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RESEARCH

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Soft computing techniques to predict the compressive strength of groundnut shell ash-blended concrete

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Abstract

Using groundnut shell ash (GSA) as a component in concrete mixtures is a viable approach to achieving sustainability in building practices. This particular kind of concrete has the potential to effectively mitigate the issues associated with high levels of CO_2 emissions and embodied energy, which are primarily attributed to the excessive utilization of cement in conventional construction materials. When GSA is utilized as a partial replacement for cement, the strength characteristics of concrete are influenced not only by the quantity of GSA replacement but also by several other factors, including cement content, water-to-cement ratio, coarse aggregate content, fine aggregate content, and curing length. This work demonstrates a predictive model for the compressive strength (*CS*) of GSA mixed concrete using ML methods. The models were constructed with 297 datasets obtained from published literature. These datasets included various input variables such as cement content, GSA content, fine aggregate content, coarse aggregate content, water need, and curing duration. The output variable included in the models was the *CS* of concrete. In this study, a set of seven machine learning algorithms was utilized as statistical assessment tools to identify the most precise and reliable model for predicting the *CS* of GSA mixed concrete. These techniques included linear regression, full quadratic model, artificial neural network, boosted decision tree regression, random forest regression, K nearest neighbors, and support vector regression. The present study evaluated several machine learning models, and it was shown that the random forest regression model had superior performance in forecasting the *CS* of GSA mixed concrete. The train data's R^2 is 0.91, with RMSE of 2.48 MPa. Similarly, for the test data, the R^2 value is 0.89, with an RMSE of 2.42 MPa. The sensitivity analysis results of the random forest regression model indicate that the cement content primarily drives the material's *CS*. Subsequently, the curing period and GSA content significantly impact the *CS*. This work systematically evaluates the *CS* of GSA mixed concrete, contributing to the existing body of knowledge and practical implementation in this domain.

Keywords: Concrete, Groundnut shell ash, Compressive strength, Machine learning, SHAP analysis