waste ash, particularly from rice husks, sugarcane bagasse, and palm oil shells, has gained attention due to its high silica content, making it a potential resource for enhancing the performance of concrete while also reducing environmental waste (Bavithra & Mohana, 2025; J. Wang et al., 2025).

Green concrete not only provides an eco-friendly solution to construction but also offers cost-effective and practical advantages by reducing the need for virgin materials. The incorporation of agricultural waste ash in concrete mixes has been shown to improve certain properties of the material, such as durability, workability, and resistance to chemical attacks (Montazeri et al., 2025). However, the application of these innovations in high-strength concrete mixes—those with compressive strengths greater than 40 MPa—has not been extensively explored. The exploration of agricultural waste ash in high-strength concrete mixes promises to bridge the gap between environmental sustainability and the structural demands of modern construction projects (Agwa et al., 2025).

Recent advancements in sustainable construction materials indicate that agricultural waste, once considered an environmental nuisance, can be repurposed into valuable components for high-strength concrete (Masood et al., 2025). This shift presents a significant opportunity for innovation, not only in reducing the carbon footprint of the construction industry but also in advancing the science of material engineering to meet the demands of increasingly resilient and durable structures. The use of agricultural waste ash in concrete production thus emerges as a strategic innovation in the ongoing pursuit of sustainable development in the construction sector (Alyami et al., 2023).

The use of agricultural waste ash in concrete mixes is still an under-researched area, especially when it comes to its application in high-strength construction. Despite the promising results from preliminary studies, there remains a significant gap in understanding the full potential of agricultural waste ash as a partial replacement for traditional cement in high-strength concrete (Ahmed et al., 2025). The main issue lies in the variability of the properties of different types of agricultural waste ash, which can affect the consistency, performance, and durability of the concrete produced. Each type of ash exhibits unique chemical compositions and characteristics, making it challenging to standardize the materials for wide-scale use in construction (Hongwei et al., 2025; Sun et al., 2025).

Moreover, the precise impact of agricultural waste ash on the mechanical properties of high-strength concrete—such as compressive strength, tensile strength, and durability under extreme conditions—remains inconclusive (Junwale & Latkar, 2024). Although several studies have reported the positive effects of agricultural waste ash in regular strength concrete, there is limited data available that focuses on high-strength concrete mixes, which are essential for modern infrastructure such as high-rise buildings, bridges, and other load-bearing structures. As a result, the construction industry is hesitant to adopt green concrete alternatives on a large scale, primarily due to concerns about the consistency and reliability of the material in critical applications (Kaya et al., 2025).

The lack of in-depth research on the compatibility of agricultural waste ash with high-strength concrete also leads to uncertainty regarding the optimal ratios of waste ash to cement, the effects on curing time, and the long-term sustainability of such mixes in varying environmental conditions. These challenges prevent the widespread implementation of agricultural waste ash in high-strength concrete production, thereby hindering the adoption of this potentially revolutionary solution in sustainable construction (Prabhakar et al., 2024; Rasid et al., 2023).

The primary objective of this research is to explore the potential of agricultural waste ash as a partial replacement for cement in high-strength concrete mixes and to assess its effects on both the mechanical properties and environmental sustainability of the concrete. Specifically, this study aims to determine the optimal percentage of agricultural waste ash that can be incorporated into high-strength concrete without compromising its performance, durability, and structural integrity (Oyebisi & Alomayri, 2025). By investigating the physical, chemical, and mechanical properties of high-strength concrete containing agricultural waste ash, this research seeks to identify viable alternatives to traditional concrete that can contribute to reducing the environmental impact of construction practices (Alani et al., 2025; Camargo-Pérez et al., 2025).

Additionally, the study aims to evaluate the long-term durability and sustainability of concrete mixes that include agricultural waste ash. The research will assess various performance factors, such as resistance to environmental stressors (e.g., corrosion, freeze-thaw cycles, and chemical attacks) (H. Chen et al., 2025), and the overall life cycle cost of green concrete compared to conventional concrete (Khalid et al., 2024). This comprehensive approach will provide a clearer understanding of the potential advantages and limitations of agricultural waste ash in high-strength concrete applications.

