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Effect of magnetized water on workability and compressive strength of concrete

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Abstract

In this research study, the effect of magnetized water on workability and compressive strength of concrete was studied, in order to obtain operative concrete with high resistance and at a lower cost. Data were collected from previous studies and researches. The magnetized water was prepared using the magnetic treatment system. Four concrete mixes were prepared, one without magnetized water and three with. Cement reduction of 12.5 % and 25 % was imposed on the last two mixes with magnetized water. Slump and compressive strength tests were carried out on all four mixes and it was found out that concrete produced by the magnetic technology is easy to operate without affecting the compressive resistance of concrete. It was also found that magnetized water increases the compressive resistance of concrete while cement is reduced up to 25 %.

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Keywords: Concrete mix; compressive strength; slump; cement reduction; magnetized water

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1. Introduction

Water consumption is rising as the population and human needs grow. Industrial sector comes in the second place with 20 % water consumption after the agricultural sector which accounts for 70 % of water use [1]. In concrete production practice there is more than one billion tonnes of water consumed each year [2]. Water used in concrete production plays a vital role in the concrete mix, starting from governing the hydration process of cement, along with proper curing in order to reach the desired strength, not to mention managing workability and durability of the concrete structure. Drinking water or tap water is usually used in concrete production to avoid the appearance of impurities. This constraint along with the limited availability of drinking water across the planet raised the important issue of optimizing the use of water in concrete constructions. Using magnetized water has promising potentials in saving water amount used in concrete construction [2,3].

1.1. Magnetized Water

When water passes through a magnetic flux it is known as magnetized water. The level of magnetization is controlled by the method used and water purity [2,4]. The structure of water is aligned in one direction after magnetization, and the molecule sizes change after the bond angle changes, therefore viscosity and surface area increases by magnetization, hence the hydration rate increases [3,5]. A study by Toledo et al. [6] examined the effect of a static magnetic field on liquid water, and suggested that stronger hydrogen bonds –which lead to a higher viscosity- was formed due to the broken hydrogen bonds after magnetization. Fig. 1(a) illustrates water molecules arrangement in normal temperature. Water molecules tend to form clusters with hydrogen bonds, while these clusters are broken due to the magnetic field when applied as shown in Fig. 1(b), hence increasing the water activity. Due to the smaller size of magnetized water molecules, the water layer surrounding the cement is thinner than normal water molecules, therefore less water demand which has positive effect of hardened concrete properties [5].

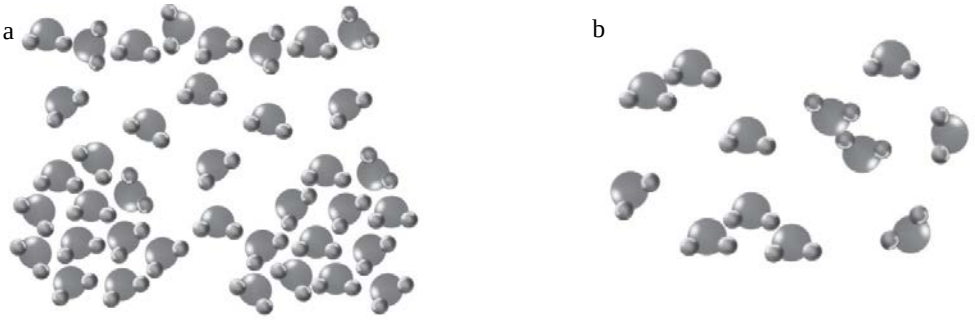

Fig. 1. (a) Water molecules before magnetic treatment; (b) Water Molecules after magnetic treatment [7].

1.2. Influence on Concrete Properties

Several studies had been done on the effect of magnetized water on cement paste and concrete properties. Magnetic treatment, using three different magnetic induction strengths, was carried out by Juan et al. [8] on cement pastes after mixing and casting in a controlled environment. For this particular study, samples were cured in wet conditions and revealed that the rate of hydration as well as setting time were accelerated and the heat of hydration was increased with respect to the samples not subjected to magnetic field [8]. The test also confirmed porosity reduction with magnetization treatment, but it had no effect after 7 days of complete hardening [8]. Another experiment suggested the application of the magnetic field on a pipe while pumping concrete in place. Tests conducted on real size pumping circuits of length 1000 m with a pipe diameter of 125 mm showed that this procedure improved concrete pump-ability due to the change in the lubricant layer properties between the interface of the concrete and the pipe wall, the thickness of this layer was measured using an ultrasonic velocity profiler [7].