Effect of Concrete Moisture on Macrocell Development in Repair of Reinforced Concrete Substructure with UHPC

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Extended Abstract

In the United States, ~27% of the ~590,000 bridges are labeled structurally deficient or functionally obsolete. These bridges should be replaced or upgraded to sustain the transportation needs of the growing public and private sectors of the US economy. It is not uncommon for structures to have advanced levels of corrosion-induced damage where major repair and maintenance are required. However, the transportation infrastructure cannot be out of service without disruption to critical economic public, civil and commercial activities. This mandates the development of new techniques and materials for accelerated rehabilitation and recovery.

In conventional repairs, structural damaged element is restored with repair patch. Due to the presence of vestigial low-level chlorides in the remaining concrete, incipient anodes develop and lead to the halo effect which is the main reason of short-lived repair.

Ultra-high performance concrete (UHPC) has been promoted as a durable construction material that can provide a barrier to corrosion due to its low permeability, ideally resulting in a durable repair solution that can slow the level of galvanic coupling between steel in the dissimilar UHPC repair material and the existing concrete with vestigial low-level chloride concentrations.

This study investigates corrosion durability of UHPC repair and its possible use to mitigate macrocell corrosion caused by the presence of incipient anodes in concrete repairs with dissimilar concrete materials. The objectives of the research presented here were to identify if concrete wetness will increase macrocell current and how much repair with UHPC may provide extended repair service life.

Earlier research done by authors revealed that application of UHPC to repair reinforced concrete in non-marine exposure can decrease macrocell current corrosion due to the poor ionic coupling associated with the low permeability UHPC. Although it was observed that corrosion cells can redevelop in steel encapsulated in the repair materials, the effect is significantly reduced with the application of UHPC in

comparison to conventional concrete repair material. Additional testing of repair concrete prisms ponded with tap water for ~250 days was done to evaluate the extent of macrocell development in wet concrete. Electrochemical tests, macrocell currents and resistance measurements in concrete prisms with discrete electrodes were used to verify the effect of concrete moisture macrocell current of UHPC repair.

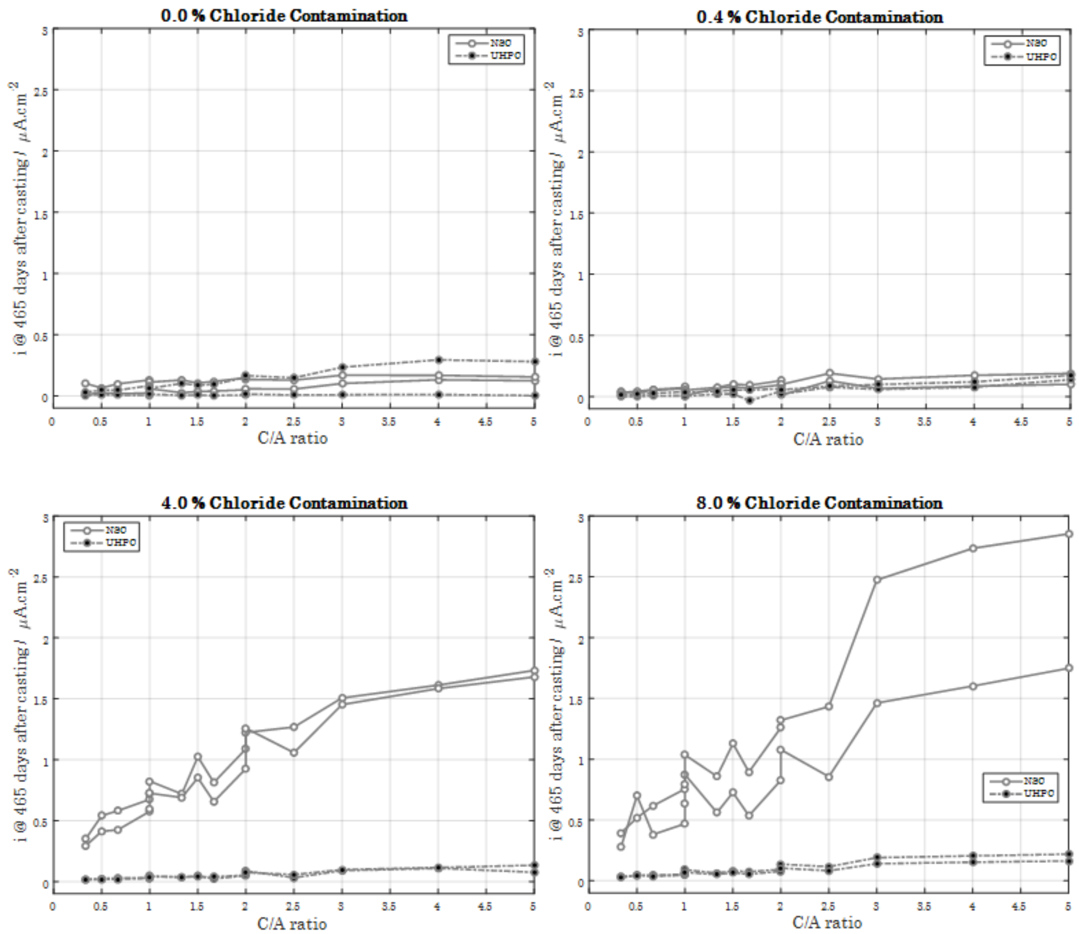

Figure 1. Effect of Cathode-to-Anode (C/A) Ratio for Rebar Embedded in UHPC or NSC Repair Concrete with Vestigial Chlorides in Substrate Concrete in Wet Condition.

As shown in Figure 1 low macrocell currents developed in samples with conventional and UHPC repair concrete when the vestigial chloride content in the substrate concrete was low. At higher vestigial chloride contents in the substrate concrete, the macrocell current was enhanced at higher C/A for samples utilizing conventional concrete for the repair concrete. In contrast, macrocell current was much reduced in samples repaired with UHPC even with higher vestigial chloride presence in the substrate concrete. In conditions with 0, 0.4, 4, and 8wt% chlorides, the macrocell was elevated relative to the dry condition but still otherwise low.