Fiber reinforced polymer (FRP) composites have become an attractive alternative to conventional methods for external-strengthening of civil infrastructure, particularly as applied to flexural strengthening of reinforced concrete (RC) members. However, durability of the bond between FRP composite and concrete has shown degradation under some aggressive environments. Although numerous studies have been conducted on concrete members strengthened with FRP composites, most of those studies have focused on the degradation of FRP material itself, relatively few on bond behavior under repeated mechanical and environmental loading.

This thesis investigates bond durability under accelerated environmental conditioning of two FRP systems commonly employed in civil infrastructure strengthening: epoxy and polyurethane systems. Five environments were considered under three different conditioning durations (3 months, 6 months, and 1 year). For each conditioning environment and duration (including controls), the following were laboratory tested: concrete cylinders, FRP tensile coupons, and FRP-strengthened concrete flexural members. Numerical investigations were performed using MSC MARC finite element software package to support the outcomes of durability experimental tests. Precise numerical studies need an accurate model for the bond between FRP and concrete, a linear brittle model is proposed in this work that is calibrated based on nonlinear regression of existing experimental lap shear data.

Results of tensile tests on FRP coupons indicate that both epoxy and polyurethane FRP systems do not degrade significantly under environmental exposure. However, flexural tests on the FRP strengthened concrete beams indicate that bond between FRP and concrete shows significant degradation, especially for aqueous exposure. Moreover, a protective coating suppresses the measured degradation. Also, experimental load-displacement curves for control beams show excellent agreement with numerical load-displacement curves obtained using the proposed bond model. Finally, a bond-slip model is predicted for concrete leachate conditioned beams by matching load-displacement curves for those beams with numerical load-displacement curves.

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The public is welcome to attend.