



Optimizing Compressive Strength of Micro- and Nano-silica Concrete by Statistical Method

Mahsa Zarehparvar-Shoja^a, Hamid Eskandari-Naddaf^{b*}

^a BS student, Department of Civil Engineering, Hakim Sabzevari University, Sabzevar, Iran.

^b Associate professor Department of Civil Engineering, Hakim Sabzevari University, Sabzevar, Iran.

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Abstract

In recent years, the use of nano-particles to improve the properties of concrete has created a new perspective on concrete technology. Studies in this field indicate improved concrete properties and higher strength by adding nano and micro silica particles to concrete mixes. In this regard, 12 mixing designs with different amounts of these admixtures with three types of cement strength classes (525, 425, 325) and 36 cubic samples ($10 \times 10 \times 10$) were designed and tested to measure compressive strength, of which we have only used 6 mixing plans in this research. The purpose of this research is to present a new method for concrete mix design by optimizing principles. Therefore, in this paper, the Taguchi statistical methods and the factorial design of the optimal mixing plan for this type of concrete are used to reduce the number of experiments to predict the optimal composition of the materials. The results obtained from the MINITAB software show that the effect of combined micro-silica and nano-silica on the compressive strength is in one direction and the effect of these two factors is more than cement strength grade of the cement and also the optimal value for micro-silica and nano-silica are estimated to have an optimum amount of micro-silica and nano-silica of 95 and 38 grams, respectively.

Keywords: HLLC Scheme; Factorial Design; Taguchi Method; Compressive Strength; Nano-Silica; Micro-Silica.

1. Introduction

In order to produce a concrete with a particular compressive strength, various factors such as the amount of combinatorial components and its related admixture, as well as the amount and time of rotation of the mixing machine in each step, should be carefully considered [1-4]. Changes in each of these factors alter the condition of the concrete. One of the important factors is the rate of admixture in concrete, which we are referring to as micro-silica and nano-silica [5]. Due to the effects of using Nano-silica in concrete, including improving microstructures, reducing permeability, reducing porosity and increasing compressive strength it can be concluded that the use of nano-silica is valuable that Collapardi et al. confirm this [6]. In recent years, the use of nano-silica to improve the properties of concrete has created a broad perspective on concrete technology [7]. Nano-particles have shown special properties in concrete mix design due to their very small particle size and their high surface area [8]. Nano-materials, including silica nano-particles, carbon nano-tubes [9], iron nano-particles [10], aluminum nano-particles [11] and nano-montmorillonite [12], have been tested to improve the properties of concrete including nano-silica particles due to their high pozzolan properties [8]. Jo et al. (2007) have shown in their experiments that the increase in compressive strength for mortars containing nano-silica is 3 to 12 percent [13]. T.Ji (2005) has shown that the permeability of concretes containing nano-silica decreases [14]. The use of nano-silica in high-strength concrete can increase short-term and long-term strength.

* Corresponding author: hamidsttu@yahoo.com

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