ABSTRACT

THE EFFECT OF AGGREGATE POROSITY ON THE CHLORIDE PENETRABILITY OF HIGH PERFORMANCE CONCRETES

by

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In the present study, 12 different types of concrete mixes were prepared from 12 different coarse aggregate types (that is, a concrete type for each aggregate type) where the porosities of these aggregate types ranged from very low to relatively high values. Except for the coarse aggregate types, all other parameters remained the same in each of these concrete types. The concrete mixes thus made could easily be qualified as HP concretes due to their relatively low water-cementitious materials (w/cm) ratio and the use of supplementary cementitious materials such as silica fume and fly ash. Through a rigorous set of experiments, it was determined that aggregate porosity had an important effect on the chloride penetrability in HP concretes as indicated by Rapid Chloride Permeability Test (RCPT) results. Three aggregate/concrete types corresponding to the lowest, mid-range and highest porosities were selected for further study. A *paste-alone* mix was prepared that would represent the bulk paste regions in all representative concrete types. Chloride profiling was done on representative *paste-alone* and concrete specimens subjected to 28-, 56-, and 91-day RCPT. Additional set of experiments showed that the interfacial transition zone (ITZ) was either absent or, at least, small enough to be difficult to detect in the concretes under investigation.

An analytical model was developed to simulate the chloride migration during RCPT through a 2-dimensional (2D) concrete model. The coarse aggregate fraction was included in the model as a porous phase with its own porosity and diffusion coefficients that were different from the bulk paste porosity and diffusion coefficients. The separate effects of fine aggregates, pores and voids in the bulk paste region of the model were taken as a single *smeared-effect*. Chloride binding in the paste region was modeled as a non-linear function of free and bound chloride concentrations. A mild level of binding was assumed inside the aggregate particles as well, based on the experimental outcomes. Based on curve fitting between the analytical and experimental chloride profile values at various pre-selected penetration depths, the diffusion coefficients at the paste regions of the representative concretes were determined from simulations. According to the simulation results, the paste diffusion coefficients in mortar and concretes varied somewhat but were in the same range at any given age. A good correlation was established between the estimated paste RCPT values and the analytical paste diffusion coefficients. This correlation demonstrated that the proposed model was able to predict the bulk paste diffusion coefficient with an acceptable margin of accuracy. The short-term and long-term simulations also demonstrated that both overall average and paste chloride concentrations significantly increase with the increase in aggregate porosities.

Major Professor Date