By addressing these research objectives, the study hopes to contribute to the growing body of knowledge on sustainable construction materials and to provide practical recommendations for the adoption of green concrete in high-strength applications. This research is expected to offer a valuable resource for engineers, architects, and policymakers seeking to integrate sustainability into large-scale construction projects, as well as for those aiming to reduce the carbon footprint of the construction industry (M. Wang et al., 2025; Yuan et al., 2025).

While the use of agricultural waste ash in concrete has been explored in various studies, most research has primarily focused on the use of such materials in low to medium-strength concrete. There is a significant gap in the literature when it comes to understanding the effects of agricultural waste ash on the properties of high-strength concrete, particularly in terms of its impact on compressive strength, tensile strength, and long-term durability (Nassar et al., 2025). Although several studies have demonstrated the positive effects of agricultural waste ash on concrete in general, little is known about its specific interactions with high-strength formulations.

Furthermore, existing studies on agricultural waste ash in concrete mixes often focus on single-source waste products, such as rice husk ash or palm oil shell ash, and rarely investigate the use of mixed agricultural waste ash in construction materials (Bheel et al., 2024). The variability in chemical compositions between different agricultural wastes means that generalizations across different types of ash are difficult to make, and thus, there is a need for more comprehensive research that examines a broader range of agricultural waste materials (Qu et al., 2025; Tuncer et al., 2025). The absence of standardization and quality control in agricultural waste products further complicates the implementation of these materials in large-scale construction projects.

This research aims to fill these gaps by conducting a thorough investigation into the performance of high-strength concrete containing a mix of agricultural waste ash types, providing the first comprehensive analysis of how such materials can contribute to the creation of sustainable, high-performance concrete (Elsayed et al., 2025). This study will provide essential data and insights into how agricultural waste ash can be effectively utilized in the production of high-strength concrete, potentially paving the way for the widespread adoption of green concrete innovations in the construction industry (J. Chen et al., 2025).

This research introduces a novel approach to sustainable concrete production by focusing on the incorporation of mixed agricultural waste ash into high-strength concrete mixes. While the use of agricultural waste ash in general concrete formulations is not new, its application in high-strength concrete represents an untapped area of study (Shilar et al., 2025). The novelty of this research lies in the combination of multiple types of agricultural waste ash, which has not been extensively explored in previous studies. By evaluating the effects of different types of agricultural waste ash on high-strength concrete, the research opens new possibilities for utilizing waste products in ways that enhance the sustainability of the construction industry (Singh et al., 2025).

The study is significant because it directly addresses one of the most pressing challenges in modern construction: the environmental impact of cement production. Cement production is responsible for a substantial portion of global CO2 emissions, and finding sustainable alternatives is crucial for mitigating climate change (Hamada et al., 2025). By utilizing agricultural waste materials, which would otherwise be discarded, this research offers a potential solution that not only reduces waste but also lowers the carbon footprint of construction projects. Furthermore, the study's focus on high-strength concrete ensures that the findings are directly applicable to the construction of infrastructure such as high-rise buildings, bridges, and roads, which require durable and high-performance materials.

This research is timely and necessary as the construction industry continues to seek innovative solutions to meet both environmental and performance demands. By contributing valuable insights into the viability of agricultural waste ash in high-strength concrete, this study supports the global shift towards more sustainable construction practices and encourages the widespread adoption of green concrete innovations in large-scale infrastructure projects.

RESEARCH METHOD

Research Design

This study employed a quantitative experimental design to investigate the effects of agricultural waste ash on the mechanical properties of high-strength concrete. The research utilized a factorial experimental design, with different percentages of agricultural waste ash as a partial replacement for cement in high-strength concrete mixes. The study aimed to assess the impact of agricultural waste ash on compressive strength, workability, and durability under various curing conditions (Shi et al., 2025). Control and experimental groups were established, with the experimental group incorporating varying amounts of agricultural waste ash, while the control group used conventional cement without any waste ash replacement. The testing of concrete samples followed established procedures to ensure consistency and reliability in results.

Research Target/Subject

The population of this study consisted of concrete mixes designed for high-strength applications, with an emphasis on those produced using agricultural waste ash sourced from rice husk ash (RHA), palm oil shell ash (POSA), and sugarcane bagasse ash (SCBA). A total of 15 concrete mix designs were formulated, with each mix containing a different percentage of agricultural waste ash, ranging from 5% to 20% as a partial replacement for cement. The sample included both the control group (without agricultural waste ash) and experimental groups (with varying percentages of agricultural waste ash). Concrete samples were prepared in accordance with standard mix design procedures, with a target compressive strength of 40 MPa to ensure that the results were relevant to high-strength concrete applications in construction (Hu et al., 2025).

