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An innovative approach for compressive strength estimation of mortars having calcium inosilicate minerals

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ABSTRACT

There are several factors that can affect on the quality of construction and all of the using elements, such as mortars, as a basic component of the building industry, are effective in the ability and performance of the building. Therefore, determination of strength of mortar is an important property in construction and many studies have been done to identify the effective parameters and the predictive relationships to determine the strength of mortars. In this paper, the effect of two types of materials including micro-Silica and also Calcium Inosilicate minerals on the compressive strength of mortars has been investigated by artificial neural networks. Also, a suitable relationship to estimate the considered strength is proposed based on the selected neural network. The results of the relationships show that these equations with a high accuracy have a proper ability and acceptance performance to predict the compressive strength of considered mortars.

1. Introduction

One of the most important parameters that have an effective rule on the quality of construction is mortars. In order to increase the capacity of this basic member of the building, the effects of many factors, such as humid [1] and thermal environment [2], acid climate [3] and also curing should be considered, but today there is a special attention to the type of materials used in mortars. Researchers have shown that some materials such as carbon fiber [4] and metal fiber [3] have the ability to increase the compressive strength of mortars and thus improve the quality of construction. The evaluating of mortars is based on the using materials for their preparation, including mineral material types or Silica fume. There are also several models for predicting their compressive strength using statistical methods or soft computing approaches. In the next sections, these issues are discussed.

1.1. Evaluating of mortars

There are several scientific studies that investigated the compressive strength as one of the most important properties for evaluating the mortars. Chen et al. [5] used a model for porous materials to determine the capacity relationship of mortars. Their results indicated that the relationship between compressive strength and tensile strength is not constant. Sabdono et al. [6] presented a method which used Nano-cement particles and increased the compressive strength of mortar. Their results also indicated that more research is required to find behavior patterns of Nano cement and its effect on mortars [6]. Some of the scientific studies used palm oil fuel ash as a replacement material in fly ash based geopolymer mortar and studied the compressive strength of mortar in those conditions [7,8]. The importance of the curing factor related to the delay time and curing temperature was evaluated by Mijarsh et al. [9]. They studied the effect of time and Sodium silicate on compressive strength of geopolymer mortar. It was found that mixtures with high Sodium silicate created the highest development in compressive strength.

1.2. Mineral admixtures of mortars

Admixtures are materials that are added in small amounts to mortars. They are used to improve the behavior of mortars and they generally are mineral. Many studies have investigated the influence of admixtures on mortars. Demirboğa [10] added silica fume, fly ash and also blast furnace slag as a replacement material for cement and investigated the influence of this mineral admixtures on compressive strength. The relationship between porosity of the cement paste with mineral additives and compressive strength was determined by Li et al. [11]. Pozzolan is a mineral admixture that is widely used in mortars and Ezziane et al. [12] investigated the compressive strength of mortars admixed with this material under various curing temperatures. Itim et al. [13] studied the effect of various amounts of mineral admixtures on compressive strength of cement mortars. Filler effect of fine particle river sand as a non-pozzolanic material was studied by Jaturapitakkul

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Table 1
Summary of considered database (mix proportion by weight).

Parameter	Median	Minimum	Maximum	Standard deviation
Microsilica	0.00	0.00	12.50	3.92
HRWR dosage	0.67	0.32	2.00	0.44
OPC	85.00	70.00	97.50	8.02
CIM	10.00	0.00	30.00	9.43
Age (Day)	44.00	3.00	126.20	365.00
Compressive Strength (MPa)	44.05	13.20	66.20	13.17

et al. [14]. The results showed that the compressive strength of mortar with smaller filler particles is higher than that of the coarser ones. Wang et al. [15] used ground granulated blast-furnace slag, fly ash and also steel slag and studied the influence of this materials on strength of mortar. Tudjono [16] studied the effect of Nano fly ash and Nano lime on mortars. Tugrul et al. [17] used feldspar, clay and mica minerals on mortars and showed that addition of clay and mica minerals in the sand would reduce the strength of mortar. Their results also indicated that the detrimental effects of feldspar and mica minerals on strength of mortar are greater with crushed un-weathered mica and feldspars than naturally-weathered mica and feldspar minerals. The effect of co-fired biomass fly ashes in compressive strength of mortars was studied by Wang [18]. The research showed that biomass-containing fly ash could increase the strength. Rao and Rao [19] investigated the compressive strength of geo-polymer and fly ash mortars in their research.

