MOUNTAIN-PLAINS CONSORTIUM

PROJECT BRIEF | December 2015

Predicting Fatigue Service Life Extension of RC Bridges with Externally Bonded CFRP Repairs

the ISSUE

Externally bonded carbon fiber reinforced polymer composites (CFRPs) are increasingly used to repair concrete bridges. CFRP design techniques are a proven approach for enhancing the strength of existing structures. This project investigated the design of CFRP repairs to extend the service life of structures subject to fatigue loading.

the RESEARCH

Studies show the fatigue life of reinforced concrete beams repaired with externally bonded CFRP is controlled by the fatigue life of the reinforcing steel. Consequently, in this project we studied the rebars in particular. Seven reinforced concrete beams were cast. Six of these beams were cast with a cylindrical void in the concrete on the bottom face of the beam at midspan. This void allowed visual access to the embedded reinforcing bars. An initial "crack" was cut into the reinforcing bars to ensure fatigue failure would initiate in the exposed region of the bars. All of the beams were tested in bending under cyclic loading. Two of the beams had no externally bonded CFRP, two of the beams had externally bonded wet-layup CFRP, and two of the beams had externally bonded prefabricated CFRP strips. During testing, photos were taken of the reinforcing bars at regular intervals to determine the fatigue crack growth rate.

MPC
MOUNTAIN-PLAINS CONSORTIUM

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

Lead Investigator

Rebecca Atadero
Colorado State University
Rebecca.Atadero@colostate.edu

Project Title

Predicting Fatigue Service Life Extension of RC Bridgeswith Externally Bonded CFRP Repairs

Co-Investigator(s)

Hussam Mahmoud

Research Assistant(s)

Tyler Sobieck

Sponsors | Partners

USDOT, Research and Innovative Technology Administration

the FINDINGS

We found that the application of the externally bonded FRP reduced the stresses in the rebar and extended the fatigue life of the reinforcing steel and thus the beams. There was scatter in the data – as expected in any fatigue study – but one of the beams with prefabricated CFRP strips provided a greater extension of the fatigue life, demonstrating the value of a stiffer FRP material. A design procedure allowing designers to explicitly design for a desired amount of service life extension was proposed based on analytical equations for fatigue. The experimental data was used to show that the proposed procedure produces reasonable results.

the IMPACT

This project will provide designers with enhanced guidance for the design of CFRP repairs for extending the service life of concrete structures, such as bridges, subject to fatigue loading. Previous guidance was based on the fatigue performance of the CFRP, which does not correspond to observed failures. The design guidance proposed here is based on the observed failure mode of CFRP reinforced concrete beams subject to fatigue-failure in the reinforcing bars.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=827

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7938 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.