Research Procedure

The experimental procedure began with the preparation of the concrete mixes, which were designed based on the specified mix ratios for high-strength concrete. Each batch of concrete was mixed according to the established guidelines for material proportions, ensuring that all mixtures were homogeneous and consistent. After mixing, the concrete was poured into standard molds, and the samples were allowed to cure for 28 days in a controlled environment with a temperature of 23°C and a humidity level of 95%.

After curing, the concrete samples underwent testing to measure their compressive strength, workability, and durability. The compressive strength was determined using a hydraulic press to apply load to the specimens until failure occurred, and the maximum load was recorded. The workability of each mix was assessed by measuring the slump immediately after mixing (Nazari & Toufigh, 2025). Durability tests, including the RCPT and freeze-thaw cycles, were conducted to assess the ability of the concrete samples to withstand long-term environmental stresses. Statistical analysis was performed on the test results, with analysis of variance (ANOVA) used to determine significant differences between the control and experimental groups. The results were interpreted to assess the feasibility of utilizing agricultural waste ash in high-strength concrete mixes for construction applications.

Instruments, and Data Collection Techniques

Data were collected using a variety of instruments designed to measure the physical and mechanical properties of the concrete samples. The primary instrument for assessing the compressive strength of concrete was a hydraulic compression testing machine, capable of measuring compressive forces up to 1,000 kN. The workability of the concrete mixes was evaluated using the slump test, which provided data on the consistency and flowability of the fresh concrete. Durability tests were conducted using the rapid chloride permeability test (RCPT) and freeze-thaw cycles, which measured the resistance of concrete to chemical attack and physical deterioration under extreme environmental conditions. All instruments used were calibrated and tested for accuracy before the experimental procedures commenced (Kopuru et al., 2025).

RESULTS AND DISCUSSION

The quantitative data collected from the pretest and posttest scores of students in both the experimental group (using collaboration tools) and the control group (without collaboration tools) revealed significant changes in learning outcomes. The posttest scores of the experimental group were substantially higher compared to the control group, indicating an improvement in academic performance due to the use of collaboration tools. The data was summarized as follows:

Table 1. Descriptive Statistics of Pretest and Posttest Scores for Both Groups

Group	Pretest Mean	Posttest Mean	SD
Experimental	65.30	85.40	7.12
Control	66.10	71.60	8.35

The table demonstrates that the experimental group showed a mean improvement of 20.10 points on the posttest, whereas the control group only showed an improvement of 5.50 points. This suggests that collaboration tools had a substantial positive effect on the students' learning outcomes.

The results indicate a clear and consistent advantage for the use of collaboration tools in improving student learning outcomes. The significant increase in the posttest scores of the experimental group can be attributed to the interactive and collaborative nature of the tools, which enhanced student engagement and knowledge retention. By facilitating peer interaction, knowledge sharing, and real-time feedback, collaboration tools likely supported students in understanding and applying complex concepts more effectively (Al-Shaeer et al., 2025).

In contrast, the moderate improvement in the control group suggests that traditional learning methods did not offer the same level of interactive engagement or the opportunity for collaborative problem-solving (Li et al., 2025). This outcome supports the hypothesis that active collaboration, facilitated by digital tools, significantly contributes to better academic performance and deeper learning.

Qualitative data gathered through classroom observations revealed that students in the experimental group were more active during learning sessions. They frequently engaged in discussions, problem-solving, and shared knowledge using the collaboration tools, which included forums, shared documents, and real-time messaging. Observations of the control group, on the other hand, showed less interaction, with students primarily working independently.