1.2.1. Silica fume in mortars

Silica fume is a common material which is used in mortars and Toutanji and El-Korchi [20] investigated the effect of this material on compressive strength of mortars. Their results indicated that partial replacement of cement by silica fume and addition of superplasticizer would increase the strength of mortars. Kadri et al. [21] used metakaolin and silica fume in their mixtures of mortars with the aim of evaluating the effect of these materials on the compressive strength. Their results showed that metakaolin has a pozzolanic activity higher than silica fume. The effect of Nano-sized powders of main oxides of cement on the compressive strength of mortars containing silica fume [22] and Nano silica [23] was also studied by researchers.

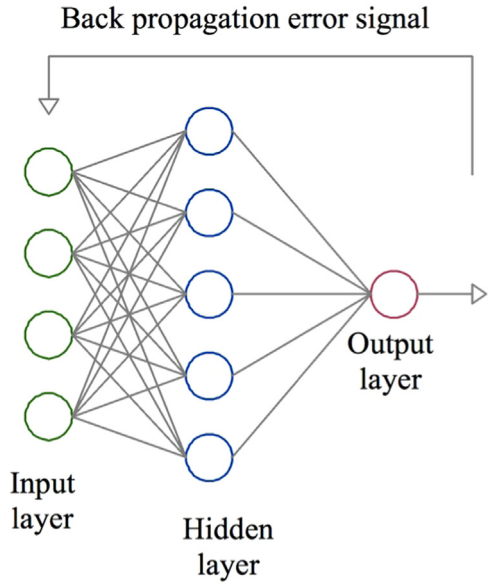

Fig. 2. Backpropagation neural network with 4 inputs and one output.

1.3. Prediction models

In civil engineering problems, estimation of the capacity of the elements is an important part of the design. In this section, the available models that are applied to determine the capacity of mortars are presented. These models are discussed under two categories includes theoretical and also soft computing approaches.

1.3.1. Theoretical approaches

There are conventional methods for predicting the compressive

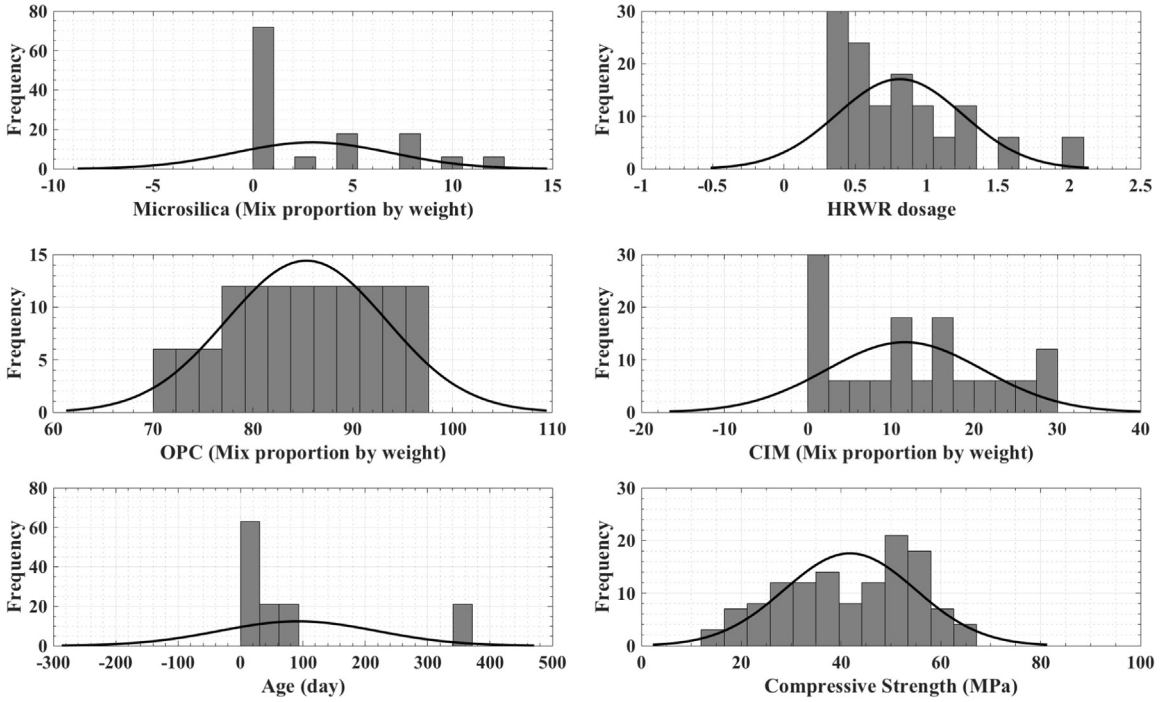

Fig. 1. The parameters Histograms of the considered database.

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