

Investigation on Feasibility of Finite Difference Method on Prediction of Durability of Concrete Structures Containing Silica Fumes in Splash Zone in the Persian Gulf Region

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Abstract

For many years, concrete have been known as one of the main materials in the construction industry. Experimental investigations and studies reveal that the concentration of salts in the Persian Gulf region is among the most aggressive environments in comparison with other marine regions in the world. Because of the high cost of repair and maintenance of concrete structures, it is essential to estimate the service life during the design and building of the structures. In addition, using appropriate material is effective in achieving sufficient service life of the concrete structures. Therefore, it is important to comprehend the process of chloride penetration and prevent corrosion of reinforcement in the marine structures.

In this study, a Crank–Nicolson based finite difference method (FDM) is implemented to solve equations of chloride penetration, which is one of the important factors in concrete’s deterioration. Most of available methods lack the sufficient accuracy for Persian Gulf region. In this model, it has been tried to adjust the equations based on special environmental condition of the Persian Gulf. The penetration of chloride is interpreted with assuming that diffusion is the only mechanism involved, and that the concrete is fully saturated and a one-dimensional diffusion problem is considered, that is described by Fick’s second law. To reach a sufficient accuracy of the given model, the numerical data will be compared with the results of the specimens of the Construction Material Institute of University of Tehran in the Persian Gulf region that have been exposed to chloride penetrating over 50 months. These specimens contain concrete mixtures with water/cement ratio of 0.4 and varieties of silica fume pozzolan (0, 5, 7.5, and 10 % of cement), Silica Fume is a supplementary cementitious material that increases durability of concrete structures significantly. Specimens are exposed in the marine environment in splash zones. Accordingly, eventually a model will be developed that matches more to the real condition of the Persian Gulf region and has the availability to predict service life of concrete structures in this region based on the applied mixture.

Keywords: Chloride penetration, corrosion, durability of concrete structures, Finite difference, splash areas, Persian Gulf, Silica fumes