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RESEARCH

Soft computing techniques to predict the electrical resistivity of pervious concrete

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Abstract

The objective of the present study was to assess how electrical resistivity (ER) of pervious concrete changes with three parameters: aggregate size, aggregate/cement (A/C) ratio and compaction energy. The pervious concrete cubes were cast using three sizes of aggregates, five A/C ratios (3.5, 4.0, 4.5 and 5.0) and five levels of compaction energy (0, 15, 30, 45 and 60 blows by protector hammer) to evaluate the effect of these parameters on ER. The aggregate sizes were 5–12, 12–18 and 18–25 mm. The study produced 225 pervious concrete cubes with 15 different mix designs, and ER was measured. The study analyzed the test data and developed a prediction model using machine-learning (ML) techniques to establish the associations between the three design parameters and the ER. Out of six machine-learning models examined, the random forest regression model and the K nearest neighbor model performed the best in predicting the ER.

Keywords Pervious concrete · ER · Compaction energy · Machine learning · SHAP

Introduction

Pervious concrete is a type of concrete that lets water pass through it. This reduces the amount of runoff from a site and helps replenish groundwater resources. It consists of cement, coarse aggregate and water. It has a high porosity of 15 to 35 percent. Some of the applications of pervious concrete are parking areas, residential streets, pedestrian walkways, greenhouses, stormwater management, tree protection, etc. The selection of characteristics of pervious concrete such as porosity, permeability and strength depends on its intended application. These characteristics depend on several parameters, such as the type and size of the aggregates, the cement/aggregate ratio, the water/cement ratio, the compaction energy (2022b; Anburuvel & Subramaniam, 2022a; Huang et al., 2020; Subramaniam & Sathiparan, 2022). Therefore, it is essential to measure these pervious concrete parameters accurately and consistently (Anburuvel & Subramaniam, 2022c). Although destructive laboratory testing is recommended for determining these values, recently non-destructive tests (NDT) have been utilized to predict the characteristics of pervious concrete (Sathiparan et al., 2023a). Ultrasonic velocity (UPV), electrical resistivity (ER) and rebound hammer tests are commonly used NDT methods to predict the characteristics of previous concrete.

An ER test is a method that measures the electrical resistance of a material, such as metal or concrete. Electrical resistance is the property of a material that determines how well it can resist the flow of electric current which is the opposite of electrical conductance. The ER of the material predominantly depends on the material type, composition, temperature and moisture content. Therefore, ER can be utilized to determine the characteristics and quality of different materials. In such a way, ER could be utilized to evaluate the water content, porosity and compaction of concrete or rocks. Although several published literature focuses on ER of concrete and the use of ER in the prediction of characteristics of concrete (Ferreira & Jalali, 2010; Lu et al., 2021; Ramezanianpour et al., 2011; Wei et al., 2012), only limited studies are available on ER of pervious concrete. As such, ER is one of the useful NDT to assess the compressive strength as well as durability of the construction materials.

Engineers are increasingly utilizing machine-learning (ML) techniques to predict the characteristics of construction materials and also to characterize materials (Ahmad

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