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The effect of Cement Content on Concrete Performance in Corrosive Environments

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Abstract

In this study, the effect of cement content on the performance of concrete in corrosive environments is investigated on concrete mixtures having the same water/cement (w/c) ratio. Three w/c ratios (0.4, 0.45 and 0.5) were used and for each w/c three mixtures were prepared with cement contents 350, 400 and 450 kg/m^3. The compressive strength, electrical resistivity and chloride diffusivity of the samples without steel reinforcement were determined. In addition, the half-cell potential of samples with steel reinforcement in 5% NaCl solution was measured to evaluate the rebar corrosion. Test results indicate that although w/c ratio is kept constant, strength increases and corrosion probability of steel reinforcements decreases when cement content in the mixture decreases from 450 to 350 kg/m^3.

1-Introduction

The unique combination of steel and concrete has made concrete one of the most popular construction principles in the world. However, the lack of knowledge about the long-term performance of concrete and the severity of environmental impacts has caused serious problems [1]. One of these problems is the corrosion of reinforcing bars that is the most common cause of deterioration of concrete structure in corrosive environments [2]. Corrosion of reinforcing bar damaged the reinforced concrete structures in two ways. First, it is reduces the cross-sectional area of steel bar. Secondly, it produces corrosion products with a larger volume than the steel itself. The volume increase induces the tensile stress in concrete, which results in cracking and eventual structural failure.

Concrete normally provides a high degree of protection to the reinforcing steel against corrosion, by virtue of the high alkalinity (12.5 and higher) of pore solution. This high alkalinity enables the formation of a passive film on the rebar surface which prevents the development of an active corrosion process. However, this passive state can be inhibited by the destruction of the protective film by aggressive ions (chlorides) or by an acidification of the environment in the vicinity of the rebar (carbonation) [3]. In addition, well-consolidated and properly cured concrete with a low w/c ratio has a low permeability, which minimizes penetration of corrosion inducing agents, such as chloride carbon dioxide, moisture, etc. to the steel surface. Further, the high electrical resisitivity of concrete restricts the rate of corrosion by reducing the flow of electrical current from anodic to the cathodic sites [4]. Thus, concrete with high quality can be considered as a primary factor that controls corrosion process in corrosive environments. So, evaluation of its performance in these environments (such as Persian Golf exposure) has especial importance.

There are several factors that influence concrete performance in corrosive environments. One of these factors is the amount of cement in the mixture. Ahmad [3] pointed out that due to