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Editorial: Structural applications of concrete with recycled solid wastes and alternatives for cement

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Editorial on the Research Topic
Editorial: Structural applications of concrete with recycled solid wastes and alternatives for cement

Concrete, as the most widely utilized construction material, has long been central to discussions on sustainability due to its intensive consumption of natural resources and significant carbon footprint. In light of increasing environmental and economic challenges, there is a growing interest among researchers and engineers in developing sustainable alternatives by integrating recycled solid waste and alternative binders into concrete. This paradigm shift not only addresses issues of waste management and resource depletion but also supports the advancement of innovative, high-performance materials suitable for structural applications. This special issue compiles a diverse range of original research and review articles focused on recent advances in sustainable concrete. The contributions span material development, durability assessment, and emerging computational and experimental strategies for optimizing mix design and structural behavior. These works collectively highlight the transition toward environmentally responsible, high-performance construction solutions.

Chen et al. proposed a systemic approach for the reuse of construction waste from abandoned buildings by establishing a material flow analysis and an evaluation index system. Their study identifies critical opportunities and challenges in the recycling process and offers a valuable framework for advancing circular economy practices within the built environment.

As far as material development is concerned, Umar et al. investigated the incorporation of bentonite clay and quarry dust as supplementary cementitious materials. Their findings indicate enhancements in compressive strength and resistance to both hydrochloric and sulfuric acids, underscoring the potential of these materials as sustainable and cost-effective alternatives to traditional cement. He et al. employed machine learning, specifically support vector regression, to predict the mechanical behavior of cement-based materials filled with

PVA-modified waste rubber. Their results affirm the utility of AI-driven tools in optimizing mix design and forecasting performance with high accuracy.

Bond behavior between concrete and steel reinforcement remains critical in structural applications. Shusen et al. explored the effect of a sludge-modified magnesium phosphate coating on bond performance. While bond strength improved for plain bars, a slight reduction was observed in ribbed bars, suggesting the need for differentiated strategies depending on reinforcement type.

Zhou et al. addressed long-term performance through enhanced creep modeling of green concrete. Utilizing the Weeks method of inverse Laplace transform, they obtained continuous retardation spectra with improved accuracy and computational efficiency. This advancement supports more reliable long-term structural analysis and deformation prediction.

Structural innovations were explored through advanced composite systems. Liu et al. introduced a novel multi-chamber concrete-filled steel tube (CFST) column with round-ended sections to enhance seismic performance. Static load testing confirmed increased ductility and energy dissipation. Jun et al. investigated CFST circular arches, analyzing the effects of geometric and material parameters. Their experimental and numerical studies revealed that arch foot slip and local buckling notably influence load-bearing capacity, offering practical insights for the design of underground support structures.

The reduction of CO_2 emissions is another central theme. Wang et al. examined the role of dispersants in nanocarbon black-modified cement paste. Their findings show that improved dispersion enhances mechanical and electrical properties, accelerates snow-melting performance, and lowers energy use and carbon emissions based on life-cycle assessment (LCA). Similarly, Ning et al. developed permeable concrete using alkali-activated sintered sludge and slag. Their work demonstrates that increasing sludge content significantly decreases CO_2 emissions while preserving adequate permeability, providing a viable solution for sustainable urban infrastructure.

Altogether, these contributions illustrate the breadth and depth of contemporary research on sustainable structural concrete. By integrating recycled materials and alternative binders and adopting advanced modeling and design techniques, researchers are paving the way toward environmentally responsible and economically feasible construction practices. The studies highlighted here demonstrate the value of interdisciplinary collaboration and innovation in achieving high-performance, sustainable infrastructure.

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