Oct. 31, 2008 Progress Report on Pooled Fund Study #1168 at the University of Kansas

Introduction

Pooled Fund Study number 1168, "Enhancement of Welded Steel Bridge Girders Susceptible to Distortion-Induced Fatigue" is now official. Dick McReynolds, Director of Research for the State of Kansas recently signed the contract with the Federal Highway Administration. Each of you is either a member of a state that has already agreed to sponsor this work or are a representative of one of the few remaining states that we hope will sign up to sponsor this work.

Although this is the start of the Pooled Fund Study, research at the University of Kansas has been ongoing for several years in the field of improvement of fatigue behavior of steel bridges. Recently, our research has focused on retrofit procedures to increase the fatigue life of details in existing steel bridges.

Background Work Sponsored By the State of Kansas and the Transportation Research Institute (TRI) of the University of Kansas

In addition to work for the State of Kansas on specific details and specific bridges, (Roddis and Zhao, 2001, Roddis and Zhao, 2003) we have had several projects that have led to the development of retrofit techniques that will be used on the Pooled Fund Study. These are listed as follows:

1) Fatigue tests of reinforced polymer fiber overlays to enhance the fatigue life of category E' details
2) Finite element analysis to analytically verify the experimental fatigue results
3) Development of a spray-on chopped fiber reinforced plastics technique to improve the fatigue behavior of a variety of structural details in the field
4) Development of a tool that will ultrasonically treat the inside of holes to enhance fatigue behavior of holes drilled at tips of fatigue cracks
5) Two-dimensional laboratory fatigue tests of both of these procedures to verify that there is indeed an increase in the fatigue life due to using these techniques

The above work is progressing well and a number of technical papers describing these activities have been published and are listed as follows:

1) Kaan, B., Barrett, R., Bennett, C., Matamoros, A., and Rolfe, S.," Fatigue Enhancements of Welded Cover Plates Using Carbon-Fiber Composites", 2008 SEI/ASCE Structures Congress, Vancouver, Canada, April 2008.

2) Vilhauer, B., Bennett, C., Matamoros, A., and Rolfe, S. (2007) "Fatigue Behavior of Welded Connections Enhanced with UIT and Bolting," Final Report to the Kansas Department of Transportation, Project KTRAN, KU-07-1, March 2008.

3) Anderson, B., Rolfe, S., Matamoros, A., Bennett, C., and Bonnetti, S., "Post Retrofit Analysis of the Tuttle Creek Bridge Br. No. 16-81-2.24", Structural Engineering and Engineering Materials SM Report No. 88, January 2007.

4) Marshall, N., Ramirez, G., Roddis, K., Rolfe., and Matamoros, A., "Field Instrumentation and Analysis of the Tuttle Creek Bridge BR. No. 16-81-24," SM Report No. 79, University of Kansas Center for Research, Inc., Lawrence, Kansas, April 2005.

The remainder of this progress report will focus on those activities directly related to the Pooled Fund Study which you are supporting.

Pooled Fund Study Activities

1) The three-dimensional test frame to be constructed in our Structural Testing Laboratory has been designed and fabrication drawings prepared for erection.

2) The large-capacity actuator needed to load the three dimensional bridge test specimens has been ordered.

3) Design of the test specimens is in progress. There will be three parallel girders with only the center girder subjected to three-point bending. Thus, the lateral connections between the center girder and the two outside girders will be subjected to out of plane bending. The two lateral connections at the load point will have four details as noted in Figure 1. Note also that there will be eight additional details which will be tested at the same time but at a lower stress range. Also, the connections may be staggered to study the effects of skewed supports, effectively doubling the number of connection details that can be evaluated at one time.

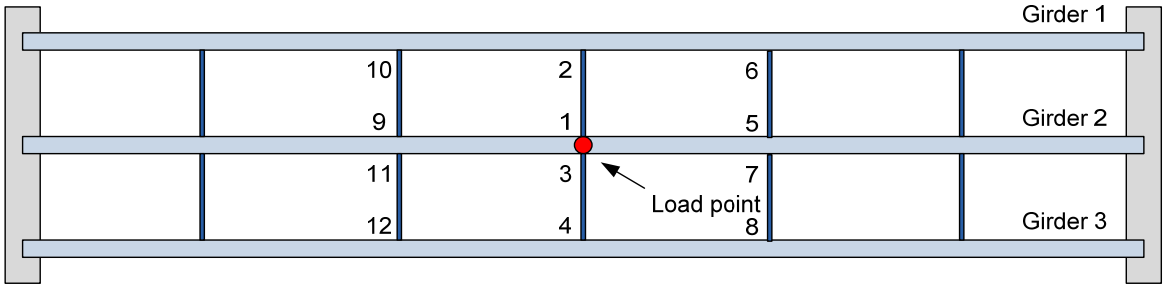

Figure 1: Test bridge layout

4) On the basis of a research project performed at the University of Minnesota, (Lindberg and Schultz, 2007), several details initially will be considered for testing. The details were selected because they were identified as the most commonly observed by the bridge engineers who responded to the survey. A literature review is being conducted to identify previous studies on the behavior and repair of these details. These details are being reviewed and drawings will be forwarded

to each of you in the near future for your comment and review. We hope to get your input as to what details are of the most concern to you, our sponsors, and therefore, identify details that should be studied as part of this research program.

After a group of connection details have been identified, each detail will be tested until a fatigue crack develops. The detail will then be retrofitted with the techniques being developed. Fatigue loading will then be continued to determine the increase in fatigue life attributable to the retrofits.

The overall focus of this research will be the development and verification of practical retrofit procedures that can be used in the field to extend the life of existing steel bridges.

Additional References:

A) Lindberg, A., and Schultz, A., “Incorporation of Fatigue Detail Classification on Steel Bridges into the Minnesota Department of Transportation,” Report MN/RC-2007-22, Minnesota Department of Transportation, June 2007.
B) Roddis, K. and Zhao, Y. (2001). “Out-of-plane fatigue cracking in welded steel bridges,” *Welding Innovations*, 27(2), 2-7.
C) Roddis, K. and Zhao, Y. (2003). “Finite-element analysis of steel bridge distortion-induced fatigue,” *Journal of Bridge Engineering*, 8(5), 259-266.