

Research Summary

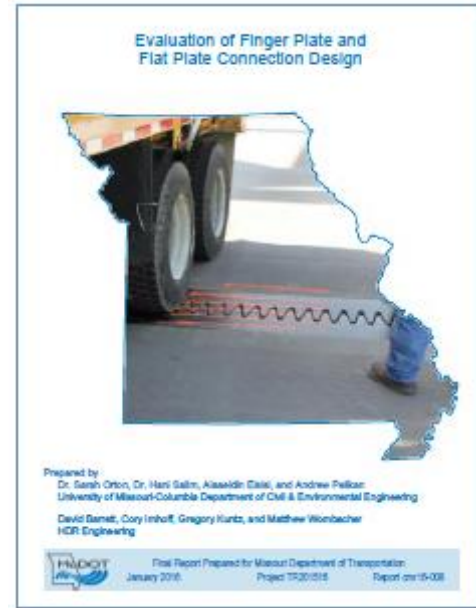
Evaluation of Finger Plate and Flat Plate Connection Design

The objective of this project was to learn the causes of premature deterioration of MoDOT finger plate and flat plate expansion devices under high traffic volumes and then use that information to design new Load and Resistance Factor Design (LRFD) finger plate and flat plate expansion devices that are intended to last 40 years or more with minimal maintenance. In addition, repair and retrofit best practices and details were developed as part of this project.

To fully evaluate the expansion devices, a literature review and survey of current expansion devices used by transportation departments across the United States was conducted. The failure of the finger plate expansion devices was attributed primarily to fatigue failure of the weld between the finger plate and the support beam beneath it as well as vertical misalignment due to poor construction.

The flat plate expansion device performed inadequately if the bridge span experienced rotation which caused a gap between the sliding flat plate and the support angle or if construction of the device was deficient.

Experimental testing was conducted on the finger plate device on Eastbound Blanchette Bridge on Highway I-70 in St. Louis and on the flat plate expansion device on Route 350 passing over Highway I-435 in Kansas City.



The test results showed that dynamic impact in the finger plate device was generally between 40% and 70% and could be as much as 160%. The effect of misalignment of the fingers can result in an increase in stress of up to 30%. The results were used to validate Finite Element Models (FEMs) of the current expansion device designs.

The FEM models showed high stresses in the weld between the finger plate and support beam which concentrated over the stiffener location. Testing of the flat plate device showed that significant stresses build in the sliding plate due to the differential movements of the abutment and bridge span. Misalignment at time of construction is a likely cause of additional stress in the flat plate devices.

The new robust finger plate expansion device was designed and evaluated with the FEM models. The new finger plate expansion device is intended for use on high volume or important routes as an alternate to Modular Expansion Device Systems and the current standard finger plate design. In addition, improvements for the existing finger plate expansion device design are



Testing of the flat plate device revealed significant stresses build in the sliding plate due to the differential movements of the abutment and bridge span.

recommended for use on less important routes with lower traffic volumes. The existing flat plate expansion device designs were modified to include adjustability of the device prior to concrete placement. Repair and retrofit best practices and details that can be implemented without concrete deck removal were developed for existing expansion devices. The new designs accommodate a wide variety of superstructure sizes, configurations, from 4 to 16 inches of movement, and from 0 to 60 degree skews when used with steel girders. New finger plate expansion devices and existing finger plate expansion device modifications were developed using infinite fatigue life criteria to exceed a design life of 40 years.



Fractured support weld on finger plate expansion device

Project Information

PROJECT NAME: Evaluation of Finger Plate and Flat Plate Connection Design

PROJECT START/END DATE: October 2014 through December 2015

PROJECT COST: \$297,289

LEAD CONTRACTOR: University of Missouri-Columbia

PRINCIPAL INVESTIGATORS: Dr. Sarah Orton

REPORT NUMBER: [cmr 16-008](#)

REPORT DATE: January 2016

Project Manager

JEN HARPER, P.E. PMP

Research Engineer
Missouri Dept. of Transportation
Construction and Materials
Research Section
1617 Missouri Blvd
Jefferson City, MO 65109
Ph. (573) 526-3636
Email Jennifer.Harper@modot.mo.gov

