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Prediction the electrical resistivity of concrete containing clinoptilolite by Gene expression programming

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Abstract

Gene expression programming (GEP) has been broadly applied to predict the various properties of concrete. For predicting electrical resistivity of concrete containing clinoptilolite, various models were proposed by using GEP. To construct the models, experimental data were obtained through manufacturing in the laboratory. From the total dataset, 80% were utilized in the training stage and the continued 20% in the testing stage. Eight input parameters comprising the age of the specimen, cement content, water content, gravel content (separated to G20 and G10), sand content, clinoptilolite content and amount of superplasticizer were settled as input variables. The consequences also demonstrated the great potential of suggested GEP models in predicting the electrical resistivity of concrete containing clinoptilolite.

Keywords: Gene expression programming, Concrete, Clinoptilolite, Electrical resistivity, Prediction

1. INTRODUCTION

Among well-known mineral additives with pozzolanic properties, the industrial wastes and natural pozzolana can be distinguished. Zeolites are of great interest due to their accessibility in large amount beds and, despite their crystalline structure, wonderful pozzolanic activity [1, 2]. Both synthetic zeolites and natural zeolites such as clinoptilolite [3, 4] are crystalline aluminosilicates with open 3D framework structures [5]. The inclusion of clinoptilolite (NZ) as an efficient supplementary cementitious material (SCM) forms reaction products with the lime from hydrated cement. These products reduce the volume of large pores and capillaries found in cement paste improving mechanical and durability properties of concrete [6, 7].

The main concern about concretes in harsh environments is the service life of reinforced concrete infrastructures [8, 9]. Electrical resistivity is one of the most effective features of concrete durability since it is a significant factor affecting corrosion in reinforced concrete. The electrical resistivity of 200 Ω-m is the limit for minimum corrosion propagation of steel rebar, above which corrosion will be low in concrete reinforcement [10]. In concrete incorporating mineral admixtures with pozzolanic reactivity, the electrical resistance will increase with the concrete age [11]. By creating, a finer pore size distribution [12] and decreased ionic concentration [13] clinoptilolite increased electrical resistivity.

Since manufacturing concrete at the laboratory and measuring its properties, especially durability and mechanical properties, is time-consuming, hence researchers use soft computing methods to predict concrete properties. In addition, some of these methods such as artificial neural networks, fuzzy logic and nature-inspired algorithms [14-16] have been used for predicting the properties of concrete incorporating diverse pozzolans. Genetic programming [15] is quite a new modeling, proven superior to regression methods and neural networks because of obtaining explicit formulations for experimental studies [17]. In this research, for the first time, the durability properties of concrete incorporating clinoptilolite was investigated by gene expression programming (GEP).

2. GENE EXPRESSION PROGRAMMING

GEP is like genetic algorithms (GAs) and genetic programming (GP), a genetic algorithm as it uses populations of individuals, selects them according to fitness and introduces a genetic variation using one or