

# Investigation of Integrity and Effectiveness of RC Bridge Deck Rehabilitation Using CFRP Composites

**Final Report**

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### Abstract:

This report develops methodologies to evaluate the integrity and effectiveness of external bonding of carbon fiber reinforced polymer (CFRP) composites to the bridge deck soffit of Spans 8 and 9 of the eastbound structure of the Watson Wash Bridge. Wet lay-up and pultruded CFRP composites are applied to the deteriorated decks of the Watson Wash Bridge. A global vibration-based nondestructive evaluation procedure measuring changes in modal strain energy is used to determine stiffness changes in the bridge structure before and after application of CFRP composites. The effect of CFRP composite material variation and degradation are incorporated into a measure of the reliability index, which is related to the probability of failure; failure is defined as the yield of steel reinforcement. The reliability index provides the means to combine the effects of material variation, CFRP composite degradation, and measured stiffness changes from the field to assess the service life of a FRP rehabilitated structure as shown from a series of progressive damage tests. Based upon the results of the measured system changes, effects of material variation, and effect of CFRP composite degradation, CFRP rehabilitation designs are recommended for the parallel westbound Watson Wash Bridge structure. Recommended CFRP rehabilitation designs are intended to prevent the occurrence of punching shear failure, and sustain HS20 and Permit Load demands in the longitudinal and transverse slab directions for a period greater than 25 years at a reliability level of 3.5, failure probability of 0.02%. A cost comparison between recommended CFRP rehabilitation and new bridge construction costs shows a savings of 75 to 80% with CFRP rehabilitation of the entire bridge deck area of the existing westbound Watson Wash Bridge.