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Editorial

Editorial for the Special Issue on Sustainable Composite Construction Materials

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Sustainable composite construction materials play a crucial role in creating more environmental friendly and energy-efficient buildings. Sustainable construction is a growing imperative in the face of global environmental challenges. As the construction industry seeks to reduce its carbon footprint, a pivotal focus has emerged in the development and utilization of sustainable composite construction materials. Traditionally, we neglected the impact of embodied and operational carbon generated during the manufacture of building materials and the operational stage of building, leading to significant carbon emissions over the last several decades, causing global warming and other related problems. The articles featured in this Special Issue of the Journal of Composites Science aim to provide engineers and scientists with a comprehensive understanding of the current challenges in sustainable construction. This Special Issue contains ten articles, including a review article and nine original research papers contributed by renowned scholars specializing in civil and construction engineering, civil and architectural engineering, structural engineering, and physical sciences; these are all appropriately cited. The topics covered in this Special Issue include principles related to lightweight bricks, eco-sustainable cement mixes, high-volume fly ash-based concrete slabs reinforced with GFRP bars and steel bars, the mechanism of steel-fiber-reinforced concrete beams and slabs, sugarcane–bagasse ash, engineered cementitious composites, bricks created using recycled plastics and bitumen, smart mortar layers, and transfer learning techniques for crack detection. These papers strike a harmonious balance between academic and industrial research, showcasing a collaborative synergy between the two sectors. The following parts of this editorial provide a summary of these ten publications.

Sambucci et al. [1] utilized recycled rubber as an aggregate in the design, modeling, and experimental characterization of lightweight concrete hollow bricks. The near-compliance of rubber concrete blocks with standard requirements and their value-added properties demonstrated significant potential for incorporating waste rubber as an aggregate for non-structural applications. This study confirmed that fractal geometries and waste aggregates can be successfully integrated into bricks to achieve eco-friendly solutions with enhanced structural and acoustic performances.

Sivanantham et al. [2] conducted an experimental investigation to examine the influence of steel fiber reinforcement on the plastic hinge length of a concrete slab under repeated loading. The results obtained through repeated loading applied to the slab indicate that the steel fibers employed at critical sections of the plastic hinge length provided similar strength, displacement, and performance outcomes as those of conventional RCC slabs and fully steel-fiber-reinforced concrete slabs. The study concludes that, rather than using steel fibers throughout the concrete slab, incorporating them specifically at the plastic hinge length is not only effective but also more economical.

Madan et al. [3] conducted a comparative study on the flexural behavior of an ordinary Portland cement (OPC) concrete slab and a high-volume-fly-ash (HVFA) concrete slab

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reinforced with GFRP rods and steel rods. In the fly ash concrete slabs, 60% of the cement used for casting the elements was replaced with class F fly ash, emerging as an eco-friendly and cost-effective alternative to OPC. The observation revealed that the GFRP rods, when utilized as a replacement for steel rods in both conventional and fly ash concrete, resulted in improved strength compared to that of the one-way slab. The findings of this investigation highlight the potential use of GFRP rods with fly ash concrete in slabs.

Madan et al. [4] investigated the flexural behavior of ordinary Portland cement (OPC) concrete slabs and high-volume-fly-ash (HVFA) concrete slabs reinforced with bi-directional GFRP sheets. Slab specimens were cast with 60% fly ash as a replacement for cement and were equipped with 1 mm thick GFRP sheets in two, three, and four layers. The experimental investigation demonstrated that HVFA concrete slabs reinforced with GFRP sheets present a more sustainable alternative compared to steel reinforcement, thereby contributing to sustainable construction. This study further underscores the potential use of high-volume fly ash as a cement replacement in concrete slabs, offering an effective means of mitigating the impact of greenhouse gas emissions and promoting sustainable construction.

