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Compressive Strength Prediction of Self-Compacting Concrete Incorporating Silica Fume Using Artificial Intelligence Methods

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Abstract

This paper investigates the capability of utilizing Multivariate Adaptive Regression Splines (MARS) and Gene Expression Programing (GEP) methods to estimate the compressive strength of self-compacting concrete (SCC) incorporating Silica Fume (SF) as a supplementary cementitious materials. In this regards, a large experimental test database was assembled from several published literature, and it was applied to train and test the two models proposed in this paper using the mentioned artificial intelligence techniques. The data used in the proposed models are arranged in a format of seven input parameters including water, cement, fine aggregate, specimen age, coarse aggregate, silica fume, super-plasticizer and one output. To indicate the usefulness of the proposed techniques statistical criteria are checked out. The results testing datasets are compared to experimental results and their comparisons demonstrate that the MARS (R^2=0.98 and RMSE= 3.659) and GEP (R^2=0.83 and RMSE= 10.362) approaches have a strong potential to predict compressive strength of SCC incorporating silica fume with great precision. Performed sensitivity analysis to assign effective parameters on compressive strength indicates that age of specimen is the most effective variable in the mixture.

Keywords: Compressive Strength; Multivariate Adaptive Regression Splines; Gene Expression Programing; Self Compacting Concrete; Silica Fume.

1. Introduction

Concrete as one of the important construction materials has been commonly applied around the world. A number of accessible knowledge about concrete technology have been mostly generated in the different parts of world especially in the developed. Recently, special concrete types such as self-compacting concrete and high-performance concrete are widely applied. Among various trends and developments in building industry, the introduction of self-compacting concrete (SCC) represents acceptable potential and attracted interest to exploit the alternative raw materials, wastes, byproducts and secondary materials as mineral additives. It is commonly characterized as a special concrete which has desirable fluid features such as increasing flow capability, good segregation resistance and settling by its own weight even at the existence of congested reinforcement at deep and narrow element sections of non-conventional geometry. Thus, SCC has ability of consolidating itself without using the external and internal vibration during the placing processes. Therefore, it avoids bleeding and segregation and maintains its stability at the same time [1, 2].

Owing to the complicated composition which is required for SCC for accomplishing its favorable features, a suitable mix design process is crucial taking into account the available raw materials and proportioned with different chemical or mineral admixtures: an optimal balance among the fine materials, coarse and chemical admixtures is the challenge to

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