Study on Mechanical Properties of Metakaolin-Based Concretes and Corrosion of Carbon Steel Reinforcement in 3.5% NaCl

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One of the techniques to improve the concrete durability is to use cement materials blended with silica fume, slag and fly ash. The use of calcined clay cement in the metakaolin form as a pozzolan for mortar and concrete has received remarkable interest in recent years. Here, in this study, corrosion behavior and mechanical property of carbon steel rebar in metakaolin cement-based concretes were investigated. To evaluate the effect of high-reactivity metakaolin in the corrosion resistance of the ordinary Portland cement (OPC) concrete, 5 wt%, 10 wt%, 15 wt% and 20 wt% metakaolin replacement levels were done in concrete production. Corrosion rate, electrochemical mass loss, compressive strength, tensile strengths, open circuit potential, and electrochemical impedance spectroscopy (EIS) of the samples were studied and discussed. The electrochemical mass loss of concrete samples revealed that 15 wt% metakaolin sample had smaller mass losses which exhibited an improvement in anticorrosive properties that had led to better corrosion behavior of the carbon steel rebar. The mechanical results of concrete samples indicated a gradually increase in compressive and tensile strengths with the increase in the cement blended with metakaolin. Furthermore, the EIS findings showed that 15 wt% metakaolin sample indicated a higher value of passive film resistance compared to other samples, indicating that more enhancement of corrosion resistance on the surface of the carbon steel rebar. Scanning electron microscopy images revealed that the concrete structure containing 15 wt% metakaolin was denser and more uniform than that of the OPC sample which was in accordance with studies reported by other researchers.

Keywords: Reinforced concrete; Metakaolin; Electrochemical impedance spectroscopy; Corrosion resistance; Mechanical properties

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