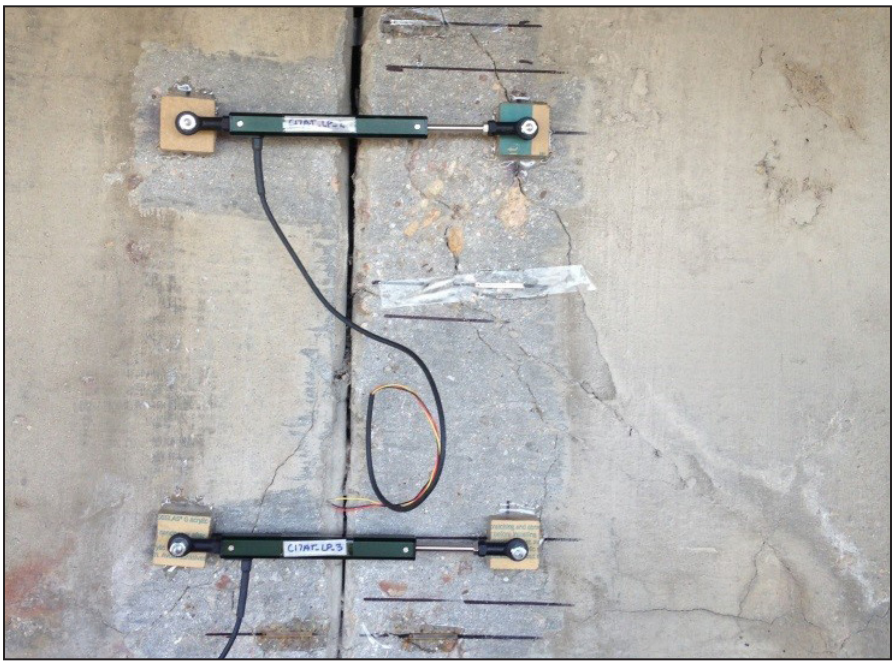
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 18-366 (project 484) | August 2018

Effect of Service Temperature on Joint Removal in Steel Bridges



the ISSUE

Bridge expansion joints are a particularly troublesome component of bridges and many departments of transportation (DOTs) are looking for a solution to deteriorating expansion joints on highway bridges. Bridge expansion joints create a break in the structural continuity of a bridge, allowing clogging gravels and corroding chlorides to enter.

the RESEARCH

The overall goal of this study is to increase understanding of thermal loading and movement exhibited by bridges in Colorado and to provide recommendations for the elimination of deck joints in existing bridges. An extensive literature review was conducted to gain an understanding of the current research that has been completed in this field of study. Moreover, a steel plate girder bridge and a reinforced concrete bridge in Colorado were selected for field instrumentation, load testing, and long-term monitoring. In addition, a three-dimensional finite element model of this bridge was developed using shell elements in CSi Bridge. The selected bridges were instrumented with thermocouples, linear potentiometers, strain gauges, and a scratch gauge. Following, field instrumentation, load testing, and validation of the numerical models, a parametric study was performed to examine the effects of different connection types at the joint, different thermal gradients, and the effect of clogged joints. To conduct a life-cycle cost analysis to compare joint maintenance options and expand knowledge of thermal gradient effects on expansion joints in existing bridges, several tasks were conducted for the completion of this study. First, an extensive literature review was conducted. From this literature review, general LCC equations were generated for existing bridges with expansion joints and for retrofitting bridges to remove joints. The LCCA was performed using MATLAB as the main coding tool and data from CDOT, LIFE 365, and the CSiBridge models.

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Utah State University
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Project Title

Effect of Service Temperature on Joint Removal in Steel Bridges

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the **FINDINGS**

The daily temperature changes, thermal gradients, and overall shifts in temperature due to changing seasons have a significant effect on bridge expansion joints in Colorado. The potential for 0.01 inch of movement and 0.5 kilopound per square inch stress increase on concrete bridges consistently and 0.5 inch movement and 5 kilopound per square inch stress on steel bridges regularly is not negligible. Additionally, there are clear differences between the AASHTO temperature gradient and what was observed in this study. Finally, the LCCA concluded that a semi-integral bridge design, which retrofits the interior expansion joints of an existing bridge would provide the most cost-effective design by decreasing joint replacement costs and pier cap corrosion. Further research could expand on this LCCA by examining environmental impacts and costs to users due to deteriorated expansion joints.

the **IMPACT**

If findings of this study, including the use of semi-integral bridge designs for retrofitting interior expansion joints of existing bridges, were implemented they could result in substantial cost savings to DOTs, other transportation agencies and ultimately to tax payers.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=948

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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