Kansas Department of Transportation

TECHNICAL SUMMARY

Enhancement of Welded Steel Bridge Girders Susceptible to Distortion-Induced Fatigue

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A Transportation Pooled Fund Study - TPF-5(189)

Introduction

Distortion-induced fatigue is a serious problem across the national bridge inventory, affecting many steel bridges designed before the mid-1980s. Because distortion-induced fatigue tends to develop in bridge connection details, near transverse elements such as cross-frames and diaphragms, repairing distortion-induced fatigue damage can be a difficult task, especially when the affected detail is near the intersection of the top flange, connection plate, and web.

The region of a girder defined by the truncation of a connection plate and the web is often referred to as a “web gap,” a detail that has been found to be highly susceptible to distortion-induced fatigue. Web gaps are formed when a connection plate is framed in the web, but not connected to the adjacent flanges(s). Before the mid-1980s, this was common practice; neglecting to weld the connection plate to the adjacent tension flange was believed to be good fatigue detailing practice, avoiding the introduction of a detail susceptible to fatigue damage in the tension flange. Unfortunately, this practice resulted in the unintended consequence of introducing a detail highly susceptible to fatigue damage in the web region, between the termination of the connection plate and the flange.

Project Objective

The goal of the study was to develop and evaluate the performance of retrofit techniques for existing steel bridges that have already sustained damage due to distortion-induced fatigue, or are anticipated to experience distortion-induced fatigue cracking within their design life. A second goal of the study was to evaluate the use of new technologies and materials for repairing distortion-induced fatigue damage in steel bridges.

Project Description

This report is intended to provide a comprehensive overview of the work performed under TPF-5(189). The remainder of the report is structured into four Appendices (A, B, C, and D). The summary provided in the report refers the reader to appropriate parts within the Appendices for detailed explanations and analysis. Appendix A covers development of the angles-with-plate repair, Appendix B covers the multiple FRP repairs developed, Appendix C covers the PICK technology developed and Appendix D covers the analytical investigations regarding skewed steel bridge systems. The four appendices represent an edited and abridged collection of work originating from student theses and paper manuscripts created under TPF-5(189), and are intended as stand-alone documents, but are richer in the context of the other sections within that particular appendix.

Project Results

While a number of retrofit techniques exist for repairing distortion-induced fatigue cracking, many of them require partial or full bridge closure to perform the repair. The retrofits developed under TPF-5(189) are intended to be able to be installed with minimal disturbance to traffic. Four primary subject matters are reported on within this document: (1) the development of the "angles-with-plate" distortion-induced fatigue repair; (2) development of fiber reinforced polymer (FRP) repairs for distortion-induced fatigue and in-plane fatigue; (3) development of Piezoelectric Induced Compressive Kinetics (PICK) technology for treatment of crack-arrest holes; and (4) a series of analytical investigations aimed at better understanding distortion-induced fatigue susceptibility of skewed bridge systems.

Project Information

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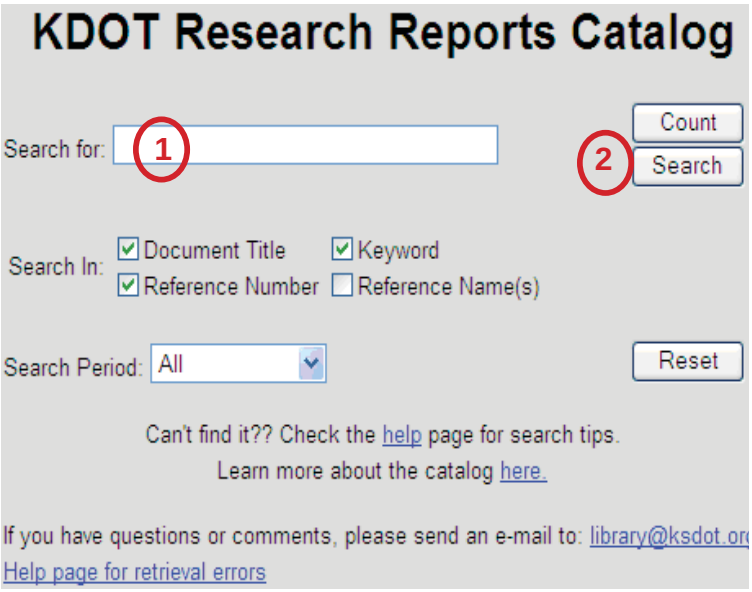

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