Study on Corrosion of Rebar Embedded in the Nanocaly Added Cement Concrete

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ABSTRACT

To reduce the chloride permeability of concrete in practice, kaolinite clay was introduced into concrete. The effects of kaolinite clay on the corrosion process of rebar embedded in the concrete were investigated. The cylinder concrete specimens with the dimension of Φ100×50mm were prepared. All blended concrete samples were prepared using a water-to-cement (w/c) mass ratio of 0.5. Ordinary Portland cement was partially replaced by kaolinite clay at 0%, 1wt%, 3wt% and 5wt% by weight of cement. After being cured in the standard curing condition for 28 days, the prepared concrete samples were immersed in the NaCl solution, and a designed electrochemical accelerated penetration system was used to accelerate the corrosion process as well. A continuous constant current of 100 mA was applied. The corrosion conditions of the rebar embedded in the concrete were measured regularly by the nondestructive testing (NDT) method. The developments of corrosion states of the rebar embedded in the concrete samples with four nanoclay addition dosages were observed. The test results showed that the damage of rebar embedded in the concrete specimen with 5% nanoclay was less than the others. It can be concluded that the nanoclay can delay the chloride penetrate into the concrete obviously. Consequently, the corrosion of the rebar embedded in the concrete is impeded efficiently.

KEY WORDS: nanoclay; rebar; concrete; corrosion; chloride; permeability

1 INTRODUCTION

With the construction and application of a large amount of coastal concrete structure, the problem of concrete cracking and steel corrosion caused by chloride ions has attracted more attention. How to improve the resistance to chloride ion erosion performance of reinforced concrete, and strengthen the durability of concrete structures has become to be a crucial issue in the practical civil engineering.

In recent years, some studies have been conducted on the transmitting procedure and diffusion mechanism of chloride ion in concrete. The research results show that the composition of concrete (Erhan 2009; Diamanti 2013; Rafat 2013), pore structures (Milani 2011; Narayanan 2010), environment temperature (Josipa 2013) play a crucial role on the chloride ion diffusion behavior in concrete. With the development of materials science, the application of active mineral admixture in concrete attracts more and more attention all over the world. Several mineral admixtures, such as slag (Deepak 2013), fly ash (Idawati 2013), silica fume (Poon 2006; Song 2010) and nano-materials (Tao 2005), were conducted to improve the property of resistance to chloride ion permeability of concrete. Rafat et al. showed that self compacting concrete (SCC) mixes made with bottom ash exhibited very low chloride permeability resistance at the duration of 90 and 365 days respectively. Abrasion resistance, water absorption and sorptivity of SCC mixes decreased with increase in age. Poon found that metakaolin (MK) concrete at a w/c of 0.3 has a lower porosity and smaller pore sizes than the plain concrete and similar chloride resistance to silica fume (SF) concrete. Owning to its excellent physical and chemical properties, nano-materials have been considered as the most promising materials in the 21st Century by scientists. Many studies showed that nano-material (e.g. nano-silica, nano limestone, nano clay, etc.) could refine the pore structure and improve the compactness of concrete (Li 2011). However, the research on the chloride ion diffusion of nanoclay modified cement-based materials is still conceptual, relative research work is necessary.

To reduce the chloride permeability of concrete in practice, kaolinite clay was introduced into concrete. The effects of kaolinite clay on the corrosion process of rebar embedded in the concrete were investigated. The corrosion conditions of the rebar embedded in the concrete were measured regularly by a rebar corrosion meter. The development of corrosion states of the rebar embedded in the concrete samples with four nanoclay addition dosages was achieved.

2 EXPERIMENTAL PROCEDURES

2.1 Materials

Ordinary Portland cement of Type 42.5R was used in all mixes. A commercially available kaolinite clay powder was used in this study. The kaolinite clay has a crystalline structure and contains silicon. Its theoretical formula is Al₂Si₂O₅(OH)₄. The chemical composition of the