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PREDICTING THE DEPENDENCY OF SOIL SHEAR WAVE VELOCITY ON SATURATION USING MACHINE LEARNING MODELS

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Abstract

Dynamic soil parameters, including shear wave velocity (Vs), shear modulus, and damping ratio, are critical in geotechnical and seismic engineering. The soil's saturation level significantly affects these characteristics. Conventional experimental techniques for measuring Vs are frequently laborious, expensive, and inappropriate for quick evaluations. Precisely simulating the nonlinear interaction between Vs and soil properties, especially saturation, continues to present challenges.

This study aims to estimate Vs using machine learning methods, including Support Vector Regression (SVR), Random Forest Regression (RFR), Gradient Boosting (GBoost), and Extreme Gradient Boosting (XGBoost). A dataset including six input variables was employed. K-fold cross-validation was applied during training to ensure model reliability and reduce the possibility of overfitting. The model's efficacy was assessed by statistical metrics: correlation coefficient R^2, Mean Absolute Error (MAE), and Root Mean Square Error (RMSE). The Random Forest model surpassed the others, attaining an R^2 of 0.893 with reduced MAE and RMSE values. Machine learning methodologies, particularly Random Forest with cross-validation, provide precise, rapid, and economical prediction of Vs.

This methodology offers innovative suggestions for efficient and non-invasive dynamic soil characterization, which enhances seismic geotechnical analysis and environmental engineering by improving the understanding of subsurface conditions that are essential for sustainable land use and infrastructure design.

Key words: degree of saturation, machine learning, prediction, shear wave velocity, statistical tests

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