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RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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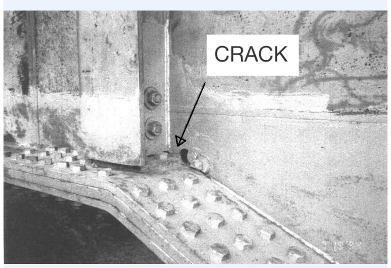
PROJECT COST:
$35,630



Haunch insert cracking on the Lexington Avenue Bridge is one of the 18 fatigue-critical details that will be represented in Pontis.

Putting Research into Practice: Implementing a Fatigue Detail Classification Scheme for Mn/DOT's Steel Bridges

What Was the Need?

Many steel bridges throughout the country, particularly those constructed before the 1990s, are approaching an age when fatigue life of certain details will be reached, making these bridges vulnerable to fatigue and fracture problems.

Current data used by the Mn/DOT Bridge Office to recommend bridge repair or replacement does not indicate which steel bridges have a high potential for fatigue problems. As a result, Mn/DOT cannot be proactive and recommend the necessary maintenance actions to prevent problems from occurring. Instead, repairs are made to fix damage.

Mn/DOT needs a cost-effective method to obtain additional information about its steel bridges that will provide for an accurate inventory of fatigue details. Understanding how fatigue details affect overall bridge inventory life will help Mn/DOT improve the accuracy of repair recommendations, focus inspection efforts and estimate future spending.

What Was Our Goal?

The goal of this project was to maximize the value of previous research by implementing a scheme that ranks steel bridges based on the frequency and severity of the most common fracture and fatigue-sensitive details that are present in each bridge. The gross ranking of bridges with high, medium or low need for preventive maintenance or special inspection will be used by bridge inspectors and those responsible for managing Minnesota's steel bridge inventory.

What Did We Implement?

Mn/DOT leveraged two important resources for this project:

- "Incorporation of Fatigue Detail Classification of Steel Bridges into the Minnesota Department of Transportation Database" (2007-22), which provided a classification scheme for ranking the fatigue and fracture susceptibility of steel bridges in the Mn/DOT inventory.
- The Pontis Bridge Management System. Developed under a Federal Highway Administration contract, Mn/DOT has used Pontis since 1994 to store information about the condition of structural elements such as beams, pier columns and decks.

How Did We Do It?

Work began on the project with a review of the more than 1,000 steel bridges in Minnesota's trunk highway system. For each steel bridge, bridge plans and inspection reports were examined to determine if any of the 18 commonly occurring fatigue/fracture-prone details identified in the 2007 research project (which include cover plates that terminate in tension flanges, and intermittent and tack welds) were present.

Data about material properties and detail geometry of the 18 fatigue details were entered into an Excel spreadsheet-based program. Additional details about each bridge were also documented, such as the paint system, bridge steel, girder depth, number of beams, railing toggles and the bridge plan's specification year.

continued

DETAIL NAME	INPUT	INPUT TYPE	WORST CASE	RANK NO.
Transverse Stiffener Web Gap		(Y/blank)	Y	0
Gap flange		(top/bot)	top	
Bridge span skew		(deg)	_	
Span length containing web gap		(ft)	_	
Web gap height		(in)	_	
Girder web thickness		(in)	_	
Insufficient Cope Radius	Y	(Y/blank)	Y	2
Is there a cope radius specified?	N	(Y/N)	N	
Cope radius (0 if none)	0	(in)	_	
Partial Length Cover Plate	Y	(Y/blank)	Y	3
Girder flange thickness	1.570	(in)	_	
Girder flange width	16.595	(in)	_	
Is the end tapered	Y	(Y/N)	N	
Cover plate width	13	(in)	_	
Is there a weld across end of cover plate	Y	(Y/N)	N	
Shelf Plate Welded to Girder Web		(Y/blank)	Y	0
Weld termination and cope distances within Detail B41 allowable dim.		(Y/N)	N	
Is any plate intersected or coped around shelf plate		(Y/N)	Y	
Length of shelf plate		(in)	_	
Thickness of shelf plate		(in)	_	
Shelf plate transition radius		(in)	_	
Stringer or Truss Floor-beam Bracket		(Y/blank)	Y	0
Floor beam connected to stringer		(Y/N)	Y	

This spreadsheet reflects the results of an Excel-based program that uses data about a bridge's fatigue-critical details to calculate detail-specific rank numbers from 0 to 4 and a composite rank number that indicates the overall fracture sensitivity of a bridge.

What Was the Impact?

The Excel program's formulas rank each of the 18 fatigue details with a number from 0 (no history of cracking) to 4 (high danger of fracture without warning). The program also computes a composite rank number for each steel bridge in the Mn/DOT inventory as the sum of the rank numbers for the most severe of each detail type, with possible composite rankings ranging from 0 to 54. A higher composite rank number indicates a more fracture-sensitive bridge.

Output of the Excel program takes two forms: a spreadsheet that presents the rank score of each fatigue detail and the composite rank of the bridge; and a single, comma-delimited line of information for each bridge that can be easily transferred to a database as a text file.

The program makes information easy to gather and access. A blank copy of the program interface can be printed and used as a questionnaire by staff examining bridge plans or performing a field inspection to record data about fatigue details that can then be entered into the ranking program. The spreadsheet generated by the ranking program makes it easy to quickly identify the detail with the most severe problems for each bridge.

Mn/DOT anticipates many uses for the new data. The rank numbers can be used to assess the scope of individual bridge preservation projects and identify bridges most likely to fatigue, and identify details requiring special attention during inspection. Costs can be cut by using a single contract that incorporates the repair of fatigue-susceptible components with general maintenance such as deck repair. Bridge engineers can also quickly gauge the effects of certain load configurations and identify bridges that would require replacement in the event of weight increases.

What's Next?

The fatigue-critical rank data and other bridge details documented by this project are expected to be uploaded and stored in Pontis by summer 2009.

This Technical Summary pertains to the implementation project MPR-6(036), "Implementation of Steel Bridge Maintenance Planning," completed December 2008. For more information about this project, contact Jim Pierce at james.pierce@dot.state.mn.us.

The research being implemented via this project can be found in Report 2007-22, "Incorporation of Fatigue Detail Classification of Steel Bridges into the Minnesota Department of Transportation Database," published June 2007. The full report can be accessed at http://www.lrrb.org/PDF/200722.pdf.

"This conceptually simple idea—gathering and classifying data from bridge plans and inspection records—means that important information will be readily available to help Mn/DOT manage its steel bridge inventory."

–Jim Pierce,
Mn/DOT Bridge Management Engineer

"Bridge managers can organize bridges by vulnerability using the composite rank numbers that represent overall bridge susceptibility to fatigue and fracture based on the details the bridge possesses."

–Arturo Schultz,
Professor, University of Minnesota Department of Civil Engineering

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