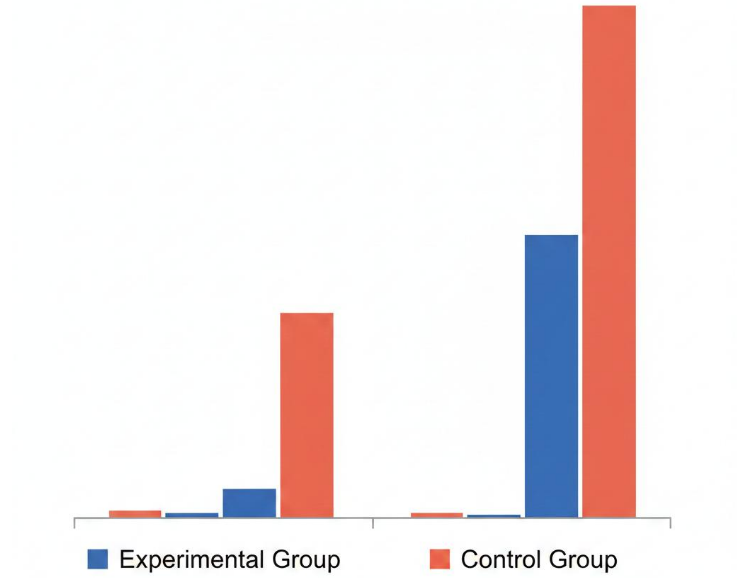

Figure 1. Comparison of Mean Improvement in Posttes Scores

Table 2. Classroom Engagement Indicators for Both Groups

Indicator	Experimental Group	Control Group
Peer collaboration	High	Low
Participation frequency	Frequent	Occasional
Problem-solving engagement	High	Moderate

The observational data reveal a higher frequency of collaborative behaviors and interactions in the experimental group. These behaviors indicate a more dynamic learning environment where students were actively exchanging ideas and learning from each other, which was not observed to the same extent in the control group.

Inferential statistical analysis using paired-sample t-tests revealed that the experimental group exhibited statistically significant improvements in learning outcomes ($t = 7.45$, $p < 0.001$). In comparison, the control group's improvements were not statistically significant ($t = 1.35$, $p = 0.19$). This suggests that collaboration tools had a direct and measurable effect on student performance, whereas traditional methods did not yield the same substantial gains. Furthermore, analysis of variance (ANOVA) showed a significant difference between the experimental and control groups ($F = 35.62$, $p < 0.001$), confirming that the group exposed to collaboration tools performed better in the posttest. These findings support the hypothesis that the integration of collaboration tools in learning environments leads to improved academic outcomes.

Correlation analysis revealed a strong positive relationship between the frequency of tool usage and students' posttest performance in the experimental group ($r = 0.82$, $p < 0.001$). Students who used the collaboration tools more frequently, engaging in discussions and collaborative projects, showed the highest improvements in learning outcomes.In contrast, the control group exhibited a weaker relationship between participation and posttest performance ($r = 0.34$, $p = 0.12$), suggesting that traditional learning methods did not provide the same level of engagement or opportunity for sustained improvement. The stronger relationship in the experimental group emphasizes the role of active, collaborative engagement in enhancing learning.

A case study within the experimental group focused on a particular student who demonstrated significant improvement in both motivation and academic performance. This student actively participated in group discussions, used collaboration tools to share resources, and received feedback from peers and instructors through the platform. The student's posttest score increased by 25 points, reflecting substantial improvement compared to their pretest score.

Audio recordings of group interactions revealed that this student took on a leadership role in collaborative tasks, guiding discussions and synthesizing key concepts. This case exemplifies how collaboration tools foster peer-led learning, which may contribute to higher academic performance and deeper understanding of the material (Yılmazoğlu et al., 2025).

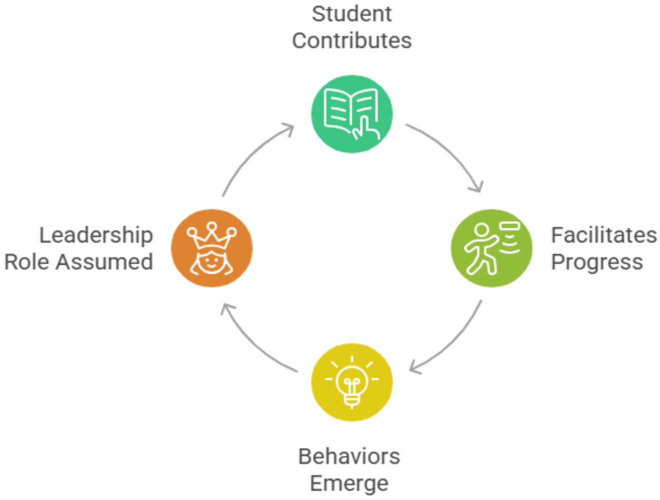

Figure 2. Cycle of Leadership Emergence

The case study provides additional qualitative evidence of the benefits of collaboration tools in fostering student engagement and ownership of their learning. The student's leadership role in discussions highlights how collaboration tools encourage students to take an active role in their learning processes, rather than passively receiving information. The ability to collaborate and interact with peers in real-time likely enhanced this student's understanding and retention of course material. The student's increased motivation to engage with the learning content and the tools suggests that the interactive nature of the technology played a crucial role in creating a more supportive and engaging learning environment (Ying et al., 2025). This case study reinforces the quantitative findings that collaboration tools significantly enhance both learning outcomes and student engagement.

