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MACHINE LEARNING MODELS FOR PREDICTING THE COMPRESSIVE STRENGTH OF CONCRETE WITH SHREDDED PET BOTTLES AND M-SAND AS FINE AGGREGATE

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Abstract

Machine Learning (ML) and Artificial Intelligence (AI) are closely intertwined and represent the latest cutting-edge technologies that facilitate the development of intelligent prototypes. Machine learning is a critical subset of AI that deliberates the development of self-trained algorithms that use previous databases and analysis for result predictions. By leveraging past data, machine learning empowers computers to make predictions and decisions. This study investigates the use of ML algorithms to predict the compressive strength of grade 30 concrete, incorporating shredded PET bottles and M-sand as fine aggregates. The experimental setup involved preparing concrete specimens

with shredded PET bottle aggregates, varying the volume from 0% to 2% in increments of 0.5%. Different percentages of M-sand were incorporated at 25%, 50%, 75%, and 100%. The mixing proportions adhered to the standards defined by the Department of Environment (DOE). Cubic specimens were cast and cured for 7, 28, and 90 days. The study employs Multiple Linear Regression (MLR), Artificial Neural Network (ANN), and Decision Tree (DT) models, using the experimental data for predictive analysis. The evaluation of the three models for predicting compressive strength yielded interesting results: The Decision Tree (DT) model demonstrated the best performance, with a relatively low Mean Squared Error (MSE) of 5.125 and Mean Absolute Error (MAE) of 1.642 and a high R^2 value of 0.918, indicating that the model explains approximately 91.8% of the variance in the target variable. The DT model's ability to handle complex, non-linear data relationships made it particularly effective in evaluating concrete strength. The Multiple Linear Regression (MLR) model provided reasonable predictions but showed higher errors compared to the DT model, with MSE and MAE values of 26.663 and 4.298, respectively, and an R^2 score of 0.571, demonstrating a moderate ability to explain the variance in the data. Conversely, the Artificial Neural Network (ANN) model exhibited the least accuracy, with the highest errors (MSE of 112.33 and MAE of 8.52) and a negative R^2 score (-0.64), indicating poor model training and an inability to capture the relationships between parameters effectively, partly due to the relatively small dataset. The study highlights the potential of DT models in sustainable construction practices, emphasizing the importance of comprehensive datasets and further exploration of alternative algorithms. The findings advocate for using ML in concrete strength prediction, contributing to advancements in sustainable engineering and material science.

Author keywords

Decision Tree (DT) and Artificial Neural Network (ANN); M-sand; Multiple Linear Regression (MLR); PET Bottles

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