EVALUATING FRP REPAIR METHOD FOR CRACKED PRESTRESSED CONCRETE BRIDGE MEMBERS SUBJECTED TO REPEATED LOADINGS (PHASE 1)

Report Number: K-TRAN: KSU-01-2

By: Calvin E. Reed*, Kansas Department of Transportation, Robert J. Peterman and Hayder A. Rasheed, both with Kansas State University

RESEARCH

Introduction

The bridge and highway infrastructure in the United States is aging. According to the Federal Highway Administration (FHWA), nearly 61% of the over 584,000 bridges in the United States were built prior to 1970. Many of these older bridges have been loaded to levels that are beyond the service limits the bridges were initially designed for. When this occurs, damage to the structure is typically the result. Repair and strengthening of bridges is becoming an attractive way of extending the useful life of a bridge. For a strengthening technique to be beneficial, however, it must be able to reliably strengthen the structure for a long period of time and be cost effective.

Project Objective

The first objective was to evaluate the flexural behavior of prestressed concrete beams strengthened with CFRP laminates. Second, to evaluate the shear behavior of the specimens and the third objective was to develop an analytical model to predict the flexural behavior of the specimens.

Project Description

Static tests to failure were run on three of the specimens to determine the effect of strengthening on the improvement of strength and stiffness. Fatigue tests were run on two of the specimens to determine the degradation of strength and stiffness under repeated load cycles. Static tests to failure were performed on both ends of each specimen. In one test setup, shear cracks were allowed to develop near the girder end, within the prestress force transfer zone causing a bond-slip failure to occur. In the other setup, the shear cracks were allowed to develop away from the prestress transfer zone causing a shear failure to occur. The ability of the CFRP to strengthen the specimens against both failure modes was examined. The analytical results were correlated with experimental results to determine model accuracy. An accurate model will prove useful for KDOT in future design and analysis of FRP strengthened prestressed and reinforced concrete beams.

Project Results

Ultimate flexural strengthening of the damaged beams was accomplished in the static tests. FRP U-stirrups designed based on a shear friction approach proved successful in overcoming horizontal shear failures. The fatigue life of the repaired specimens under the simulated effect of a repeated HS-20 live load ranged between 150,000 to 270,000 cycles. The CFRP U-Stirrups made shear strengthening of the OH specimens possible. The specimens were strengthened by as much as 30-40%. Continuous transverse U-wraps at the ends of the specimens greatly improved the performance of the NOH specimens.

Report Information

For technical information on this report, please contact: Robert J. Peterman, Kansas State University, 2118 Fiedler Hall, Manhattan, Kansas 66506; Phone: 785-532-7612; Fax: 785-532-7717; e-mail: bob@ksu.edu.

For a copy of the full report, please contact: KDOT Library; 700 SW Harrison Street, Topeka, Kansas 66603-3754; Phone: 785-291-3854; Fax: 785-291-3717; e-mail: library@ksdot.org.

**Affiliation at time of research report, current affiliation not known.*