Corrosion Inhibition Effect of Phosphate on Fine-grain High-strength Reinforcement in Simulated Concrete Pore Solutions with Carbonation and Chloride-intrusion

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The passivation performance of fine-grain high-strength (HRBF500) reinforcement in simulated concrete pore (SCP) solutions was seriously impaired by carbonation and chloride-intrusion of concrete. Phosphate was used as corrosion inhibitor and the effect of $[\text{PO}_4^{3-}]/[\text{Cl}^-]$ ratio was investigated. The corrosion properties of HRBF500 reinforcement were investigated via potentiodynamic polarization, electrochemical impedance spectroscopy (EIS) and scanning electron microscopy (SEM). The semiconductor features of the corrosion products were studied according to Mott–Schottky theory. The results show that the anodic corrosion process of HRBF500 reinforcement can be greatly inhibited by sufficient high phosphate concentration, while the influence on the cathodic process is generally smaller. The corrosion products on HRBF500 reinforcement manifest as n-type semiconductors. With the increase in $[\text{PO}_4^{3-}]/[\text{Cl}^-]$ ratio, the donor concentration N_D decreases, while the efficiency of corrosion protection first increases considerably and then tends to be stable. The compactness of the corrosion products is also enhanced. For the case with $0.6 \text{ mol}\cdot\text{L}^{-1} \text{ Cl}^-$ but without carbonation ($\text{pH} \approx 12.5$), the corrosion current density i_{cor} decreases from 13.2 to $0.40 \mu\text{A}\cdot\text{cm}^{-2}$ at $[\text{PO}_4^{3-}]/[\text{Cl}^-] = 1.0$, while for $\text{pH} = 10.5$ and $[\text{Cl}^-] = 0.3 \text{ mol}\cdot\text{L}^{-1}$ (more aggressive), i_{cor} is still up to $0.80 \mu\text{A}\cdot\text{cm}^{-2}$ and decreases to $0.42 \mu\text{A}\cdot\text{cm}^{-2}$ at $[\text{PO}_4^{3-}]/[\text{Cl}^-] = 4.0$. Therefore, to obtain better corrosion protection under the combined action of carbonation and chloride-intrusion, a higher phosphate concentration is required.

Keywords: Reinforcement; Fine grain; Corrosion; Simulated concrete pore solution; Phosphate

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