Compressive Strength Estimation of Ultra-High Performance Fiber Reinforced Concrete (UHPFRC) for Retrofitting of Reinforced Concrete Elements

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Over the years, concrete structures have played a pivotal role in shaping urban landscapes. However, one critical concern in recent times is that most concrete structures may undergo premature deterioration as a combined effect of significantly increased live loads and aggressive environmental conditions. As the traditional and primal method of demolishing and rebuilding structures is detrimental to the environment and a massively expensive process, the introduction and implementation of innovative and cost-effective methods are required to extend the service life of reinforced concrete structures. Ultra-high Performance Fiber Reinforced Concrete (UHPFRC) has been identified as one of the most promising retrofitting materials due to its remarkable mechanical properties, low permeability, and durability. Selecting the optimum mix design is a pivotal factor in conducting effective retrofitting of concrete structures. Given the inherent complexity of UHPFRC due to the involvement of numerous constituents, comprehending the influence of each parameter on the compressive strength of the material is essential. Therefore, in this research, a comprehensive sensitivity analysis was conducted to investigate the key influential parameters of the compressive strength of UHPFRC. A database comprising 200 datasets from previous experiments was developed and the Random Forest Regression technique was selected as a suitable machine learning approach to predict the compressive strength of different UHPFRC mixes. Performance evaluation was carried out using three statistical parameters: determination coefficient (R^2), Mean Square Error (MSE), and Mean Absolute Error (MAE). R^2, MSE, and MAE for the model were calculated as 97.90, 7.13, and 0.866, respectively. The results of the sensitivity analysis highlighted that the water-to-binder ratio was the most influencing parameter to the compressive strength of UHPFRC. Superplasticizers, supplementary cementitious materials, cement, and fiber volume also showed high feature importance values while fiber type, fillers, and aspect ratio were found to have comparatively lower influence on compressive strength.

Keywords: UHPFRC, Compressive strength, Sensitivity analysis, Random forest regression

Acknowledgment: This research is funded by the University Research Grant (Grant No: URG/2023/16/E)