U.S. Department of Transportation
Federal Highway Administration

TECHBRIEF: BRIDGE CURB/RAILING AND APPROACH TREATMENT FOR EXTREMELY LOW-VOLUME ROADS

BACKGROUND

Bridges cross over a variety of features ranging from drainage ditches to deep valleys and serve a variety of functions. There are several competing considerations when evaluating bridge railings: the risk of injury and death for vehicle drivers and occupants, the structural integrity of the bridge itself, and the service provided to the principal users of the bridge.

The United States Bureau of Reclamation (USBR) is a Federal Land Management Agency (FLMA) responsible for 315 bridges within the National Bridge Inventory (NBI). The USBR inventory is dominated by low-speed and low-volume bridges. The Federal Lands Transportation Program (FLTP) was established in 23 U.S.C. 203 to improve the transportation infrastructure owned and maintained by FLMAs.

There has been interest for several decades in developing selection guidance for the multiple performance, service, or test levels of bridge rails. The recent completion of the National Cooperative Highway Research Program (NCHRP) 22-12(03) (*Recommended Guidelines for the Selection of Test Levels 2 through 5 Bridge Rails*) provided this guidance, but did not address extremely low-volume roads nor low-speed roads.[1] FHWA, in collaboration with USBR, conducted a study to address this gap and create a guide for bridge rails and approach treatments for extremely low-volume, and low-speed roads. This tech brief summarizes the research and information used to develop the *Guide for Bridge Curb/Rail and Approach Treatment for Extremely Low Volume Roads* (the Guide).[2] The project also produced a research report that documents the entire effort: *Bridge Curb/Railing and Approach Treatment for Extremely Low Volume Roads*.[3]

EVALUATION OF EXISTING HARDWARE

The research team compiled existing guidance for bridge rail design on low-and very low-volume roads. There is variety in how States address bridge rail and approach treatments on low-volume roads. (See references 2 through 10). Guidance for extremely low volumes (i.e., less than 50 vpd) and low-speed roads is limited. One observation that is repeated throughout the literature review is that upgrading bridge rails on bridges servicing low-volume roads is generally not cost-beneficial. Conversely, however, there are crash risks associated with these bridges that must be balanced with the costs of improvements to these bridges.

NEW HARDWARE DEVELOPED

The research team modified the MASH TL-1 low profile WVBR for installation on a lower strength bridge structure (e.g., 4x12 wood plank bridge deck), and assessed the crash performance under MASH TL-1 conditions using finite element analysis (FEA).[11] The research team then developed three alternative mount designs that met performance criteria in MASH for

TL-1 impact conditions and successfully contained and redirected the pickup with minimal damage to the system.

The research team also performed supplemental evaluations to determine the performance threshold for a 12-inch-tall timber railing regarding successful containment and redirection of a 5,000-lb pickup. Although these lower profile railings do not meet MASH TL-1, a Technical Advisory Committee expressed interest in the limits for impact conditions at which these low-profile barriers will successfully contain and redirect the 2200P vehicle (i.e., 5,000-lb quad-cab pickup). The only safety metric of concern was the tendency for the vehicle to override the barrier, which may be useful for bridge owners in assessing "risk" for bridge design options (e.g., to widen bridge or not) for these low-profile railing/curbs which are used on many narrow, single-lane bridges to support farming and logging industry.

CONCLUSION

The research team concluded that the 12-inch-tall curb/railing would successfully contain and redirect the 5,000-lb pickup at impact speeds of 20 mph when the impact angle was equal to 15 degrees. The research team analyzed various combinations of angles and impact speeds and concluded that impact severity does not appear to correlate well with the pass/fail conditions for the low-profile barrier. Success or failure was predominately determined by the tendency for the tire to climb the barrier during impact, which occurred more prevalently at impact angles greater than 15 degrees due to the tire tread having more contact with the railing.

