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Prediction of Rockfill Materials' Shear Strength Using Various Kernel Function-Based Regression Models—A Comparative Perspective

(2022) *Materials*, 15 (5), art. no. 1739, .

DOI: 10.3390/ma15051739

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Abstract

The mechanical behavior of the rockfill materials (RFMs) used in a dam's shell must be evaluated for the safe and cost-effective design of embankment dams. However, the characterization of RFMs with specific reference to shear strength is challenging and costly, as the materials may contain particles larger than 500 mm in diameter. This study explores the potential of various kernel function-based Gaussian process regression (GPR) models to predict the shear strength of RFMs. A total of 165 datasets compiled from the literature were selected to train and test the proposed mod-els. Comparing the developed models based on the GPR method shows that the superlative model was the Pearson universal kernel (PUK) model with an R-squared (R2) of 0.9806, a correlation coef-ficient (r) of 0.9903, a mean absolute error (MAE) of 0.0646 MPa, a root mean square error (RMSE) of 0.0965 MPa, a relative absolute error (RAE) of 13.0776%, and a root relative squared error (RRSE) of 14.6311% in the training phase, while it performed equally well in the testing phase, with R2 = 0.9455, r = 0.9724, MAE = 0.1048 MPa, RMSE = 0.1443 MPa, RAE = 21.8554%, and RRSE = 23.6865%. The prediction results of the GPR-PUK model are found to be more accurate and are in good agreement with the actual shear strength of RFMs, thus verifying the feasibility and effectiveness of the model.

Author Keywords

Gaussian functions; Pearson universal kernel; Polynomial kernel; Radial basis function; Rockfill materials; Shear strength

Index Keywords

Cost effectiveness, Errors, Forecasting, Functions, Mean square error, Regression analysis, Rock mechanics, Shear strength, Well testing; Gaussian functions, Gaussian process regression, Kernel function, Kernel models, Mean absolute error, Pearson universal kernel, Polynomial kernels, Rock fill materials, Root mean square errors, Shears strength; Radial basis function networks

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Publisher: MDPI

ISSN: 19961944

Language of Original Document: English
Abbreviated Source Title: Mater.
2-s2.0-85125199853
Document Type: Article
Publication Stage: Final
Source: Scopus