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The Effects of Incorporation Al_2O_3 Nanoparticles on Compressive Strength of Concrete

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Abstract

Currently, the most active research areas dealing with cement and concrete are understanding of the hydration of cement particle sand the use of nano-size ingredients such as alumina and silica particles. There are also a limited number of investigations dealing with the manufacture of nano-cement. If cement with nano-size particles can be manufactured and processed, it will open up a large number of opportunities in the fields of ceramics, high strength composites and electronic applications.

In this paper, the compressive strength with the setting time of concrete by partial replacement of cement by Al_2O_3 nanoparticles with the average particle size of 80 nm at different curing days (7 days, 28 days, 90 days) were cast and tested has been studied.The results indicate that Al_2O_3 nanoparticles up to maximum of 2.0% produces concrete with improved compressive strength.

Key words: nano-size; concrete ; compressive strength; Al_2O_3 nano-particles.

1. INTRODUCTION

Nanotechnology is a very active research field and has applications in a number of areas. Currently this technology is being used for the creation of new materials, devices and systems at molecular, nano- and micro-level [1-8].

Recently, nanotechnology has attracted great scientific attention because of the new potential uses of particles in nanometer (10^{-9} m) scale. This may be due to the nano scale size of particles being able to result in significantly improved properties from predictable grain-size materials of the same chemical composition.

2. SUBMISSION

There are few reports on incorporation of nanoparticles in cement-based concrete. Hui Li et al. (2003) [9] investigated the properties of cement mortars blended with nanoparticles to explore their super mechanical and smart (temperature and strain sensing) potentials. Also useful applications of nano-SiO_2 are addressed by the Fuji Chimera Research Institute (2002).

There are several reports on incorporation of nanoparticles in concrete specimens which most of them have focused on using SiO_2 nanoparticles [10-13] and TiO_2 nanoparticles [14,15]. There are a few studies on incorporating nano-Fe_2O_3 [16], nano-Al_2O_3 [17], and nanoclay particles [18,19]. Additionally, a limited number of investigations are dealing with the manufacture of nanosized cement particles and the development of nanobinders [20]. Nanoparticles can act as heterogeneous nuclei for cement pastes, further accelerating cement hydration because of their high reactivity, as nano-reinforcement, and as nano-filler, densifying the microstructure, thereby, leading to a reduced porosity. The most significant issue for all nanoparticles is that of effective dispersion.

3. Materials and methods

Ordinary Portland Cement (OPC) conforming to ASTM C150 [21, 22] standard was used as received. The chemical and physical properties of the cement are shown in Table 1.