PREDICTION ON THE MECHANICAL STRENGTH OF COAL ASH CONCRETE USING ARTIFICIAL NEURAL NETWORK

Muhammad Nor Syahrul Zaimi[1], Nur Farhayu Ariffin[2*], Sharifah Maszura Syed Mohsin[3], Abdul Muiz Hasim[4] Nurul Natasha Nasrudin[5]

[1]Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak 26300 Gambang, Pahang, Malaysia
**farhayu@ump.edu.my*

Keywords: COAL BOTTOM ASH, MECHANICAL STRENGTH, MACHINE LEARNING, REGRESSION MODEL, JUPYTER NOTEBOOK

Abstract

Machine learning approaches are essential for assessing the mechanical strength of concrete in civil engineering. With little work and expenditure, machine learning algorithms provide remarkable accuracy. However, these methods need information on the proportions of various components used including water, cement, aggregate, etc. This study uses a dataset that contains information on the composition of 105 distinct types of materials. The collection contains both conventional and cutting-edge materials that include fly ash (FA) and coal bottom ash (CBA) in addition to other essential components of concrete mix. Since CBA and FA are waste and by-products materials, adding it to the concrete mix helps create concrete that is environmentally beneficial. The prediction of concrete compressive strength is therefore made more difficult by the addition of more elements to the concrete. To maintain the safety of building projects, it is crucial to anticipate the compressive strength (CS) of concrete containing coal ash. This study presents the most accurate methods of the exact prediction in term of compressive and flexural strengths of concrete containing CBA and FA. The prediction incorporates the decision tree, linear regression (LR), and random forest through soft voting. This type of analysis involves one or more independent variables that may most accurately predict the value of the dependent variable and calculates the coefficients of the linear equation. The difference between the output values anticipated and those obtained is minimised by linear regression by fitting a straight line or surface. Model performance was evaluated using several well-known metrics, including R2, mean square error (MSE), mean absolute error (MAE), and root mean square error (RMSE) (R-square). With scores of 4.46 and 2.51, respectively, the random forest model beat the most sophisticated models, according to the findings. Random forest outperforms LR and decision tree in terms of computation efficiency. The application of 50 percent CBA into the concrete give an increasing strength compare to the other replacement in concrete along with duration of time. The mechanical strength prediction based on machine learning is more exact, accurate, and dependable than the standard concrete strength estimate.

1. Introduction

International Organization for Standardization (ISO) state that the infrastructure and structures may also be constructed using a variety of building materials A variety of natural resources are often used in the assembly of construction components. Typically, information on the materials used in building is arranged singularly to support the specific substance, such as steel or cement, and its application in several other industries. Numerous studies have looked at how to make concrete mixtures more successful by using more environmentally friendly materials, to enhance the mechanical properties of the concrete [1], [2] and reducing cost of concrete manufacturing [3]. The aforementioned areas have attracted more interest, which supports the necessity for more study on all elements of concrete mixing parameters as well as improvements in experimental methods and viable alternate solutions with the aim of cutting costs and time. [4]. There are limited comprehensive data available for the usage of materials across the whole global building value chain. The main source of construction and demolition debris that contributes significantly to excessive global land filling is masonry waste. It is made up of minute quantities of a wide range of wastes, including wastes from masonry, concrete, mineral, and other materials. [5]. Masonry waste is one of the main contributors of waste to landfills worldwide, measured by weight. In Malaysia, trash from the power plant industry is the most prevalent. More than half of the entire amount of coal waste must be disposed of every year out of all solid garbage [6] [7]. Typically, the finest concrete mixes are developed by preparing many test batches in the laboratory to meet a required performance. However, if completely other parameters must be forced to be produced, which takes time and money, the required number of samples may increase exponentially [8]. Additionally, even with a similar mixture percentage, the diversity of the natural action environment (humidity and temperature) and constituent qualities (the size and form of aggregates and kind of building material materials) may create modest changes in concrete