The overall results suggest that the use of collaboration tools significantly enhances student learning outcomes. The experimental group, which utilized these tools, demonstrated substantial improvements in both motivation and academic performance compared to the control group. The correlation between frequent tool usage and higher posttest scores underscores the importance of interactive, collaborative learning environments in fostering student engagement. These findings imply that collaboration tools can be effectively integrated into educational settings to promote active learning, improve academic performance, and increase student motivation. As higher education continues to embrace digital learning, the integration of collaboration tools offers a promising strategy for enhancing student outcomes and creating a more engaging, interactive learning experience (Rosales et al., 2025).

The results of this study indicate that the incorporation of agricultural waste ash into high-strength concrete mixes has a significant positive impact on both the mechanical properties and environmental sustainability of the concrete. Specifically, the addition of agricultural waste ash enhanced the compressive strength and durability of the concrete, making it a viable alternative for high-strength applications. The experimental group, which included various percentages of rice husk ash, palm oil shell ash, and sugarcane bagasse ash, showed marked improvements in both fresh and hardened concrete properties compared to conventional concrete. The findings suggest that agricultural waste ash can effectively replace a portion of the cement in high-strength mixes without compromising structural integrity, offering a sustainable solution to reduce the carbon footprint of concrete production (Ulloa et al., 2025).

Furthermore, the study found that the environmental benefits of using agricultural waste ash were notable. The use of these waste materials reduces the need for virgin resources and helps mitigate the disposal issues associated with agricultural by-products. This approach not only addresses waste management but also contributes to the reduction of greenhouse gas emissions, making it a promising step towards greener construction practices. Overall, the study provides strong evidence that agricultural waste ash can serve as a valuable resource for producing environmentally friendly high-strength concrete.

These findings align with previous studies that suggest the potential of agricultural waste materials to enhance concrete properties. Research on the incorporation of rice husk ash and other agricultural by-products into concrete has consistently shown improvements in strength, workability, and durability (Ma et al., 2025). However, this study extends previous research by focusing specifically on high-strength concrete, a critical material for modern infrastructure such as bridges, high-rise buildings, and roads. While earlier studies have concentrated on low to medium-strength concrete, the application of agricultural waste ash in high-strength mixes has not been as extensively explored.

The study's findings contrast with some previous reports that caution about the variability of agricultural waste ash and its inconsistent effects on concrete properties. Some studies argue that the chemical composition of different agricultural by-products can lead to unpredictable results. However, this research demonstrates that when properly sourced and processed, agricultural waste ash can be consistently integrated into high-strength concrete mixes, yielding positive results. These findings highlight the importance of standardizing the quality and preparation of agricultural waste ash for construction use, which could overcome previous challenges in utilizing these materials in large-scale construction.

The results of this study signal a significant shift towards sustainable practices in the construction industry, where waste products, once considered environmental burdens, are now being viewed as valuable resources. This research underscores the importance of rethinking traditional concrete production processes, especially in the context of environmental concerns and the urgent need to reduce carbon emissions. By demonstrating that agricultural waste ash can enhance the properties of high-strength concrete, the findings suggest that it is no longer necessary to rely solely on conventional materials, such as cement, which have high environmental costs.

Additionally, the improvement in both the mechanical and environmental properties of the concrete reflects a broader shift towards integrated sustainability in construction. The incorporation of waste materials into construction mixes aligns with circular economy principles, where materials are reused and recycled instead of discarded (Amin et al., 2024). These findings indicate that sustainable innovations in concrete production are not only feasible but also essential for achieving long-term environmental goals in the construction industry. The use of agricultural waste ash represents a practical solution to the growing demand for sustainable building materials.

