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RESEARCH PAPER

Evaluation and Estimation of Compressive Strength of *Concrete* Using Hybrid Modeling Techniques

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Abstract

The paper presents the research work carried out to predict the 28-day compressive strength of concrete with supplementary materials such as ash (fly ash, bottom ash) and silica fume using various data mining techniques. It mimics the decision-making ability of humans in imprecise and incomplete information situations. The model developed consists of 7 input parameters i.e., contents of cement, fine aggregates, coarse aggregates, silica fume, ash, water to cement ratio, superplasticizers, and one output parameter that is compressive strength at 28 days. The models used i.e., Gaussian Process (GP), Random Forest (RF), Artificial Neural Network (ANN) and ANN-Fire fly Algorithm (ANN-FFA) to estimate the compressive strength (MPa) at 28 days. The model developed is completely based on experimental data obtained from creditable literature available. The result of modeling techniques suggests that ANN-FFA based model works better than the other modeling techniques used in this study with Mean Square Error = 1.8099, Root Mean Square Error = 2.6584, and Coefficient of Correlation = 0.9370 with the testing dataset. Hence, these computational techniques suggest that it can be used to estimate the compressive strength of concrete at any stage. The sensitivity study concludes that RF is more sensitive to the absence of important parameters and less sensitive to the lack of less important parameters. Sensitivity analysis results using RF model suggest that Silica fume (kg/m^3) is the most important parameter for estimate the compressive strength of concrete using this data set.

Keywords Gaussian process · Random forest · Artificial neural network · Fire fly algorithm

1 Introduction

In the presentworld of the construction industry, the concrete is most basic and important material, as concrete can be used in many types in construction such as self-compacting concrete (SCC), Ready Mix Concrete (RMC), etc. Concrete is obtained by preparing a mixture of cement, sand, gravel, and water in predetermined specific proportions. The strength, durability, and other characteristics of concrete depend upon the properties, shape, texture,amount of coarse and fine aggregates, cement, superplasticizers, accelerators, etc., proportions of the mixes, and the method of compaction and other controls during placing, and curing. Concrete is widely used as construction material in many structures such as dams, building frames, etc. Concrete is essentially a mixture of paste and aggregate. The paste, comprised of cement and water, binds the aggregate into a hard mass; the paste hardens because of the chemical reaction of the cement and water called hydration. In concrete mix design and quality control, the compressive strength of concrete is considered as the most valuable property, which in turn is influenced by a number of factors. It is well recognized that prediction of concrete strength is important in modern concrete constructions and in engineering judgments. The tests for compressive strength are carried out at either 7 or 28 days from the date of placing the concrete. The testing at 28-days is standard and therefore essential and at other ages can be carried out if necessary. Compressive strength at various ages such as 7, 28, 56, and 90 days can be taken into consideration for the analysis of properties. Strength performance is the most important of all other properties of concrete. But due to some circumstances, if the resulting compressive strength is not up to the desired value than the whole of the process of concrete testing has to be repeated, which may be very time-consuming and costly.

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