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Effect of W/C and Thickness to Corrosion Properties of Reinforced Concrete

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ABSTRACT
Reinforced concrete structures have increased in number due to the rapid development of industrial society. In addition, these reinforced concretes are often exposed to severe corrosive environments such as sea water, contaminated water, acid rain and seashore etc. Thus, corrosion problems of the inner steel bar embedded in concrete are very important from a safety and economic point of view. In this study, the effects of cover thickness and W/C ratio(water to cement ratio) on corrosion properties of reinforced concrete were investigated with electrochemical methods such as corrosion potentials, polarization curves, cyclic voltammograms, oxygen diffusion limiting current densities and oxygen diffusion coefficient measurements, etc. Corrosion potentials shifted to the noble direction with increasing cover thickness. Oxygen diffusion limiting current densities decreased with increasing cover thickness. However, oxygen diffusion coefficients showed a relatively increasing trend regardless of w/c ratio with increasing cover thickness. Furthermore, it appeared that diffusion coefficients decreased with increasing w/c ratios for the same cover thickness. Resistance polarization is nearly controlled by the cover thickness in sea water solutions, however the effect of cover thickness was observed to be smaller with increasing w/c ratios.

KEYWORDS: Reinforced concrete; Corrosion potential; Impedance; Cover thickness; W/C; Oxygen diffusion coefficient; Resistance polarization

INTRODUCTION

The use of reinforced concrete structures in marine environments is increasing with the rapid development of marine industrial society. These reinforced concretes are exposed to severe corrosive environments such as offshore and contaminated sea water etc. Therefore, corrosion problems of the inner steel bars embedded in concrete are very important from a safety and economic point of view. As a result there are some papers to examine the corrosion of reinforced concrete. In particular corrosion of the inner steel bars is becoming more serious due to use of sand containing sea water and to exposure in more contaminated marine environments. Furthermore, cover thickness and W/C (water to cement ratio) of concrete are significantly related to these corrosion problems mentioned above. Thus there are some protection methods to control corrosion of inner steel bars and some papers that relate to cover thickness, W/C ratio and other parameters etc. However, in the case where many concrete specimens are made to examine corrosion properties, their physical and electrochemical properties may be different from each other. In this study, a complex body specimen, including 6ea steel bars with variations in cover thickness, was produced with parameters of W/C ratio to remove some of the problems mentioned above. The effects of cover thickness and W/C ratio on corrosion properties were investigated with electrochemical methods. Therefore, these results obtained by electrochemical methods and the use of the complex body specimens may give available data to evaluate corrosion properties of the inner steel bars. Furthermore, the complex body specimens may serve as a good reference in the design and successful maintenance of concrete structures in marine environments.

EXPERIMENTAL PROCEDURES

Production of Test Specimens

The size of the molding box for the complex body test specimens is 37cm x 20cm x 17cm, which is made of wood plate of thickness of 1cm. Each hole with dia 1.5cm ϕ was placed at a position of 2cm, 4cm, 6cm, 8cm, 10cm, and 12cm from the upper side. Each hole clearance is 5cm. The steel bars of length 26cm and dia of 1cm ϕ were polished with sand paper from No.200 to No.2000, degreased with acetone, and inserted into each hole of the molding box respectively. All other surfaces of the steel bars except $1cm^2$ of center area were insulated with silicon epoxy (Fig.1). Sand to cement ratio is 2:1 and water to cement ratio (W/C) is 0.4, 0.5 and 0.6. The cement used is Portland cement made in Korea and the chemical composition is shown in Table 1. The