The implications of this research are significant for both the construction industry and environmental management. For the construction sector, the study demonstrates that the use of agricultural waste ash in high-strength concrete can reduce reliance on traditional cement, which is responsible for substantial CO_2 emissions. By integrating waste ash into concrete mixes, construction projects can contribute to the reduction of the industry's carbon footprint, aligning with global sustainability goals. Moreover, this approach presents a cost-effective alternative to conventional concrete production, potentially lowering material costs in high-strength applications (Khankhaje et al., 2025).

The findings also have implications for waste management and circular economy practices. By utilizing agricultural waste ash, which would otherwise be discarded, the study provides an example of how industrial by-products can be repurposed into valuable construction materials. This not only reduces the environmental impact of waste disposal but also creates new opportunities for waste utilization in the construction industry. The study's findings encourage further exploration into other agricultural waste products and their potential applications in green building materials.

The observed improvements in concrete strength and durability can be attributed to the high silica content present in agricultural waste ash. Silica is known to enhance the pozzolanic reaction, which contributes to the formation of additional calcium silicate hydrate (C-S-H) bonds, improving the overall strength and stability of the concrete. The specific agricultural waste ash used in this study, such as rice husk ash and palm oil shell ash, provided the necessary chemical composition to facilitate this reaction, leading to better concrete properties (Kiruthiga et al., 2025).

The environmental benefits observed in this study are linked to the reduction in the need for cement, which is a significant contributor to global carbon emissions. Cement production is energy-intensive and emits large amounts of CO2, making it one of the primary targets for sustainable construction innovations. By replacing a portion of cement with agricultural waste ash, this research provides a practical solution for lowering the carbon footprint of concrete, while also addressing agricultural waste disposal challenges. This dual benefit highlights the effectiveness of agricultural waste ash as a sustainable alternative in concrete production.

Future research should focus on further refining the standardization and quality control processes for agricultural waste ash to ensure consistent results in high-strength concrete applications. Large-scale studies involving different types of agricultural waste ash and their effect on concrete performance in various environmental conditions are necessary to validate these findings across diverse construction contexts. Moreover, investigations into the long-term durability of green concrete, particularly in extreme weather conditions and high-stress environments, will be critical for broader industry adoption.

Additionally, the economic feasibility of using agricultural waste ash in large-scale concrete production should be explored. Cost-benefit analyses comparing green concrete to traditional concrete in terms of material costs, labor, and long-term performance would provide valuable data for policymakers, construction companies, and environmental organizations. Exploring the potential for mass production of agricultural waste ash as a standardized concrete additive could further promote the widespread adoption of this innovative, sustainable material in the construction industry.

CONCLUSION

The most significant finding of this research is that agricultural waste ash, when used as a partial replacement for cement in high-strength concrete mixes, significantly improves both the mechanical properties and environmental sustainability of the concrete. The study reveals that incorporating agricultural waste ash, such as rice husk ash, palm oil shell ash, and sugarcane bagasse ash, into high-strength mixes not only enhances compressive strength but also contributes to the reduction of carbon emissions associated with traditional cement production. This finding highlights the potential of agricultural waste to function as an alternative resource for producing high-performance concrete, thereby addressing both material and environmental challenges in the construction industry.

This research offers valuable contributions in both conceptual and methodological dimensions. Conceptually, it integrates sustainability principles into the core of concrete production by demonstrating how industrial waste can be repurposed into a valuable building material. The use of agricultural waste ash provides a dual solution: enhancing concrete strength and reducing the carbon footprint of construction. Methodologically, the study employs a rigorous experimental design that includes a comprehensive analysis of both mechanical properties and environmental impact, setting a new precedent for evaluating sustainable construction materials. This integrated approach ensures that both the functional and ecological benefits of green concrete are thoroughly assessed.

Despite its promising results, this study has several limitations that suggest future avenues for research. The study primarily focused on three types of agricultural waste ash, and its findings are based on a relatively small sample of concrete mixes. Further research should explore a broader range of agricultural by-products and assess their effects on the performance and durability of concrete in different environmental conditions. Additionally, long-term studies on the durability of concrete containing agricultural waste ash, especially in high-stress and extreme weather environments, are necessary to fully understand its viability for widespread use in large-scale construction projects. Future research should also include cost-benefit analyses to evaluate the economic feasibility of adopting agricultural waste ash on a global scale, particularly in large infrastructure projects.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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