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# Incorporating Compressive Strength Statistical Models into Multi-Objective Optimization: An Approach for Mixture Proportioning of Sustainable Concrete Mixtures

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**Abstract:** Concrete mixtures are complex material systems with a multitude of characteristics that decision-makers may deem important. These characteristics can include economic, environmental, and physical properties of a concrete mixture. This paper utilizes a new hybrid approach for both modelling important physical properties of concrete and incorporating these prediction models in to a multi-objective optimization problem for optimizing concrete mixture performance. Specifically, a tree-based, random forest statistical model is employed to predict the compressive strength of concrete. Mixtures. Compressive strength is predicted as a function of the proportions of the mixture constituents because these relationships are known to be complex and highly nonlinear. Other concrete objectives such as cost, durability, embodied, energy, embodied carbon, and slump are modelled with physics-based or linear combination models. These relationships are then incorporated into a multi-objective evolutionary algorithm to examine trade-offs between conflicting objectives. Selected solutions are visualized using parallel axis plots. Furthermore, the effect of the use of ANN models on computational effort and predictive performance of the objectives is discussed.

**Keywords:** Tree-based models; multi-objective optimization; concrete; predictive modelling.