Modelling mechanical strengths of blended cement concrete incorporating corncob ash and calcite powder: experimental and machine learning approaches

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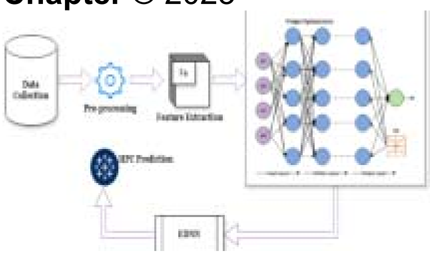
Abstract

The building and construction sector has focused on sustainable cement alternatives due to the rise in carbon dioxide emissions caused by rising cement usage. Blended Cement Concrete (BCC) enhanced with Supplementary Cementitious Materials (SCMs) such as Corncob Ash (CCA) and Calcite Powder (CP) offers a sustainable substitute. Thus, this study utilized Deep Neural Networks (DNNs) to predict the Compressive Strength (CS), Flexural Strength (FS), and Split Tensile Strength (STS) (output variables) of BCC with respect to the mixed design proportions as input variables using concrete classes 25 and 30 MPa after 3–120 curing days. The DNNs were chosen for their ability to learn complex patterns and relationships in the data, making them suitable for predicting the mechanical strengths of the BCC. The models were trained with an experimental data set consisting of 100 values for each strength feature. A set of 8 raw experimental values were used to verify the accuracy of the developed model. The 8–20-20–20-1 network structures exhibited the best performance metrics for training, validating, and testing the input and output variables compared to other architectures. For CS, FS, and STS, the correlation coefficient (R) values were 99.97, 98.69, and 97.24%. There was a strong correlation with 98.82, 99.61, and 99.54% R^2 for CS, FS, and STS when the developed models were validated using raw experimental datasets. The standard of BCC integrating SCMs would be improved by using this approach.



Data and Code availability

The complete results of mechanical properties (CS, FS, and STS) and code generation are freely accessible through open access in the Zenodo Repository at https://zenodo.org/doi/https://doi.org/10.5281/zenodo.10997686.

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Contributions

Author contributions S.O. conceptualized and designed the study, S.O. collected the data, S.O., M.I.S., S.O.O. and R.S. analysed and interpreted the results, S.O. analysed the data with software, and S.O. wrote the manuscript in consultation with M.I.S., S.O.O. and R.S. All authors reviewed the manuscript.

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Ethics declarations

Conflict of interest

The author declares that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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