Smart Green Materials

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Editorial Article

Challenges and Solutions for Using Waste Materials in Various Construction Applications

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Summary

The construction industry faces growing challenges in managing waste materials while striving for sustainability and resource efficiency. Incorporating waste materials into construction processes can mitigate environmental issues, reduce resource consumption, and enhance sustainability. This volume two of the Smart and Green Materials Journal explores the potential of utilizing waste materials in various construction applications, highlighting both the opportunities and obstacles associated with their integration. Key challenges include inconsistent material properties, environmental risks, and the absence of standardized guidelines for safe and effective use. Proposed solutions focus on advanced material characterization, innovative processing technologies, and the establishment of supportive policies and frameworks. By addressing these issues, the adoption of waste materials in construction can lead to reduced environmental impacts, cost savings, and the promotion of circular economy principles in the built environment.

In the second volume of the Smart and Green Materials Journal, two out of the five accepted articles explore different aspects of concrete properties, while the remaining articles focus on advancements in the pavement industry.

Fabric-reinforced concrete is versatile and has a broad range of applications, including repair work, structural strengthening, ditch lining, erosion control, pipe protection, trackways, flood defenses, roofing, and emergency helicopter landing pads. In their study, Ahmad and Mahmood [1] focused on structural strengthening, particularly shear strengthening and jacketing techniques. They discovered that applying textile layers in a straight pattern significantly enhances load capacity compared to a spiral pattern. Additionally, using epoxy resin as a mortar in fabric-reinforced concrete led to improved load-bearing capacity for column strengthening. Columns strengthened with two layers of textiles exhibited greater capacity than those strengthened with a single layer.

Concrete paving blocks have become increasingly popular since their introduction nearly a century ago, offering an alternative to burned clay bricks and natural stone. They are commonly used for both vehicle and pedestrian areas. However, durability is a key factor in the production of high-quality concrete paving blocks. Abir and Sarker [2] conducted a study to optimize the mechanical properties of concrete paving blocks using different admixtures. They evaluated attributes such as compressive strength, water absorption, oven dry density, and drying shrinkage. The study also compared production costs with and without the use of an admixture to achieve similar compressive strength. They found that admixtures could enhance the production of concrete paving blocks by increasing their early strength, which is considered an economical advantage. The use of admixtures boosted compressive strength by 30–40% across all ages. While these additives did slightly raise density, they also reduced water absorption and drying shrinkage in the blocks.

The growing demand for durable and cost-effective pavements has brought attention to several challenges faced by modern pavement engineering. Over time, bitumen pavements experience harsh environmental conditions and traffic loads, leading to issues like rutting, cracking, fatigue, and stripping. To address this issue, Mior Sani et al. [3] examined the impact of incorporating coconut fiber (at 0%, 0.50%, 0.75%, and 1%) as a sustainable modifier in bitumen mixtures. They focused on its effects on mechanical properties, including Marshall Stability, indirect tensile strength (ITS), flow, stiffness, and abrasion resistance. Their findings showed that lower fiber percentages (0.50%) improved wear resistance, while higher contents (1%) enhanced structural integrity but also increased wear susceptibility. The study suggests that a 1% coconut fiber content strikes the best balance between mechanical strength and durability, offering a viable method for improving bitumen performance in sustainable road construction.

In a different study by Mior Sani et al. [4] they explored the performance of bituminous mixtures incorporating varying contents of sugarcane bagasse ash (0%, 3%, 5%, and 7%). The impact on physical, chemical, and mechanical properties was evaluated. The modified binders showed reduced penetration and higher softening points at 3% and 5% sugarcane bagasse ash, indicating better resistance to deformation at high temperatures. Mechanical tests revealed significant improvements in Marshall Stability, stiffness, and indirect tensile strength at these levels. However, using a higher content of sugarcane bagasse ash (7%) led to reduced stability, stiffness, and tensile strength due to excessive voids and weakened cohesion.

Recently, numerous studies have focused on transitioning the construction industry towards greener and more sustainable practices. One such investigation, the latest by Hashim et al. [5] is a prime example. Their study examined the effect of using kaolin as a partial replacement for asphalt in pavement engineering, assessing its impact on the mechanical properties of the mixture under different aging conditions. Their conclusion indicates that incorporating kaolin improves the overall performance of asphalt mixtures, with a 6% kaolin replacement providing the best balance between stability, stiffness, and flexibility. Unaged

samples with higher kaolin content showed increased Marshall Stability, resilient modulus, and dynamic creep modulus, indicating improved rutting resistance. Long-term aging further enhanced the mechanical properties, with kaolin-modified mixtures outperforming those aged for shorter periods. These findings suggest that kaolin can be an effective and sustainable modifier for improving the durability and performance of pavement materials in an economically viable way.

The main objective of our comprehensive research in this second volume is to deepen the understanding and engagement of researchers and practitioners involved in the latest developments and advancements in various construction applications.

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Conflicts of Interest

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Author Contributions

Ramadhansyah Putra Jaya: writing, reviewing and editing. **Reza Pahlevi Munirwan:** writing, reviewing and editing. **Bunyamin Bunyamin:** writing, reviewing and editing.

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