The research team used the research results to develop the *Guide for Bridge Curb/Rail and Approach Treatment for Extremely Low Volume Roads (Guide)*.[(2)] The Guide leads inspectors and engineers to practical, low-cost solutions based on the characteristics of the bridge, anticipated traffic, and the intended use of the bridge. The Guide also assists in determining if the existing bridge rails, associated roadside hardware, and other conditions can be left as-is; if improvements should be considered to achieve the safety performance goal; and, potential solutions that might be implemented to achieve the safety performance goal.

The Guide follows inspectors and engineers with a two-part decision matrix. First, inspector and engineers inspect and evaluate the existing conditions at the bridge site and second, consider possible improvements to the bridge rails and approach hardware. The Guide also provides specific guidance for a variety of bridge rail mounting configurations, a form to characterize terminals and/or transitions, and worksheets to document bridge deck features, roadway features, and the presence of delineation.

REFERENCES

1. Ray, M., et al., *Developing Selection Tables for Bridge Railing*. 2013: researchgate.net.

2. Carrigan, C. and Plaxico, C. (2022). *Bridge Curb/Railing and Approach Treatment for Extremely Low-Volume Roads: Final Report*, Report No. FHWA-FLH-23-003b, Federal Highway Administration, Washington, DC.

3. Carrigan, C. and Plaxico, C. (2022). *Guide for Bridge Curb/Rail and Approach Treatment for Extremely Low Volume Roads.* Guide No. FHWA-FLH-23-003a, Federal Highway Administration, Washington, DC.

4. IDOT, *Bureau of Local Roads and Streets Manual, in Chapter 35, Roadside Safety*. 2007.

5. IowaDOT. *Instructional Memorandum 3.213 Traffic Barriers (Guardrail and Bridge Rail)*. 2013 07/18/2013 [cited 2020 09/21/2020]; Available from: https://iowadot.gov/local_systems/publications/im/rev_2013-02.pdf

6. IowaDOT. *Instructional Memorandum 3.230 Traffic Barriers (Guardrail and Bridge Barrier Rail)*. 2018 04/24/2018 [cited 2020 09/21/2020]; Available from: https://www.iowadot.gov/local_systems/publications/im/3230.pdf

7. Seitz, R.J., et al., *Guardrail and Bridge Rail Recommendations for Very Low-Volume Local Roads in Kansas*. 2014. p. 166.

8. Seitz, R.J., T. Salfrank, and T. Kansas Department of, *Guardrail and Bridge Rail Recommendations for Very Low-Volume Local Roads in Kansas: Addendum to Include Bridges Up to 100 Feet Long and Traffic Volume Up to 100 Vehicles Per Day*. 2017. p. 158.

9. MoDOT and E.P.G. contributors. 606.1 Guardrail. 2019 07/22/2019; Available from: https://epg.modot.org/index.php?title=606.1_Guardrail&oldid=45956.

10. SDDOT, *Local Roads Plan*. 2011.

11. AASHTO, *Manual for Assessing Safety Hardware*. 2016, American Association of State Highway and Transportation Officials: Washington, D.C. p. 259.

Researchers—VHB, in collaboration with RoadSafe, performed this study under contract 693JJ320F000318. Christine Carrigan and Chuck Plaxico were the lead researchers; Catherine Chestnutt was VHB's project manager and the project's communications lead. The Contracting Officer's Representative and Task Manager was Yanira Rivera of the FHWA Office of Safety Research and Development.

Distribution—This TechBrief is being distributed according to a standard distribution. Direct distribution is being made to the FHWA divisions and Resource Center.

Availability—This TechBrief may be obtained from the FHWA Product Distribution Center by email to report.center@dot.gov, fax to (814) 239-2156, phone to (814) 239-1160, or online at https://highways.dot.gov/research.

Key Words—low-volume roads, bridge rail, approach treatments.

Notice—This document is disseminated under the sponsorship of the U.S. Department of Transportation (USDOT) in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document. The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this TechBrief only because they are considered essential to the objective of the document.

Quality Assurance Statement—The Federal Highway Administration (FHWA) provides high-quality information to serve the Government, industry, and public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.