

## Special Issue

# Multi-Target Machine Learning Model for Optimized and Sustainable Concrete

### Message from the Guest Editors

Concrete is the most used construction material, but its production is energy-intensive, emits high CO<sub>2</sub>, and consumes vast resources. Sustainable alternatives like alkali-activated materials, geopolymer, and blended systems with fly ash, slag, or agricultural wastes are gaining interest. These materials show complex interactions from precursor, activator, curing, and mix design, causing nonlinear and interdependent performance. Traditional methods struggle with these relationships, especially for multiple criteria. Machine learning (ML) offers a data-driven solution. ML models map constituents to performance. Ensemble and stacking-based hybrid models improve accuracy and robustness by combining learners. A multi-target ML approach enables simultaneous prediction of strength, durability, workability, carbon footprint, and cost. Unlike single-target models, it accounts for trade-offs. This Special Issue on an integrated multi-target ensemble learning framework supports sustainable concrete design by balancing performance, durability, and environmental impact, while reducing experimental effort and accelerating innovation.

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## Materials

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