Joint Transportation Research Program

Principal Investigator: Ashley P. Thrall, University of Notre Dame, athrall@nd.edu, 574.631.2533

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

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Assessment of Bridges Subjected to Vehicular Collision

Introduction

Vehicles often collide with bridges. However, there are no available guidelines for bridge inspectors to assess damage and make repair decisions. This project addresses this gap by investigating the behavior of steel girder bridges subjected to vehicular collision through (1) performing non-destructive field testing, (2) developing validated numerical models, and (3) performing parametric investigations to extend research findings. Field testing was performed using digital image correlation (DIC)—a portable, non-destructive photographic measurement technique. The focus was on two- and three-span continuous multi-girder steel bridges in which an exterior girder had sustained Category T damage (i.e., torsion about the longitudinal direction). This project can benefit the Indiana Department of Transportation (INDOT) by potentially reducing the number of repairs, leading to cost savings and longer lifespans for bridges.

Findings

- DIC is a powerful monitoring technique that can provide full-field measurements to understand system behavior and capture strain gradients.
- Pressure-activated adhesive tape (with a 10-year or more durability) has been qualified as a DIC pattern strategy to monitor strains in coated steel bridges. This approach can be implemented more rapidly than conventional approaches to reduce the required time for lane closures, leading to cost savings and safety benefits. This has enabled the successful use of DIC in field monitoring for this project.
- DIC, combined with finite element numerical modeling, can provide a better understanding of bridge behavior.
- The measured strains in all girders, subjected to quasi-static dump truck loads, are small (less than 0.022%), demonstrating conservatism in design.
- Loads are generally redistributed away from damaged girders to adjacent girders and rail. This is an area for future research.
- Vehicular collision may damage the shear connectivity between the deck and the damaged girder in composite bridges.
- Cracked or damaged railings may cause positive moment (i.e., tension in the bottom flange) redistribution, resulting in higher strains in damaged girders.
- Damage at the center of a span with a large web rotation angle results in the greatest loss of stiffness compared to other locations and smaller rotation angles.
- Load redistribution in multi-girder bridges and continuity generally reduce safety issues for Category T damage to exterior girders from vehicular collision. However, bridge inspectors must evaluate the potential for this load redistribution when assessing the safety of damaged bridges.

Implementation

This research culminated in *Recommendations for Bridge Inspectors for Evaluating Steel Girder Bridges Subjected to Vehicular Damage* (see Appendix to report). This will be made available on the INDOT website and will be considered in the upcoming rewrite of the *Indiana Bridge Inspection Manual*. Findings and recommendations were presented at the INDOT Bridge Inspector Workshop on February 13, 2019 (presentation will be available online for one year), the 2019 Purdue Road School, and the INDOT/Joint Transportation Research Program Poster Session on February 13, 2019. To further investigate rail participation, a new project, *Evaluating Reserve Strength of Girder Bridges due to Bridge Rail Load Shedding* (SPR-4311), has been awarded (beginning January 2019).

Examples of damage

Recommended Citation for Report

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