Pore solution composition and reinforcement corrosion characteristics of microsilica blended cement concrete

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Abstract: Plain and microsilica blended cement pastes with water-cement ratio of 0.6 were prepared using a 14% C3A cement. Two levels of chloride from NaCl corresponding to 0.6% and 1.2% by weight of cement were added through mix water. The pastes were allowed to hydrate in sealed containers for 180 days and then subjected to pore solution expression. The expressed pore fluids were analyzed for chloride and hydroxyl ion concentrations. The results show that the OH- ion concentration in the pore solutions of both chloride-free and chloride-bearing pastes drop steeply with increasing cement replacement by microsilica. For 10% microsilica cement pastes the pH for both 0.6% and 1.2% chloride addition was found to be around 13.30. However, the pH drops to a level below that of saturated Ca(OH)2 solution when cement replacement by microsilica is increased from 10% to 20%. This is ascribable to the consumption of Ca(OH)2 by microsilica as shown by the DTA/TGA results. 10% and 20% microsilica blending more than doubles the free chloride ion concentration in the pore solutions of the chloride-bearing pastes. 10% microsilica replacement raises the Cl-/OH- ratio 4 to 5 fold, whereas for 20% microsilica replacement, the Cl-/OH- ratio is increased to 77 and 39 folds over the corresponding values for the plain cement pastes for 0.6% and 1.2% chloride additions respectively. Accelerated corrosion monitoring tests carried out on steel bars embedded in plain and microsilica blended cement concretes exposed to 5% NaCl solution show a 3 fold superior performance of microsilica blended cement concretes in terms of corrosion initiation time. This corrosion behaviour is contrary to the prediction from the increased aggressivity of pore solution composition in terms of highly elevated Cl-/OH- ratios. This is attributable to the densification of cement matrix by the pozzolanic reaction between microsilica and calcium hydroxide. No discernable advantage in terms of corrosion initiation time is evident by increasing microsilica blending from 10% to 20%.