Prabhath et al. [5] conducted a review of existing research on concrete containing various percentages of sugarcane bagasse ash (SCBA) as a partial replacement for OPC. The potential to minimize the cost of concrete in large-scale construction via the incorporation of suitable amounts of SCBA while meeting required standards and specifications was investigated as well. Based on the literature, it was concluded that SCBA shows promise as a viable partial replacement material for OPC. This research could be extended to explore additional cement replacement materials, which, when combined with SCBA, may contribute to the development of low-cost and high-performance concrete.

Chinnasamy et al. [6] presented the results of an experimental investigation on the cyclic response of a GFRP beam column infilled with high-volume-fly-ash engineered cementitious composites (HVFA-ECC), incorporating 60%, 70%, and 80% fly ash as a replacement for cement. Consequently, GFRP sections infilled with HVFA-ECC could serve as lightweight structural components in buildings intended for construction in earthquake-prone areas. The utilization of high-volume fly ash, a byproduct of coal-burning power plants, in conjunction with manufactured sand in ECC due to the scarcity of river sand, not only enhances the structural properties of the engineered cementitious composite (ECC) but also contributes to a reduction in CO_2 emissions.

Sivanantham et al. [7] investigated the effects of carbon fiber mesh jacketing and steel fiber reinforcement at the plastic hinge length of a concrete beam subjected to a vertical monotonic load. Rather than distributing steel fibers throughout the entire span of the beam, they concentrated them solely at the plastic hinge length. This approach yielded comparable performance outcomes under monotonic loading while reducing the number of fibers, making it a more economical alternative. Meanwhile, they used carbon fiber jacketing for the whole beam span with fiber being placed at the plastic hinge length, which showed the best performance outcome when compared to that of other techniques.

Durairaj et al. [8] conducted an experimental study on the flexural behavior of sustainable reinforced cement concrete (RCC) beams featuring a smart mortar layer incorporated into the concrete mixture. The experimental results demonstrated that the smart mortar layer could detect damage in the RCC beams and interpret the damage through electrical measurements, enhancing the sustainability of the beam. Notably, compared to the hybrid brass-carbon-fiber-incorporating mortar layer, the brass-fiber-incorporating mortar layer exhibited a substantial increase in the fractional change in electrical resistivity (f_{cr}) values.

Koppula et al. [9] maximized the use of plastic waste to manufacture bricks that match the properties of conventional bricks without negatively impacting the environmental or ecological balance. These bricks were produced using a well-balanced mixture of high-density polyethylene (HDPE), quartz sand, and certain additive materials such as bitumen. The incorporation of HDPE and quartz sand ensured that the bricks were void-free and free of alkalis, making them a suitable and environmentally friendly choice for the construction industry.

Philip et al. [10] conducted a comprehensive analysis of well-known pre-trained networks for the classification of cracks in concrete buildings. The classification performance outcomes of convolutional neural network designs, including VGG16, VGG19, ResNet 50, MobileNet, and Xception, was compared using a concrete crack image dataset. This study revealed that the features acquired through training are highly accurate when applied to various materials. Pre-trained networks emerge as an excellent choice for the application of convolutional neural networks (CNNs) in crack detection tasks, as they require fewer training samples and exhibit a faster convergence rate.

The editors of this Special Issue express sincere appreciation to all the authors who generously shared their scientific knowledge and expertise. Their contributions do not only enrich this Special Issue but also significantly advance research in the field. The meticulous evaluation of numerous submissions conducted by peer reviewers deserves recognition, as their valuable insights and constructive feedback have markedly improved the overall quality of the papers published in this Special Issue. Lastly, the editors extend their gratitude to the Managing Editors of the Journal of Composites Science for their steadfast support throughout the entire process. Their dedication and assistance played a crucial role in ensuring the successful completion of this Special Issue. We hope that 'Sustainable Composite Construction Materials' will become a valuable resource for researchers, practitioners, and students in science and engineering. We believe that the presented findings and insights will contribute to a deeper understanding of sustainable construction, and we anticipate that the innovative solutions discussed in these papers will inspire further research and advancements in this field.

