C21.2022-Prediction and Prevention of Bridge Performance Degradation due to Corrosion, Material Loss, and Microstructural Changes

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Abstract

Corrosion can significantly impact the performance of structures, and corrosion-related maintenance is a primary contribution to annual transportation infrastructure costs. Bridges are primarily constructed of A7, A36, A588, and A242 steel. ASTM A7 steel was used in bridge construction until 1967. Major limitations of A7 steel include poor corrosion resistance and mechanical properties, which ultimately led to the replacement of A7 steel by A36 steel after 1967. Though A36 steel shows better mechanical properties, it does not possess improved corrosion performance compared to A7. A588 and A242, display significantly higher corrosion resistance paired with desired mechanical properties, but the cost of these so-called weathering steels is also higher.

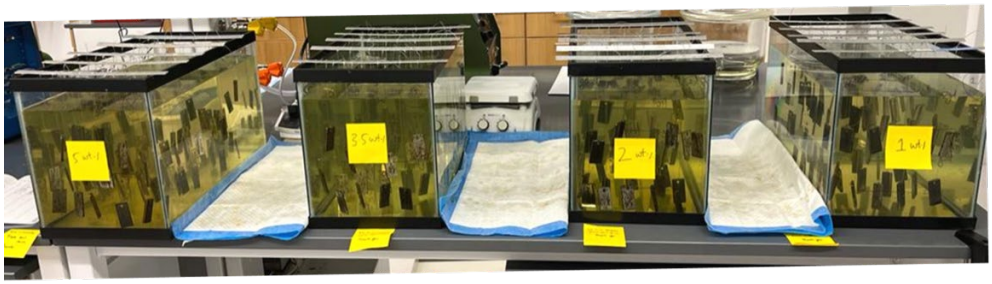

Fig. Wet/Dry cycle testing setup

The current study compares the corrosion performance of A7, A36 and A588 alloys at different NaCl concentration exposure (1 wt.%, 2 wt.%, 3.5 wt.% and 5 wt.%) for difference steel surface conditions (oxidized and polished). Corrosion studies on these alloys were performed using wet-dry cyclic exposure to obtain corrosion at an accelerated pace. Test coupons were 50 mm×25 mm×4.76 mm. A total of 400 wet/dry cycles were performed to understand the effect of longer exposure to salt environments. Batches of samples of each alloy were collected at 25, 50,75, 100, 150, 200, 250, 300, 350, 400 cycles to observe corrosion trends with increase in cycles. Further, the samples were photographed, and the surfaces were compared. Samples retrieved from bridges in Connecticut were compared to the lab-tested coupons. The phases present in the corrosion products were characterized using XRD and SEM. The results showed lower magnetite compared to the field samples, and the presence of detrimental β – FeO (OH, Cl) oxide was significantly higher at the higher [Cl^-] concentrations. These results will be used to build and validate a prediction tool for field evaluation of bridge corrosion.

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