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Case study

An agile, intelligent and scalable framework for mix design optimization of green concrete incorporating recycled aggregates from precast rejects

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ABSTRACT

Recent advances highlight the potential of low-carbon concrete using recycled aggregates from precast rejects. This material, called precast recycled aggregate concrete (PRAC), shows superior properties compared to traditional recycled aggregate concrete. However, accurately predicting PRAC's mechanical properties remains challenging due to numerous influencing variables. This challenge is further compounded when PRAC's design must align with mechanical, economic and ecological objectives. In light of these challenges, this study presents a framework that leverages Bayesian model updating and metaheuristic techniques to optimize PRAC's mix proportions. Initially, a comprehensive database was compiled from existing literature. Subsequently, employing Bayesian model updating, two definitive expressions were established linking PRAC's mechanical strengths to key variables. Finally, a multi-objective optimization approach, integrating the posterior model and the Cuckoo search algorithm, was devised to identify optimal mix designs for PRAC. The proposed models adeptly capture PRAC's nuanced property trends, while the Bayesian-Cuckoo search hybrid significantly expedites the mix optimization process. Results advocate for a minimum of 60 % recycled aggregate substitution to strike a balance between PRAC's strength and environmental impact. In essence, this framework furnishes dependable solutions for PRAC formulations and demonstrates adaptability for potential use in broader concrete mix design scenarios.

1. Introduction

To achieve long-term sustainability, the civil and infrastructure sector must transition from its traditionally resource-intensive practices to a cleaner and more eco-friendly development approach [1–6]. Precast construction is gaining prominence, thanks to

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