Challenges and Considerations: While the potential benefits of sustainable composite construction materials are evident, challenges persist. The upfront cost, durability, and end-of-life considerations require careful attention. Sustainable composite construction materials stand at the forefront of a paradigm shift in the construction industry, offering a path towards the development of environmentally friendly resilient buildings and infrastructures. As innovation continues to drive the development of these materials, their integration into mainstream construction practices holds the promise of a more sustainable and regenerative built environment. The pursuit of sustainable construction is not merely a choice but an imperative for a resilient and environmentally conscious future.

Conflicts of Interest: The authors declare no conflict of interest.

List of Contribution

1. Sambucci, M.; Sibai, A.; Fattore, L.; Martufi, R.; Lucibello, S.; Valente, M. Finite Element Multi-Physics Analysis and Experimental Testing for Hollow Brick Solutions with Lightweight and Eco-Sustainable Cement Mix. *J. Compos. Sci.* **2022**, *6*, 107.
2. Madan, C.S.; Munuswamy, S.; Joanna, P.S.; Gurupatham, B.G.; Roy, K. Comparison of the Flexural Behavior of High-Volume Fly Ash Based Concrete Slab Reinforced with GFRP Bars and Steel Bars. *J. Compos. Sci.* **2022**, *6*, 157.
3. Sivanantham, P.; Gurupatham, B.G.A.; Roy, K.; Rajendiran, K.; Pugazhlendi, D. Plastic Hinge Length Mechanism of Steel-Fiber-Reinforced Concrete Slab under Repeated Loading. *J. Compos. Sci.* **2022**, *6*, 164.
4. Madan, C.S.; Panchapakesan, K.; Reddy, P.V.A.; Joanna, P.S.; Rooby, J.; Gurupatham, B.G.A.; Roy, K. Influence on the Flexural Behaviour of High-Volume Fly-Ash-Based Concrete Slab Reinforced with Sustainable Glass-Fibre-Reinforced Polymer Sheets. *J. Compos. Sci.* **2022**, *6*, 169.
5. Prabhath, N.; Kumar, B.S.; Vithanage, V.; Samarathunga, A.I.; Sewwandi, N.; Maduwantha, K.; Madusanka, M.; Koswattage, K. A Review on the Optimization of the Mechanical Properties of Sugarcane-Bagasse-Ash-Integrated Concretes. *J. Compos. Sci.* **2022**, *6*, 283.
6. Chinnasamy, Y.; Joanna, P.S.; Kothanda, K.; Gurupatham, B.G.A.; Roy, K. Behavior of Pultruded Glass-Fiber-Reinforced Polymer Beam-Columns Infilled with Engineered Cementitious Composites under Cyclic Loading. *J. Compos. Sci.* **2022**, *6*, 169.
7. Sivanantham, P.; Pugazhlendi, D.; Gurupatham, B.G.A.; Roy, K. Influence of Steel Fiber and Carbon Fiber Mesh on Plastic Hinge Length of RCC Beams under Monotonic Loading. *J. Compos. Sci.* **2022**, *6*, 374.
8. Koppula, N.K.; Schuster, J.; Shaik, Y.P. Fabrication and Experimental Analysis of Bricks Using Recycled Plastics and Bitumen. *J. Compos. Sci.* **2023**, *7*, 111.

9. Durairaj, R.; Varatharajan, T.; Srinivasan, S.K.; Gurupatham, B.G.; Roy, K. Experimental Investigation on Flexural Behaviour of Sustainable Reinforced Concrete Beam with a Smart Mortar Layer. *J. Compos. Sci.* **2023**, *7*, 132.
10. Philip, R.E.; Andrushia, A.D.; Nammalvar, A.; Gurupatham, B.G.A.; Roy, K. A Comparative Study on Crack Detection in Concrete Walls Using Transfer Learning Techniques. *J. Compos. Sci.* **2023**, *7*, 169.