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Abstract

Prediction of 28-day Compressive Strength of Macau Cement

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The research of artificial neural networks (ANN) in prediction of properties of construction materials such as concrete had already begun for a certain period. With not great surprise, the ability of ANN to learn directly from historical process data and then represent them in system models was applicable for predicting the compressive strength of cement for a cement producer, though traditional statistical and simulation model were usually adopted. Due to the complexity of the chemistry and internal structure of cement paste, there was still no adequate theoretical approach for the determination of the relationship between strength and composition of cement. Therefore, it seemed better to use ANN methods than normal statistical model to characterize the behavior of this material.

This study presented an application of mathematical models to cement compressive strength prediction in a Macau cement factory (MCM). By using a feed-forward network with backpropagation (BP) learning algorithm, ANN models were developed for predicting the 28-day compressive strength of both Type I Ordinarily Portland Cement (OPC) and Type II Pulverized Fly Ash Portland Cement (PFAC), based on

more than 100 sets of historical data along 6 months. The ANN models were constructed with input variables which were relevant to the compressive strength, both directly and indirectly. The corresponding outputs were then compared mutually and with those from multiple linear regression (MLR) models.

The results of this study showed that predictions of cement compressive strength (in the case of OPC) by means of MLR models had maximum root mean square error of 2.36 MPa, maximum average error of 3.74% and 11.95% maximum individual error. In contrast, the ANN model had the corresponding error of 2.36 MPa, 3.77% and 12.04%, respectively. This showed both methods were able to predict the 28-day compressive strength of Macau cement successfully. For the case of PFAC, similar behavior occurred like OPC, of which both methods demonstrated accurate and stable performance. Also, in order to test the predictability of the mathematical models, an extra wider range of data was adopted by combining the OPC and PFA cement data. Prediction results could show that both mathematical models were applicable to handle various data, especially in the case of ANN.

In general, both ANN and MLR methods were suitable for use in prediction of cement compressive strength at 2-days' time after production. From this case study, the results provided a useful base for cement producers for optimization of the production process and maintaining a better stabilization of the cement strength, an important criteria for auto-control of quality of cement in a factory.