The Spread of Corrosion from Concrete Crack Zone due to Macrocell Current Flow in Steel reinforcement

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ABSTRACT

Experiments have been carried out to investigate the macrocell current flow between steel reinforcement in uncracked concrete and steel intersecting concrete cracks. Specimens contained four separate rebar sections in uncracked concrete in line with a short section intersecting a crack. Specimens were immersed in natural seawater and the macrocell current between the electrically connected five steel sections was monitored with a zero resistance ammeter.

The macrocell current between the steel sections was found to be strongly time-dependant over the early immersion period. Although macrocell currents were initially high and depended upon cement type the currents dropped to the same order of magnitude after six months immersion. Surprisingly the crack width was found to have an insignificant influence on the macrocell current or the corrosion rate of the steel in the crack zone. A major observation was the change with time in the corrosion activity of steel reinforcing bar adjacent to the crack. This was initially cathodic but development of anodic activity over the rebar section next to the crack zone was identified as time progressed. This was evidenced by the current flowing into the rebar section becoming greater than that flowing out of it, in other words, oxidation was happening on the steel surface. It is important to note that in the experimental set up employed this spread of anodic activity could not be ascribed to a disruption of the steel/concrete interface by expansive corrosion product. It may be postulated that a slow rate of oxygen replenishment may be responsible for the observed effects. The corrosion spreading phenomenon and the consequent reduction of effective cathode to anode ratio of the macrocell may help to explain the lack of correlation between the crack width and corrosion rate of steel in concrete observed.