Bridge Rail and Approach Railing for Low-Volume Roads In Iowa

tech transfer summary

Guidelines for bridge rail and approach guardrails can help improve the safety benefits of these devices while minimzing costs.

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Center for Transportation Research and Education

BRIDGE ENGINEERING CENTER

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RESEARCH PROJECT TITLE
Bridge Rail and Approach Railing for Low-Volume Roads In Iowa

SPONSORS
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The Bridge Engineering Center (BEC) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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Objective

The primary objective of the research summarized below was to describe the state of the practice regarding the nation's bridge rails and approach guardrails and to perform a statewide crash analysis involving bridge rails and approach guardrails on Iowa's low-volume road (LVR) bridges.

Problem Statement

Bridge rail and approach guardrails provide safety to drivers by shielding hazardous roadside objects and redirecting vehicles to the roadway. However, guardrails can increase a bridge's initial and maintenance costs while adding another object that vehicles may strike. Additionally, the use and type of rail systems on non-national highway systems—which include LVRs—is left to state or county discretion.

LVR concrete bridge with timber and metal bridge rails and damaged signing

Research Description

To synthesize bridge rail and approach guardrail information for Iowa's LVR bridges, this project included

- A literature review of bridge and approach rail usage and guidance
- A survey of state and county agencies regarding how agencies determine bridge rail and approach rail usage criteria for LVRs
- A system-wide crash analysis for Iowa's LVR bridges to quantify crash-related metrics
- Statistical analyses to identify relationships between crash metrics such as rail usage, rail condition, roadway geometry, bridge geometry
- A review of economical and aesthetically pleasing railing alternatives

Findings

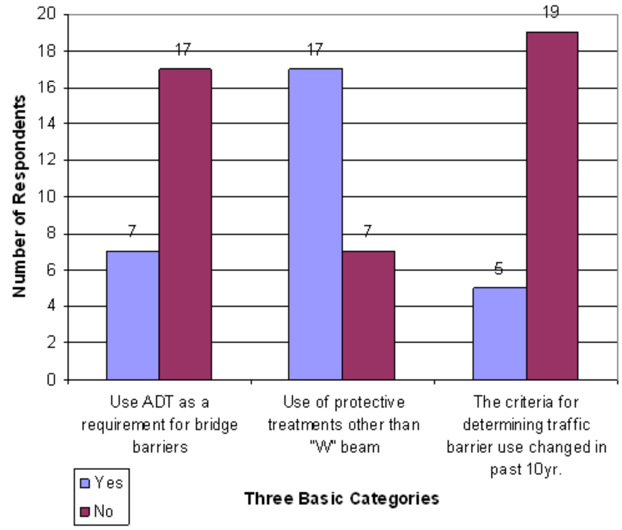
- The Federal Highway Administration advises that adding a continuous section of standard guardrail in front of, and attached to, an existing bridge is the most economical way to upgrade a substandard bridge rail. The retrofitted bridge rails should be assessed to ensure structural and functional adequacy.
- The statewide crash analysis indicated that LVR bridge crashes are fairly rare events: the overall number of crashes at Iowa's 17,000+ inventoried (and unknown number of non-inventoried) LVR bridges is under 350 crashes over eight years. This is less than 0.1% of the statewide reported crashes.
- The majority of the 350 LVR bridge crashes occurred on bridges with traffic volumes less than 100 vehicles per day (vpd) and widths less than 24 feet. The majority of LVR bridges have similar characteristics.
- Crash rates were highest for bridges with lower traffic volumes, narrower widths, and negative relative bridge widths (i.e., bridge width minus roadway width). Bridge length did not appear to affect crash rate. Statistical analysis confirmed that vehicle crash frequency was higher on bridges with lower widths compared to roadway widths.
- Weather conditions did not appear to impact crash frequency, but crashes may be over-represented at night or in dark conditions. Statistical analysis indicated that crashes on dark roadways were more likely to result in major injuries or fatalities.
- Benefit-cost (B/C) analyses yielded very low B/C ratios for statewide bridge rail improvements. This finding is consistent with the recommendation in Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400) that safety improvements should only be initiated when a safety problem exists at a site.

Recommendations

- In general, each bridge and its crash history should be evaluated independently for bridge rail improvements.
- The findings of the crash frequency and severity analyses may highlight the importance of appropriate delineation and signing. Future research into bridge delineation and signing are recommended to better understand their potential benefits for Iowa's LVR bridges.

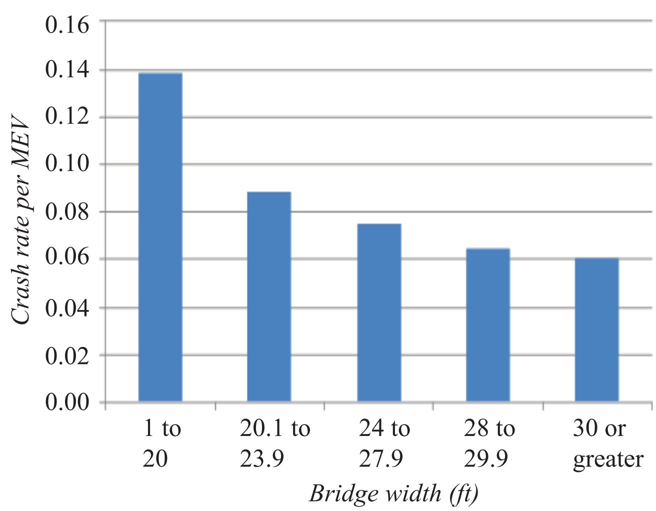
Implementation Benefits

Iowa's 17,000+ inventoried LVR bridges and unknown number of non-inventoried LVR bridges can benefit from an understanding of how various agencies apply guardrail policy, potential safety impacts including benefits and costs, and current state of practice for guard rail systems.



Responses of 24 county bridge owners (outside Iowa) to questions about their agencies' bridge rail criteria

LVR concrete bridge in Iowa with continuous guardrail, not included in the state inventory



Crash rate versus bridge width for the LVR crash data; note that crash rate decreases as bridge width increases