Kansas Department of Transportation

TECHNICAL SUMMARY

Response of No-Name Creek FRP Bridge to Local Weather

Report Number: FHWA-KS-12-6 ▪ Publication Date: September 2012

Wenjie Liu
Eric Zhou
Youqi Wang
Kansas State University Transportation Center

Introduction

Since 1996, over 30 Fiber Reinforced Polymer (FRP) composite bridges have been installed in the United States. Bridge locations are in Kansas, Missouri, New York, Iowa, Colorado, West Virginia, Ohio, California, Idaho, Washington, Pennsylvania, Illinois, Maryland, Oregon, North Carolina and South Carolina.

Compared to traditional steel and concrete bridge structures, the FRP panel shows several significant advantages: reduced weight, higher strength, better corrosion resistance and quicker installation. However, FRP materials exhibit different physical properties. As such, a composite bridge would demonstrate different deformation and failure patterns than a traditional bridge. During the past years, much experimental research has been conducted to investigate FRP bridge deck performance. Most experiments divide into two types: 1) static and fatigue tests in the laboratory and 2) real traffic load tests in the field. These experimental results, as well as FEM analytical results, have served as baseline data for FRP bridge deck design.

Project Description

A long-term remote monitoring system was designed to investigate the response of the No-Name Creek composite bridge to the local weather. The characteristics of the bridge temperatures, the temperature differences of the two panel surfaces and the relationship between the temperature difference and the deflection were investigated with respect to the different weather patterns. Twelve thermal sensors were embedded into the FRP bridge panels. In addition, 3 laser sensors were installed to measure bridge thermal deflection. Between October 2004 and September 2005, bridge temperature and deflection were measured at 20 minute intervals. Relations between weather condition, temperature distribution and bridge thermal deflection for that bridge were analyzed.

Project Results

From the analysis of the experimental and FE methods, the responses of the composite bridge to weather are summarized as follows:

(1) The temperatures of the upper and bottom panel surfaces and their differences greatly change with time of day and season. The extreme temp usually appears in the early afternoon and the minimum temp usually appears in the early morning or in the night. The bottom surface temperature is near the climatic temperature.

(2) The bridge deflections are approximately proportional to the temperature differences.

(3) The bridge had a significant upward deflection on a sunny day during the summer with the maximum often occurring between 3:00-5:00PM. The bridge has a downward deflection during the night with it being the most severe in the winter.

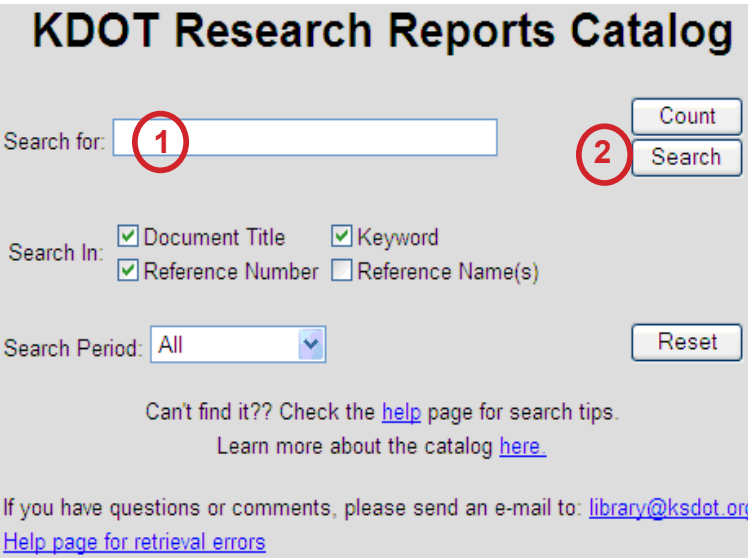
(4) Comparing climate induced deflection to traffic load induced deflection, the climate induced deflection is at least on the same order of deflection as allowable traffic load. Therefore, it should be considered in the FRP bridge design process.

(5) Thermal load and deflection usually are larger on clear days than on unclear, rainy, and snowy days.

(6) Distributions of thermal load in the panel can form a larger amount of deflection in the hot season than in the cold season.

Project Information

For information on this report, please Dr. Youqi Wang at the Kansas State University Department of Mechanical and Nuclear Engineering; 3048 Rathbone Hall; Manhattan, Kansas 66506; 785.532.7181; youqi@k-state.edu.



Directions for Downloading the Full Report

To download the full report, visit http://www.ksdot.org/burmatrres/kdotlib2.asp and do the following:

1. Enter FHWA-KS-12-6 in the search box.
2. Click the Search button to the right of the search box.
3. You may have to scroll to find the specific report.
4. To download the report, click on the title of the report to open the PDF file and save it to your hard drive.

If you have any questions, please email us at library@ksdot.org.