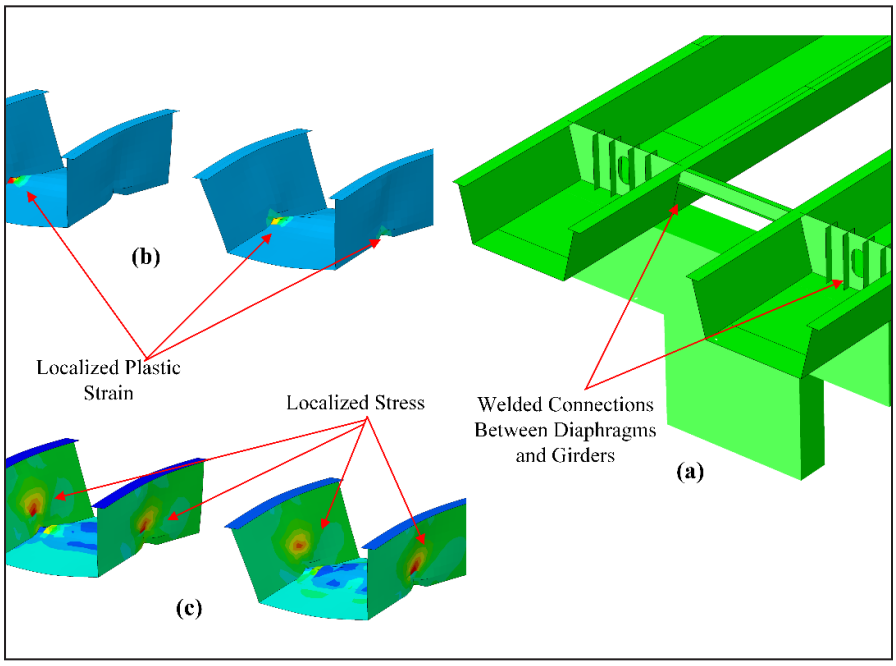
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 18-368 (project 382) | September 2018

Seismic Behavior of Steel Bridges with Fatigue-Prone Details



the ISSUE

Steel bridges are vulnerable to earthquake ground motions. On question that is unanswered is, what role does fatigue cracking play in the seismic performance of bridges? This is an important question because many steel bridges, particularly those built before 1970, have shown signs of excessive deterioration and fatigue cracking.

the RESEARCH

In this study, detailed finite elements models of a twin-tub girder bridge with fatigue-prone detail was developed. The bridge was assumed to be located in Denver, CO, and subjected to light daily traffic. The model was then utilized to evaluate the low-cycle fatigue behavior of the bridge when subjected to a suite of ground motions in the presence and absence of a fatigue crack. The Coffin-Manson approach was utilized to evaluate the low-cycle fatigue behavior and calculate the total number of cycles to reach failure. The calculated number of cycles to failure where then compared to the total number of cycles the bridge was subjected to during the a given earthquake, which was determined using rainflow counting analysis.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

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Project Title

Seismic Behavior of Steel Bridges with Fatigue-Prone Details

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the **FINDINGS**

The following conclusions can be drawn:

Model without a crack

- The global displacement in the bridge, from all earthquakes, ranged between 1 in and 17 in.
- Normal stresses at piers from all earthquakes ranged between 40 ksi and 60 ksi.
- EQ#5 and EQ#6 resulted in the maximum demand on the bridge as manifested by high stress ranges.
- Seismic loadings caused low-cycle fatigue failure in the bridge.

Model with crack

- Local plastic strain around the crack tip was very minimal, suggesting relief in strain in the presence of a crack.
- The presence of a crack resulted in more flexibility in the bridge model which caused minor reduction in global displacement of about 1%.
- The model with crack showed small values of plastic strain and very high values of stress around the crack tips.

the **IMPACT**

These results highlight the importance of detailed assessment of the superstructures for bridges in moderate to high seismic regions.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=944

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.

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