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Application of Machine Learning Algorithm for Prediction of Failure Loads and Fracture Characteristics of High Strength Concrete and Ultra-High Strength Concrete Beams

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Abstract:	The construction sector benefits from the development of artificial intelligence (AI) systems because they can more accurately forecast the mechanical properties of concrete, which saves time, money, and effort. However, there hasn't been enough research done on ultra-high strength concrete (UHSC). Therefore, this work examines the use of sophisticated AI approaches to forecast the failure loads and fracture characteristics of high strength concrete (HSC) and ultra-high strength concrete (UHSC) beams. In order to develop Machine Learning (ML) models, a dataset of 87 experimental tests with seven input variables was collected from the published literature. Four ML models, namely the Extreme Gradient Boosting (XGB), the Random Forest (RF), the Convolutional neural network (CNN) and K-nearest neighbors (KNN) were developed. The prediction effectiveness and generalizability of the created models are validated using a wide range of performance parameters once a regression model has been adjusted. In both the stages of training and testing, the employed ML models show a significant correlation (correlation coefficient > 0.97) between the experimental and predicted values for four different outputs, namely failure loads (Pmax), fracture energy (GF), critical stress intensity factor (KIC), and critical crack tip opening displacement (CTODC). The proposed XGB model outperformed CNN, KNN, and RF during the testing phase, achieving the best accurate prediction. Based on the findings of the paper, the developed XGB model can be used as an alternate tool for estimating the Failure Loads and Fracture Characteristics of HSC and UHSC Beams in civil engineering projects.