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Stochastic approach to quantify structural performance of Recycled Aggregate Concrete (RAC)

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ABSTRACT

This study assesses the structural performance and degradation of Recycled Aggregate Concrete (RAC) compared to Natural Aggregate Concrete (NAC). Utilizing recycled aggregates (RA) reduces waste, aligning with environmental sustainability goals, but these materials often exhibit diminished mechanical properties due to inherent microcracks from prior usage cycles. This degradation, evaluated through the water absorption (Wa) of RA, prompts conservative design specifications that limit RAC's broader application. The research adapts Xiao's stress-strain model to account for variations in Wa, using a comprehensive numerical analysis to classify RAC quality and accurately predict the mechanical performance of reinforced concrete (RC) members under different loading conditions. Probabilistic approaches assess material uncertainty, refining the analysis of RAC's structural components. Results show that RAC beams can maintain structural resistance within 5% of that of NAC beams for Wa up to 10%, suggesting no need for increased sectional dimensions. However, RAC columns display greater variability in performance, necessitating design correction factors and sectional adjustments to achieve up to 95% of the resistance capacity of equivalent NAC columns. These findings propose engineering solutions to enhance the practical applicability of RAC, facilitating its adoption in sustainable construction practices while maintaining structural integrity and performance.

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