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Residual Fatigue & Static Strengths of Full-Scale Bridge Girders Strengthened In Shear with CFRP

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Extended Abstract

Bridges in northern climates, exposed to severe environmental conditions and daily fatigue loading, experience accelerated deterioration and corrosion. The use of carbon fiber reinforced polymer (CFRP) bonded to bridge girders or deck-slabs has demonstrated its effectiveness in enhancing shear and flexural strengths. This study capitalizes on a unique opportunity presented by the deconstruction of a Canadian bridge to evaluate 60-year-old reinforced concrete bridge girders strengthened with CFRP. Real-service conditions, including fatigue loads and environmental exposure, informed a research program that explored residual fatigue life and strengths. Full-scale girders-5m span length, directly taken from the deconstructed bridge, which was strengthened with CFRP during the final decade of the bridge's service life, underwent comprehensive non-destructive testing before being subjected to two million fatigue load cycles and subsequent monotonic testing until failure at Sherbrooke's University structural lab. Post to final testing, samples were cut on the girder extremities to examine material properties. The results illustrate that CFRP-strengthening extends the service life of the bridge elements, preserving shear capacity. Notably, excellent bonding behavior at the CFRP-concrete interface was observed, with no occurrence of damage-debonding failure or tensile rupture until the formation of a diagonal shear crack. Comparisons with ACI 440 2R-17 and CSA S6-19 design guidelines underscore the effectiveness of the CFRP strengthening technique, demonstrating its capability to extend the service life while challenging guideline conservatism. This research provides valuable insights into the residual fatigue life and load-carrying capabilities of 60-year-old reinforced concrete bridge girders strengthened with CFRP under various conditions, emphasizing the technique's efficacy for bridge rehabilitation.

Keywords: Bridges, CFRP, Full-Scale, Fatigue Loads, Residual Strength, Service Life, Shear Behavior, Bond between CFRP and Concrete.