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Prediction of properties of fly ash and cement mixed GBFS compressed bricks

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Abstract

In the present study the artificial neural network is used to predict the properties of fly ash and granulated blast furnace slag mixed compressed bricks. Bricks containing fly ash, different proportion of granulated blast furnace slag with constant quantity of cement are fabricated. The bricks are cured by three ways such as, by sprinkling water, by dipping into the alkaline water, and by immersing into the acidic water for 3, 7 and 28 days respectively. After curing, the bricks are tested to determine its compressive strength, water absorption and pH. The results from the experiments were used for the training of the artificial neural network neurons. Using the trained artificial neural network, the values for the composition 0% to 60% were obtained with 5% increment in every interval. It is observed that as the content of granulated blast furnace slag increases than the fly ash content, the compressive strength increases. With the increase in granulated blast furnace slag content the water absorption reduces and pH increases and hence increases the resistance against acid attack.

Keywords: Artificial neural network; Fly ash; Granulated blast furnace slag; Compressed bricks; Compressive strength; Water absorption; Acid attack.

1. Introduction

The industrial wastes are substantially different in properties as well as composition with natural aggregates. It leads to complexity to predict the performance of the industrial wastes such as Fly Ash (FA) and Granulated Blast Furnace Slag (GBFS) in the manufacturing of building materials. This study aims to show the possible utilization of these industrial-by-products in manufacturing of Compressed Bricks (CB). Along with the rapid depletion in the natural resources and due to the effects of the urban development, the trend of using alternative aggregates is increased substantially over many parts of the world, particularly in India. The major building wall units in India are burnt clay bricks. It consumes a huge amount of fuel for burning the bricks in kilns.

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The main cost aspect in the burnt brick fabrication is from fuel consumption. To overcome the above problem an attempt to cast the CB using hand pressing machine is conducted. CB is one of the most commonly used masonry units as a building material made primarily from semi-dry mixture compressed at high pressure to form bricks.

2. Materials

FA, which also refers to flue-ash, is also one of the residues generated in combustion of coal. The major source for fly ash in India is thermal power plants. Nearly 65% power in India is generated by coal-based thermal power plants (India Energy book, 2015) [1]. At present the production of fly ash estimated per year is nearly 112 million tonnes with 65000 acre of land being occupied by ash ponds and is expected to cross 225 million tonnes by the year 2017 [2]. It is reported that nearly about 75 million tons of FA being utilized during 2012 by ministry of Science and Technology and very large quantity of FA still remains unutilized [3]. In the present study, FA of IS-3812 (Part-1):2003 standard is used for fabrication.

GBFS is sand-type slag manufactured by spraying high-pressure water jets on a blast-furnace molten slag. It can be used as lightweight aggregate where its high fire resistance and insulation properties make it an excellent aggregate for concrete and masonry units where high fire resistance is required. It is extensively available from steel mill as a by-product and replaces cement up to 80% [4].

Portland cement (C) is a part and parcel of building material. It acts as binding material in concrete, mortar matrix and with other constituents. In the present experimental investigation Zuari Ordinary Portland Cement 43 grade had been opted confirming to IS-269:1989, IS-8112: 1989, IS-12269: 1987. The various tests on cement such as, specific gravity, fineness, standard consistency, initial and final setting time etc., was done before it is used for experiment.

0.25 % concentrated Na_2SO_4 acidic solution of pH range 0.9 to 2.1 and 3 % concentrated NaOH alkaline solution of pH range 8 to 9 is adopted to check the behaviour of CB in both acidic and alkaline environment individually.

Experimentally 136 numbers of CB specimens (casted by utilizing different proportions of FA, GBFS and C of above mentioned quality) were casted and tested to analyze its compressive strength, water absorption and pH.

2.1 Artificial neural network (ANN)

From the past few decades many researchers have made attempts to investigate the utility of the industrial wastes using various methods to predict the properties of alternative building wall materials. Among those other methods, ANN is quite popular. This is mainly due to the following advantages of ANN; Easy to use, because ANN has the capacity to learn directly from examples i.e., the relation between the input and output variables are generated by the data themselves. And high accuracy, ANN can bear approximate results, relatively incomplete tasks, imprecise tasks and even less vulnerable outliers [5]. Because of the above mentioned advantages, some researchers have adopted ANN techniques to predict the performance of the various industrial by-products and other building materials [5-16].

3. Methodology

3.1 ANN

It is a computational system consisting of simple, highly interconnected processing elements (neurons) that work together to solve specific problems. It is an algorithm inspired by research in biological nervous systems to generate a simplified model of how the brain works [17].

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